

Leveraging CSCL technology to support and research shared task perceptions
in socially shared regulation of learning

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M.A., University of Victoria, 2009

B.A.H., University of Victoria, 2003

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Abstract

Collaboration is a vital skill in today's knowledge economy. Regrettably, many learners lack the regulatory skills required for complex collaborative tasks. In particular, groups struggle to construct shared task perceptions of collaborative tasks on which to launch engagement. Thus, the purpose of this dissertation was to examine how computer supported collaborative learning (CSCL) tools can be leveraged to support shared task perceptions for regulating collaboration. Because investigating this process brings forth a wide array of methodological challenges, a second purpose of this dissertation was to explore how CSCL tools can be used as a methodological solution for capturing this process. Towards this end, research unfolded across one conceptual paper and two empirical studies: (a) Miller & Hadwin (2015a) extended work conceptualizing self-, co-, and shared-regulation in successful collaboration and drew on this theoretical framework to propose ways in which CSCL tools can be designed to support and research regulation of collaboration; (b) Miller, Malmberg, Hadwin, & Järvelä (2015) investigated the processes that contributed to and constrained groups' construction of shared task perceptions in a CSCL environment in order to inform further refinement of supports; (c) Miller & Hadwin (2015b) examined the effects of tools providing different levels of individual and

group support on construction of shared task perceptions and task performance. Together, findings revealed the potential of blending pedagogical tools to support shared task perceptions with research tools for examining and understanding regulation. In particular, findings evidenced shared task perceptions to be a complex and challenging social phenomenon and shed light on ways in which CSCL tools may prompt and promote this process. In addition, data generated by learners as they interacted with CSCL supports created valuable opportunities to capture shared task perceptions as they unfolded in the context of meaningful collaborative tasks across the individual and group level.

Table of Contents

Supervisory Committee	ii
Abstract	iii
Table of Contents	v
List of Tables	vi
List of Figures	vii
List of Original Manuscripts	viii
Acknowledgments	ix
Introduction	1
Theoretical Framework	5
Regulation of Collaborative Learning	5
Modeling Regulation of Collaboration	9
Shared Task Perceptions for Regulating Collaboration	15
Leveraging Technology to Support Shared Task Perceptions	20
Methodological Considerations	26
Researching Regulation of Collaboration as Social	26
CSCL Environments as a Methodological Solution.....	31
A Systematic Approach to Investing CSCL Tools and Shared Task Perceptions	34
Research Purpose and Overview	39
Manuscript 1: Miller M., & Hadwin, A. F. (2015a).....	40
Manuscript 2: Miller, M., Malmberg, J., Hadwin, A. F., & Järvelä, S. (2015)	41
Manuscript 3: Miller M., & Hadwin, A. F. (2015b)	43
Ethics.....	45
Discussion: Promoting and Researching Shared Task Perceptions	46
Aim 1: How can CSCL Tools be Designed to Support Shared Task Perceptions?.....	46
Aim 2: Leveraging CSCL Tools to Research Shared Task Perceptions.....	59
Future Directions	64
Conclusions.....	68
References	71
Manuscripts	89

List of Tables

Table 1. <i>Phase 1 COPES of self- and shared regulation of collaborative learning</i>	11
Table 2. <i>Methodological aspects addressed in each empirical manuscript</i>	33
Table 3. <i>Overview of the aims and methods in each manuscript</i>	38

List of Figures

<i>Figure 1.</i> Three forms of regulated learning in successful collaboration (self-regulated [SRL], co-regulated, and shared regulation of learning).....	7
<i>Figure 2.</i> Reciprocal relationship between conditions and products at the individual and group level	15
<i>Figure 3.</i> Progression of research aims across each manuscript.....	36
<i>Figure 4.</i> CSCL tools supporting regulation of collaboration in Miller et al. (2015) and Miller and Hadwin (2015b).....	50

List of Original Manuscripts

This dissertation is based on the following manuscripts referred in the text by author and year.

1. Miller, M.* & Hadwin, A. F. (2015a). Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Computers in Human Behavior*. doi:10.1016/j.chb.2015.01.050
2. Miller, M.,* Malmberg, J., Hadwin, A. F., & Järvelä, S. (2015). Examining the processes contributing to and constraining shared planning for regulating collaboration in a CSCL environment. *Manuscript in submission*.
3. Miller, M.* & Hadwin, A. F (2015b). Investigating CSCL supports for shared task perceptions in socially shared regulation of collaborative learning. *Manuscript in submission*.

Corresponding author (*) primarily responsible for study design, data analysis, and interpretations

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The whole is something over and above its parts and not just the sum of them all.

Aristotle

Introduction

The ability to work and learn with others is a critical skill for today's 21st century graduates (Premier's Technology Council of BC, 2010). Across educational and work contexts, team projects are ubiquitous with the assumption that collaboration can result in innovative knowledge products and solutions. Furthermore, as the emphasis on teamwork has increased, there has been exponential growth in development of technological tools and platforms for collaboration. These advancements have broken down the physical boundaries of teams allowing groups to work together both face to face and remotely. While research in this field has focused heavily on testing functionality and usability of technology for teamwork (Gress & Hadwin, 2010), simply placing people in online environments does not automatically result in successful collaboration or learning (Dillenbourg, 2002).

Collaboration is a complex and learner driven activity involving much more than individuals working side by side (Dillenbourg, 1999; Salomon & Globerson, 1989). It requires groups to coordinate engagement in a shared space to co-construct knowledge and shared understanding through exchanging, transforming, and integrating knowledge in productive collaborative interactions (Barron, 2003; Resnick, Levine, & Teasley, 1991; Roschelle & Teasley, 1995).

Contemporary perspectives have emphasized that achieving the purported benefits of collaboration and collaborative learning requires learners and groups to regulate their cognition, behaviour, motivation, and emotion through (a) intentionally planning by interpreting tasks and creating goals and standards, (b) strategically using tools and strategies, (c) monitoring progress and intervening if needed, and (d) persisting in the face of challenge (Hadwin, Järvelä, & Miller, 2011; Hadwin & Winne, 2012; Volet, Vauras, & Salonen, 2009). While much research indicates

successful students actively engage in self-regulated learning (SRL, Winne & Hadwin, 1998; Zimmerman, 1989), these perspectives further suggest successful collaboration depends on (a) co-regulated learning (CoRL) in which group members support and prompt one another to self-regulate their engagement in the collaborative task (Hadwin et al., 2011; Hadwin & Oshige, 2011), and (b) socially shared regulation of learning (SSRL) in which groups collectively regulate their cognition, behavior, motivations, and emotions together in a synchronized and productive manner (Hadwin et al., 2011; Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013).

Regrettably, many learners lack the regulatory skills required for complex collaborative tasks and encounter a wide array of challenges derailing their efforts to learn together (Järvelä, Järvenoja, Malmberg, & Hadwin, 2013; Kreijns, Kirschner, & Jochems, 2003; Strijbos, Kirschner, & Martens, 2004; Winne, Hadwin & Perry, 2013). In particular, the emergent research consistently indicates group members misinterpret tasks, find themselves working at cross-purposes, and report numerous strategic planning challenges that hinder their collaborative efforts (McCardle, Helm, Hadwin, Shaw, & Wild, 2011; Miller & Hadwin, 2012). Difficulties constructing shared task perceptions, or common interpretations of the task features, are particularly problematic in regards to regulating collaboration. Specifically, shared task perceptions are essential for regulating collaboration as they provide foundational metacognitive knowledge on which groups can set goals and make plans for approaching the task as well as create standard against which to monitor their progress and products (Winne et al., 2013).

Thus, post-secondary education has a responsibility to prepare students for the contemporary world beyond academia by facilitating the development of skills for regulating collaboration including skills for constructing shared task perceptions. One potential solution is offered by learning technologies themselves (Järvelä & Hadwin, 2013; Morris et al., 2010). The

past two decades have witnessed an explosion of computer supported collaborative learning (CSCL) technologies supporting collaboration (Dillenbourg, Järvelä, & Fischer, 2009; Stahl, Koschmann, & Suthers, 2006). One limitation in this research is that CSCL tools often target productive interaction or functional coordination in the aim of domain knowledge construction. To date, the capacity of these tools to facilitate shared regulation or shared task perceptions has received little attention (Hadwin, Oshige, Gress, & Winne, 2010; Järvelä & Hadwin, 2013; Kirschner & Erkens, 2013). Furthermore, while design of CSCL tools requires a great deal of knowledge about the target processes, we have limited understanding of how groups successfully negotiate shared task perceptions in order to inform design of tools that best support this process. Moreover, exploring how groups dynamically construct shared task perceptions during collaboration across the individual and group level brings forth a number of methodological challenges that require a broader set of approaches than is common in research about self-regulated learning (Hadwin et al., 2010; Perry & Winne, 2013; Volet & Vaurus, 2013).

As such, the purpose of this dissertation was to examine how CSCL tools can be leveraged to support and research shared task perceptions for regulating collaboration. Towards this end, this dissertation unfolded across three manuscripts. Manuscript 1 (Miller & Hadwin, 2015a) extended work conceptualizing self-, co-, and shared regulation in successful collaboration and drew on this theoretical framework to propose ways in which CSCL tools can be designed to support and research regulation. Manuscript 2 (Miller, Malmberg, Hadwin, & Järvelä, 2015) investigated how shared task perceptions emerged in collaborative learning situations to identify factors that contributed to and constrained this process. Manuscript 3 (Miller & Hadwin, 2015b) built on these results to examine the effects of different levels of CSCL support on shared task perceptions and performance. This dissertation is presented in two

parts. Part 1 provides an overview of the theoretical foundations and methodological orientations of the research and concludes with a discussion of the main findings, limitations, and directions for future research. Part 2 consists of three published (or submitted) manuscripts. These manuscripts comprise the empirical work conducted to examine how CSCL tools can be leveraged to support and research shared task perceptions for regulation of collaborative learning.

Theoretical Framework: Regulating Collaboration as a Quintessential 21st Century Skill

Collaboration is a complex and powerful social phenomenon in which groups engage in “coordinated, synchronous activity that results of a continued attempt to construct and maintain a shared conception of a problem” (Roschelle & Teasley, 1995, p70). Thus, collaboration can be distinguished from cooperation in which group members work alongside one another, dividing the labour and merging distributed work into a final product (Dillenbourg, 1999).

In essence, collaboration is social. Groups leverage one another’s expertise and perspectives to co-construct innovative shared knowledge products and solutions beyond what any member could accomplish alone (Johnson & Johnson, 1989; Roschelle & Teasley 1995). As such, successful collaboration requires groups to coordinate their strategic engagement in a shared space to co-construct knowledge and shared understanding through exchanging, transforming, and integrating knowledge in productive collaborative interactions (Barron, 2000; King, 1998; Resnick et al., 1991).

In this way, achieving success in collaboration is no easy feat (Barron, 2003). The research is clear that successful collaboration does not occur spontaneously and groups encounter multiple challenges interfering with and endangering group work in terms of knowledge constructed and task completion (Kreijns et al., 2003; Rummel & Spada, 2005). Ultimately, collaborative efforts too often fall short of expectations or potential (Lou, Abrami & d’Apollonia, 2001; Strijbos, et al., 2004).

Regulation of Collaborative Learning

Recent perspectives emphasize that achieving this kind of success in collaborative tasks requires learners to regulate learning (Hadwin et al., 2011; Järvelä & Hadwin, 2013; Volet et al., 2009). Regulation of learning can be defined as an intentional, goal directed, metacognitive

activity in which learners take strategic control of their actions (behavior), thinking (cognitive), and beliefs (motivation and emotions) towards completion of a task (Zimmerman & Schunk, 2011). In the context of collaborative tasks, three types of regulation are posited to be required for achieving success: (a) *self-regulated learning (SRL)* in which group members take control of their own thinking, behaviour, motivation, and emotion in the collaborative task, (b) *co-regulated learning (CoRL)* in which group members provide transitional support facilitating one another's engagement in self-regulatory processes within the task, and (c) *socially shared regulation of learning (SSRL)* in which group members work together to regulate their cognition, behaviour, motivations, and emotions together in a synchronized and productive manner (Hadwin et al., 2011; Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013). These forms of regulation arise alongside one another and work together as a basis for successful collaboration (Figure 1).

Self-regulated learning. Grounded in socio-cognitive perspectives (Zimmerman, 1989, 2008), two decades of research indicate successful learners self-regulate learning through (a) intentionally setting task goals and standards, (b) strategically adopting tools and strategies, (c) monitoring and evaluating learning and making changes when needed (Hadwin & Winne, 2001; Winne & Hadwin, 1998; Zimmerman & Schunk, 2011). In the context of collaborative tasks, group members self-regulate by taking control of their own learning and contributions in service of the joint task. Although self-regulation concerns individual and personal adaptation, taking responsibility for one's own learning is an important aspect of collaboration whether it is by contributing in a timely and productive manner or dealing with the unexpected challenges that can arise during group learning situations.

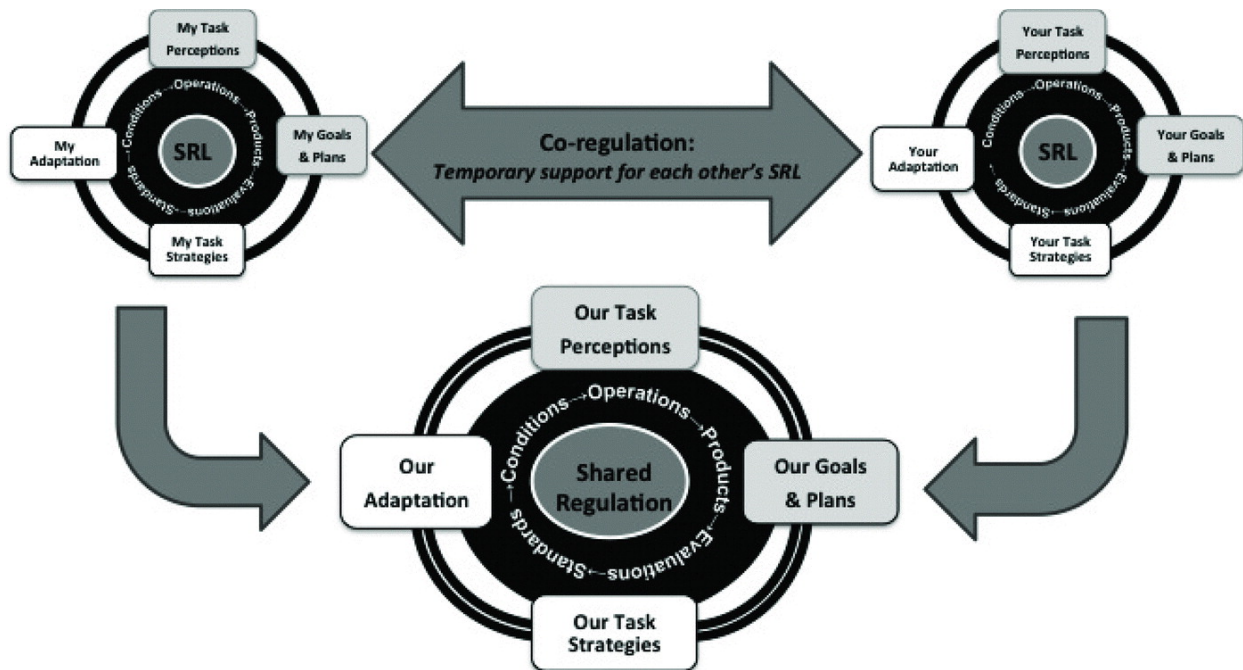


Figure 1. Three forms of regulated learning in successful collaboration (self-regulated [SRL], co-regulated, and shared regulation of learning). Source. Järvelä, S. & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL (p. 29). *Educational Psychologist*, 48(1), 25-39.

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Co-regulated learning. Co-regulated learning (CoRL) involves supporting others to engage in regulation of their own learning, often in the service of the collaborative task (Hadwin et al., 2011; Hadwin & Oshige, 2011; Volet et al., 2009). This perspective is influenced by Vygotsky's (1978) socio-cultural theory of learning, which emphasizes gradual appropriation of regulation through interpersonal interactions. CoRL occurs when individuals' regulatory activities are guided, supported, or shaped by others in the group (Hadwin et al., 2011; Hadwin & Oshige, 2011; Volet et al., 2009). In collaborative tasks, this means group members (a) become aware of one another's task perceptions, goals, strategic engagement, and progress and consider these in relation to the shared task, and (b) actively monitor and support each other's

self-regulation, such as through questioning, prompting and restating. CoRL indirectly supports teamwork because individuals in the group are temporarily supported to take personal responsibility for directing and adapting their behavior, cognition, motivation, and beliefs in ways that leverage the collective potential of the group.

Socially shared regulation of learning. A third aspect of regulating collaboration is socially shared regulation (SSRL) referred to in the remainder of this dissertation as shared regulation (Hadwin et al., 2011; Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013). Shared regulation is framed by notions of shared cognition and recent research about collaboration emphasizing that shared knowledge is co-constructed and arises through metacommunicative awareness and successful strategy coordination (Barron, 2003; Levine, Resnick, & Higgins, 1993; Roschelle & Teasley, 1995). This type of regulation involves engagement in or construction of collectively shared regulatory processes, beliefs, and knowledge (e.g. task perceptions and goals, strategies, judgments of progress or performance, motivation and drive to get the job done, and metacognitive decision making) orchestrated in the service of a co-constructed or joint outcome (Hadwin et al., 2011; Järvelä et al., 2013a; Winne, et al., 2013). Although self-regulation and co-regulation can assist group members to engage productively in joint tasks, shared regulation is essential for optimizing collaboration.

Taken together, groups are conceptualized as being social systems comprised of multiple self-regulating individuals who must at the same time regulate together as a social entity (Järvelä, Volet, & Järvenoja, 2010; Volet et al., 2009). Self-, co-, and shared regulation arise simultaneously and reciprocally over time within physical and social contexts (Hadwin et al., 2011). This complements situative views on learning. Situative perspectives consider learning as arising in activity systems in which learners interact with one another and the environment

(Greeno, 2011; Lave & Wenger, 1991). While individual cognitive constructivist perspectives have largely considered social context as an external influence, situative perspectives consider learning to be socially constructed in context (Greeno, 1997, 2006). Learning is therefore viewed *as* social with knowledge constructed in reciprocal activity between interacting minds and contextual affordances.

Modeling Regulation of Collaboration

Several models of self-regulated learning have been developed over past decades (e.g. Pintrich, 2000; Winne & Hadwin, 1998, 2008; Zimmerman, 1989, 2008). Models differ in their theoretical backgrounds and emphasize different aspects or components of regulation (Puustinen & Pulkkinen, 2001); However, they generally share a common assumption that SRL is cyclical in nature and involves a preparatory or preliminary phase, performance or task completion phase, and an appraisal or adaptation phase. In this dissertation, Winne and Hadwin's (1998, 2008) four-phase model of self-regulated learning was chosen as a framework for conceptualizing how individuals and groups regulate collaboration. In the following section, I describe how this model can provide a nuanced and detailed account of how self- and shared regulation unfold and intertwine reciprocally within the context of collaboration.

Self-regulating collaboration. Winne and Hadwin (1998, 2008) characterize self-regulated learning as unfolding over four weakly sequenced and recursively linked phases. In the first phase (*Phase 1: Task perceptions*), learners construct interpretations of the task. In the context of collaboration, the product of this phase is group members' personal interpretations of the joint task. In phase 2 (*Phase 2: Goal setting and planning*), learners draw on their perceptions of the task to set personal goals to attain during the task and make plans regarding how to strategically approach the task to reach them. In the context of collaboration, this means

individual group members set personal goals and plans for participating effectively in the joint task.

In phase 3 (*Phase 3: Task enactment*), learners engage in the task by drawing flexibly upon a range of strategies to achieve goals for the joint task. As work unfolds, learners metacognitively monitor and evaluate processes, progress, and products in each phase. For instance, individuals may check their own understanding of the task (phase 1), evaluate the utility of their goals and plans (phase 2), or assess the effectiveness of their approach and the quality of their products in relation to goals and standards (phase 3). Based on this, learners exercise metacognitive control to strategically adapt their task perceptions, goals, and engagement if needed in phase 4 (*Phase 4: Large and small scale adaptation*). This adaptation may occur on the fly to optimize collaboration in the current task (i.e. small scale adaptation) or may involve larger scale changes that make future tasks easier or better (i.e. large scale adaption).

Winne and Hadwin (1998, 2008) also suggest that a common cognitive architecture underlies the work within each phase, referred to using the acronym COPES (conditions, operations, products, evaluations, and standards). This architecture provides a detailed account of how products of each phase arise and how regulation unfolds cyclically over time in context.

The COPES architecture emphasizes that learners' choices in each phase are inextricably intertwined with dynamic internal, social, and environmental conditions. Thus, conditions are affordances and constraints that surround the work in the phase. Winne and Hadwin (1998, 2008) define conditions as being internal (e.g. beliefs, motivation, prior knowledge of domain and task, products of previous phases of regulation) or external (e.g. resources in the environment, instructional cues, time, social context). However, when considering groups as social systems

regulating collaboration across multiple levels, I suggest conditions can be re-framed in three categories (Table 1).

Table 1. *Phase 1 COPES of self- and shared regulation of collaborative learning*

	Self-Regulation of Collaboration	Shared Regulation of Collaboration
Conditions	<p>Self (me): <i>My beliefs; Knowledge of domain, learning, and task, Products of self-regulation in previous phases</i></p> <p>Group (us): <i>Our co-constructed or negotiated beliefs; Knowledge of domain, learning, and task, Products of shared regulation in previous phases</i></p> <p>Social, task, and physical surround: <i>Other group members' individual strengths, weaknesses and beliefs, distributed knowledge of the task and domain, products of others' self-regulation, instructor's written or verbal directions, CSCL supports in the environment, time</i></p>	<p>Group (us): <i>Our established norm, beliefs about the groups' strengths and weaknesses, group dynamics, products of shared regulation and domain knowledge from previous work</i></p> <p>Social, task, and physical surround: <i>Other group members' individual strengths, weaknesses and beliefs, distributed knowledge of the task and domain, products of others' self-regulation, instructor's written or verbal directions, CSCL supports in the environment, time</i></p>
Operations	Operations for individual construction <i>(e.g. Identifying, Self-questioning, elaborating, integrating, rehearsing, translating)</i>	Operations for co-construction <i>(e.g. Articulating, eliciting, integrating, extending)</i>
Products	My Task Perceptions	Our Task Perceptions
Evaluations	My judgments about task perceptions, COPES, emotions, comparisons with other sources of info	Our judgements about task perceptions in relation to our standards, COPES of the task, emotions, comparisons with other information
Standards	Grading criteria, Conditions	Grading criteria, Conditions

Self conditions consist of what the individual brings to the phase (e.g. personal beliefs, motivation, and prior knowledge of domain and task, my ability to work with others, products of my self-regulation in previous phases). *Group conditions* consist of what the group collectively brings to the task (e.g. our established beliefs about the group's strengths and weaknesses, group dynamics and norms, products of shared regulation and domain knowledge created and established in our previous work together). *Social, task, and physical conditions* consist of affordance and constraints created by others and the larger social context, task context, and physical context (e.g. other group members' individual strengths, weaknesses and beliefs, distributed knowledge of the task and domain, products of others' self-regulation, instructor's written or verbal directions, CSCL supports in the environment, time).

Conditions are key for regulation as they inform the standards and operations learners perform in the phase. Standards are multifaceted criteria that depict learners' perceptions of the optimal end state the phase. Operations refer to the work learners perform in the phase including selecting, monitoring, assembling, rehearsing, and translating information (Winne, 2001). Through operations, learners create the products of the phase (e.g. task perceptions in Phase 1). Learners then monitor and evaluate products by comparing them to standards in order to determine whether the work of the phase is complete. If the learner perceives the fit between products and standards to be poor, they may enact control over operations to refine the product or revise the conditions and standards for the phase. Finally, the products of each phase become the conditions of subsequent regulation. In this way, regulation unfolds cyclically and recursively over time. For example, task perceptions products become conditions for goal setting.

Shared regulation of collaboration. Winne and Hadwin's (1998, 2008) model can also be extended to conceptualize regulation as shared (Winne et al., 2013). In this way, shared regulation also unfolds over four loosely sequenced and recursive phases. In phase 1 (*Phase 1: Shared task perceptions*), groups negotiate shared perceptions or interpretations of the collaborative task. In phase two, groups draw on their collective awareness of task conditions, contexts, and target outcomes to set shared goals, standards, and plans for strategically approaching the task (*Phase 2: Shared goal setting and planning*). In Phase 3 (*Phase 3: Task enactment*), groups coordinate their strategic task engagement, collectively and flexibly drawing upon a range of cognitive, socio-emotional, behavioural, and motivational strategies. Strategies in shared regulation are co-constructed and distributed in ways that leverage individual metacognitive and meta-motivational knowledge and capacities for the greater good of the group. Throughout these regulatory cycles, collective monitoring and evaluation emerge to guide

team decision-making and adaptation of collaborative processes, progress, and products. Based on these evaluations, groups may choose to make changes to optimize learning if needed. For instance, groups may strategically adapt task perceptions, goals, or engagement to optimize collaboration in the current task (i.e. small scale adaptation) or make changes to improve collaboration in future tasks (i.e. large scale adaption).

I suggest the COPES architecture in Winne and Hadwin's model (1998, 2008) can also be used to conceptualize how groups complete the work in each phase of shared regulation. At the group level, I suggest conditions include two main categories (Table 1). *Group conditions* consist of what the group together brings to the task (e.g. our established beliefs about the groups' strengths and weaknesses, group dynamics and norms, products of shared regulation and domain knowledge created and established in our previous work together). *Social, task, and physical conditions* consist of affordance and constraints created by others and the larger social context, task context, and physical context (e.g. other group members' individual strengths, weaknesses and beliefs, distributed knowledge of the task and domain, products of others' self-regulation, instructor's written or verbal directions, CSCL supports in the environment, time).

Together, conditions influence the group's shared standards for the phase and the operations performed. At the group level, operations include knowledge co-construction processes (e.g. articulating, eliciting, and building on one another's ideas). Through these processes, groups create the products of the phase (e.g. Shared task perceptions in Phase 1). Groups then share in the monitoring and evaluating of products by comparing them to standards in order to determine whether the work of the phase is complete or whether the group needs to refine the product or revise the conditions and standards for the phase.

Overall, although Winne and Hadwin's (1998, 2008) model has often been characterized

as an information-processing model (Puustinen & Pulkkinen, 2001; Winne, 2001; Zimmerman & Schunk, 2011), this model is well suited to research in this dissertation for two key reasons. First, this model separates planning in regulation into two separate phases: construction of task perceptions and goal setting. By explicitly recognizing construction of task perceptions as a critical phase of regulation, this model facilitates consideration of the role of task perceptions in regulation of collaboration.

Second, this model provides a nuanced and detailed account of how regulation unfolds as a situated and social phenomenon. Specifically, because products of each phase become conditions of the next, the COPES architecture provides a way to understand how regulatory process, such as shared task perceptions, unfold in context and over time (Greene & Azevedo, 2007). Furthermore, this architecture suggests that (a) the products of individual regulation become conditions of shared regulation, and (b) the products of shared regulation become conditions of individual regulation. In this way, this architecture provides a detailed understanding of the mechanisms by which self and shared regulatory processes reciprocally intertwine and evolve together in the context of a collaborative task (Figure 2).

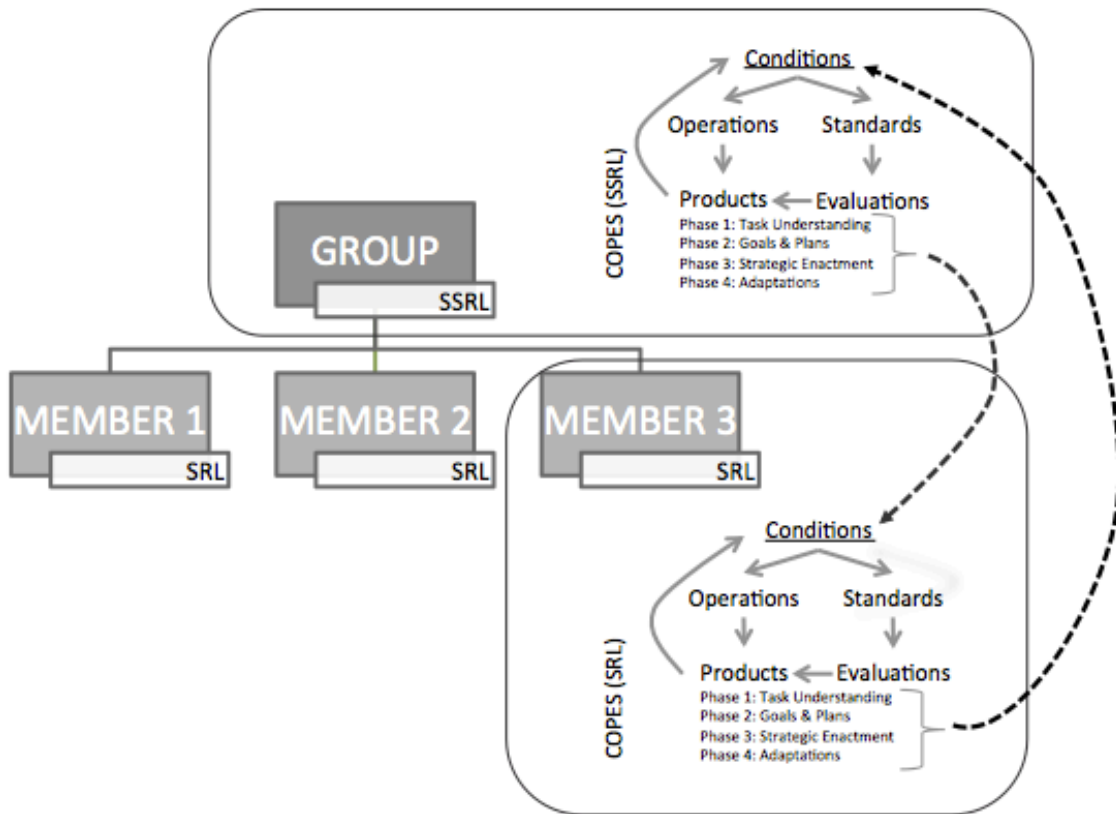


Figure 2. Reciprocal relationship between conditions and products at the individual and group level

Shared Task Perceptions for Regulating Collaboration

The primary focus of this dissertation was groups' shared task perceptions for regulating collaboration. Shared task perceptions refer to groups' co-constructed interpretations of the externally assigned task or situation. In this way, shared task perceptions can be distinguished from shared domain knowledge (Järvelä & Hadwin, 2013). While it is widely accepted that groups create shared understanding about domain concepts as they work together, shared task perceptions refer specifically to groups' construction of shared metacognitive knowledge about task features and requirements on which to launch future engagement in the task (Hadwin & Oshige, 2011; Winne, et al., 2013).

Shared task perceptions are vital to regulating collaboration. They provide the foundation on which groups can (a) negotiate strategic goals and decisions about how to progress forward and (b) collectively monitor and evaluate progress and products against the same standards (Winne & Hadwin, 1998, 2008). On the other hand, when shared task perceptions are miscalibrated amongst group members or with the situation, groups may encounter difficulties managing or adapting their work. For example, group members may work at cross-purposes, forge forward in ways ill-suited to task demands, or exercise metacognitive control based on faulty or invalid premises (Greene & Azevedo, 2007; Winne & Hadwin, 1998). In essence, collaboration may become a negative and frustrating experience as groups exert too much time and effort keeping collaboration on track and too little time constructively collaborating.

The notion that groups need a shared frame of reference to guide teamwork has been similarly emphasized in research from both organizational perspectives and the learning sciences. Across these areas, a wide range of constructs have been proposed including shared mental models (Mohammed & Dumville, 2001; Salas, Sims, & Burke, 2005; Stout, Cannon-Bowers, Salas, & Milanovich, 1999) and common ground (Beers, Boshuizen, Kirschner, & Gijsselaers, 2006; Clark & Brennan, 1991).

For instance, in research on team effectiveness, shared mental models are conceptualized as being a supporting and coordinating mechanism for teamwork (Akkerman et al., 2007). From this view, shared mental models are defined as overlapping mental representations of group members' knowledge (Klimoski & Mohammed, 1994; Van den Bossche, Gijsselaers, Segers, Woltjer, & Kirschner, 2010). By providing a framework promoting common understanding and action, shared mental models facilitate groups to coordinate engagement. For instance, in a recent study, Fransen, Kirschner, and Erkens (2011) found shared mental models to be the

largest predictor of both performance and mutual performance monitoring in collaboration.

Although shared mental models and shared task perceptions both concern the degree to which groups have a common frame of reference for collaboration, they differ in (a) the kinds of content they contain, and (b) their role in collaboration. Shared mental models contain a wide array of information and are often distinguished into different types (Akkerman et al., 2007; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000). For example, these include (a) team mental models regarding team functioning, roles and responsibilities, and expectations for group member behaviours, and (b) task mental models regarding strategies, procedures, likely scenarios and contingencies, components, and environmental constraints. In this way, shared mental models are akin to a holistic ‘vision’ of how the task can be successfully completed. The expansive nature of this content also means information often revolves around domain specific knowledge of the task. On the other hand, shared task perceptions include groups’ metacognitive knowledge about task requirements and specifications. As the first phase of regulation, shared task perceptions inform subsequent regulatory processes (e.g. goals for the task). Furthermore, shared task perceptions dynamically evolve and change during the task as regulation recursively unfolds over time.

Construction of shared task perceptions. Construction of shared task perceptions for shared regulation can be conceptualized as involving two dimensions. The first dimension centers on the way in which task perceptions are constructed amongst group members. The term ‘shared’ can hold multiple meanings including (a) *commonality*, such as team members holding overlapping or similar beliefs, and (b) *division*, such as distributed knowledge of task features among team members. In the context of regulation, shared means *co-constructed* or *negotiated* by the group. Therefore, groups must invest in a process to (a) become mutually aware of

potential differences among members' personal task interpretations, and (b) negotiate a joint representation of the task. Akin to notions of knowledge convergence (Roschelle, 1996; Teasley, 1997), groups create shared task perceptions when members understand and build on each other's perspectives, and acknowledge and resolve differences among their ideas (Fischer & Mandl, 2005; Van Boxtel, Van der Linden & Kanselaar, 2000; Weinberger, Stegmann, & Fischer, 2007). For example, building on Teasley's (1997) notions of transactivity in knowledge construction (i.e. operating on the reasoning of another), Weinberger and Fischer (2006) proposed learners can build consensus about domain knowledge in different ways that is also applicable to groups' negotiation of task perceptions (i.e. quick, integration- oriented or conflict-oriented consensus building). While quick consensus building involves simply accepting other's ideas and may not even signify knowledge becoming shared, integration or conflict oriented consensus building enables learners to more transactively build on each other's ideas, and thus would likely facilitate construction of shared task perceptions.

The second dimension centres on the information comprising shared task perceptions. Groups must not only come to consensus about perceptions of the task, but these perceptions must also be well aligned with the situation in which the task occurs. In this way, task perceptions must be *accurate and complete* in order to be optimally effective for informing subsequent regulation. However, complex tasks, such as those warranting collaboration, are comprised of multiple layers of information learners must decipher and interpret (Butler & Cartier, 2004; Winne & Perry, 2000). Hadwin (2006) proposed that learners must consider at least two types of information. First, *explicit task information* concerns surface level task criteria and requirements. This type of task information is often presented overtly by the instructor or client (Jamieson Noel, 2004). Second, *implicit task information* refers to the deeper contextual

meaning or bigger purpose of the task. This type of task information is often embedded in course objectives and descriptions, or in the social, conceptual, or physical resources accessible within the context of the work. Thus, learners must often infer this type of task information. It is important to note that constructing accurate and complete task perceptions does not mean there is one correct way to go about the task. Task perceptions provide the foundational information upon which learners and groups can set their own goals for engagement. However, constructing accurate and complete task perceptions enable groups to do so in a purposeful, strategic, and informed way.

Shared task perceptions require support. Task perceptions play a key role in regulating learning (Winne & Hadwin, 1998; 2008), and research indicates they influence subsequent regulation and achievement (Greene, Hutchinson, Costa, & Crompton, 2012; Schellings and Broekkamp, 2011). However, learners often struggle with this process. For example, investigations of task perceptions in solo tasks indicate learners' interpretations often differ from those of the instructor (Luyten, Lowyck, & Tuerlinckx, 2001; Miller, 2009). Furthermore, learners misinterpret tasks across a wide range of academic disciplines, particularly when tasks are complex or ill-structured, and often fail to recognize misinterpretations (Hadwin, Oshige, Miller, & Wild, 2009; Miller, 2009; Oshige, 2009). These difficulties limit learners' opportunities to optimize learning in and across tasks.

Working collaboratively might be expected to alleviate these struggles by providing students with opportunities to discuss task interpretations. However, emergent research indicates collaboration may amplify these challenges instead. For instance, in an examination of groups' shared regulation of a collaborative task, Hadwin, Malmberg, Järvelä, Järvenoja and Vainionpää (2010) found that group members' task perceptions were often misaligned with each other as

well as the instructor. In addition, these difficulties persisted across tasks.

Moreover, despite the need to coordinate task perceptions and plans, learners can be hesitant to externalize metacognitive knowledge regarding task planning (Azevedo, Moos, Johnson, & Chauncey, 2010; Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Groups sometimes pay scant attention to this facet of regulation simply jumping into task completion with little attention to what is required. For example, Rogat and Linnenbrink-Garcia (2011) observed social regulation in elementary school students working in small collaborative groups on a series of three mathematics tasks. Findings indicated that while some groups demonstrated in-depth interpretation of the task while planning, others simply read directions and started the task with little discussion of what the directions meant. The authors further suggested that this type of low quality engagement disrupted group progress by undermining engagement and interfering with monitoring.

These findings are similar to the emergent research about shared regulation and shared metacognition in general. While social and shared regulatory processes appear to contribute to success in group work, quality varies and learners do not always recognize opportunities to engage in these processes (DiDonato, 2012; Hurme, Palonen, & Järvelä, 2006; Järvelä et al., 2013a; Khosa & Volet, 2014).

Leveraging Technology to Support Shared Task Perceptions

In light of these challenges, helping learners to develop skills for regulating collaboration has become a priority for adequately preparing 21st century undergraduates for their future careers. In recent years, there has been emergent interest in how learning technologies themselves can remediate these difficulties (Hadwin et al., 2010; Järvelä & Hadwin, 2013; Lajoie & Lu, 2012; Molenaar, Roda, van Boxtel, & Slegers, 2012). From this perspective, online

environments move from simply being platforms for collaboration to being tools for supporting and scaffolding regulatory processes.

Scaffolding can be defined as a method of “controlling those elements of the task that are essentially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence” (Wood, Bruner, & Ross, 1976, p. 9). Originally, scaffolding concerned interactions in which an adult (parent or tutor) provided support to a less knowledgeable or experienced child or student (Bruner, 1975). However, in recent years, the notion of scaffolding has expanded to encompass technological tools that support learning through providing prompts and hints (Puntambekar & Hubscher, 2005). One criticism of this broadened definition is that technological supports do not always address the critical theoretical features of scaffolding such as ongoing diagnosis, calibrated support, and fading. However, from this view, technological environments afford opportunities for regulation and provide much needed guidance for developing skills for regulating collaboration.

Currently, the potential of technology to facilitate shared regulatory processes has been largely overlooked. Specifically, research about technological supports for regulation has mainly been limited to studies of self-regulated learning in computer-based pedagogical tools (CBPTs) (Winters & Azevedo, 2005; Winters, Greene, & Costich, 2008). For example, research has examined how technological tools, such as pedagogical agents, can support learners’ self-regulatory skills, processes, and engagement (Azevedo, 2005; Azevedo & Hadwin, 2005; Dabbagh & Kitsantas, 2005; Perry & Winne, 2006). While findings have evidenced the ability of online environments to facilitate regulation of learning, few studies have examined whether these types of supports can directly support shared regulatory processes (see Järvelä et al., 2014; Malmberg, Järvelä, Järvenoja, & Panadero, 2015).

Research in the area of computer supported collaborative learning (CSCL) presents exciting opportunities for this purpose. CSCL is an emerging field that focuses on how computer environments can facilitate and enhance collaborative learning (Koschmann, 1996; Kreijns, Kirschner, & Vermeulen, 2013; Stahl et al., 2006). The last two decades have witnessed an explosion of CSCL technologies and tools for supporting collaborative learning and interactions (Dillenbourg, et al., 2009; Soller, Martínez-Monés, Jermann, & Muehlenbrock, 2005). Two such tools are (a) scripting tools that structure groups' interaction and engagement in collaborative tasks and, (b) group awareness tools that use visualizations of group knowledge and processes to create opportunities for improving collaboration.

Scripting tools. Building on the *scripted cooperation* approach (O'Donnell, 1999; O'Donnell & Dansereau, 1992), scripts in CSCL support collaborative processes by specifying, sequencing, and distributing activities learners are expected to engage in during collaboration (Dillenbourg, 2002; Kollar, Fischer, & Hesse, 2006). Scripts typically target communicative-coordinative processes towards the aim of collaborative knowledge construction (Fischer, Kollar, Stegmann, Wecker, 2013), but vary widely in terms the objectives or aims, methods of delivery or utilization, and the types of activities they support (Kobbe et al., 2007).

The research about CSCL scripts broadly distinguishes between two types of scripts based on the level of granularity at which they support learners. Specifically, *macro-scripts* support collaboration by broadly orchestrating activities and processes expected to enhance collaborative learning, but typically do not provide further support on how to enact these activities (Dillenbourg & Hong, 2008; Dillenbourg & Tchounikine, 2007). For example, Jermann and Dillenbourg's (2003) ArgueGraph macro-script specifies and sequences general phases in a classroom argumentation task. Learners are asked to express their opinion on a controversial

topic by individually completing a questionnaire. Students with conflicting opinions are then placed in dyads and are tasked with coming to consensus on a single set of responses to the questionnaire. Subsequently, the instructor facilitates dyads to elaborate on and revise their arguments. Finally, each student is assigned a question and synthesizes all arguments for that question.

In comparison, *micro-scripts* typically provide more fine-grained support for the specific activities learners need to engage in during collaboration. For example, Weinberger, Ertl, Fischer, and Mandl (2005) micro-scripted online peer discussion to facilitate negotiation and elaboration of domain concepts. This micro-script consisted of sentence openers (e.g. *my proposal for an adjustment of the analysis is....*) that prompted learners to contribute domain content to the discussion and critique one another's contributions.

Group awareness tools. Recently, group awareness tools have gained attention in the CSCL literature as an alternative or complementary approach for supporting collaboration. While scripting collaboration provides learners with structured guidance for collaboration (Dillenbourg, 2002), group awareness tools take a more non-directive or reactive approach placing the locus of control in the hands of the learners (Janssen & Bodemer, 2013; Soller, et al., 2005). Group awareness tools take advantage of the unique affordances of online environments to help learners become aware of actions, thinking, knowledge, or social functioning in the group (Bodemer & Dehler, 2011; Janssen, Erkens, & Kirschner, 2011).

By interpreting information provided in these tools, learners and groups can operate on this information to improve collaboration without being explicitly instructed on how to collaborate. For instance, Sangin, Molinari, Nussli, and Dillenbourg (2011) investigated the effects of a knowledge awareness tool (KAT) on learners' collaborative processes and outcomes.

The KAT facilitated dyads' awareness of knowledge differences and gaps by providing them with a visual representation of their pre-test scores during collaboration. Findings indicated this tool triggered negotiation, elaborative talk, and learning gains. In comparison, learners who did not receive this tool focused on known concepts, fast consensus building, and quick task completion.

Designing CSCL regulation tools. Overall, research on CSCL indicates that technology can support positive social interactions and knowledge construction (Dillenbourg et al., 2009; Koschmann, 1996). However, turning attention to how CSCL environments can support shared task perceptions for regulating collaboration brings forth two key questions. The first question centres on *what* specific processes technological tools should target. Designing effective supports requires a great deal of knowledge of the core mechanisms the tools aims to promote (Dillenbourg, 2002). However, shared regulation is an emerging field, and relatively few studies have empirically investigated shared regulatory process (Panadero & Järvelä, 2015). As such, we have little knowledge about how collaborative learners establish and maintain shared task perceptions. Research is needed to explore how negotiation of shared task perceptions unfolds, what factors contribute to this process, and with what aspects students need support in order to inform design of CSCL tools for this purpose.

A second critical question centres on *how* supports should be configured and provided to learners. Designing effective supports means taking care to provide learners and groups with levels of support that adequately facilitate learners' engagement in the targeted process without disrupting the rich interaction that is the hallmark of collaboration itself (Beers, Boshuizen, Kirschner, & Gijsselaers, 2005; Dillenbourg, 2002). When tools do not provide learners with sufficient guidance, they are unlikely to help learners engage in processes they may not engage

in on their own. On the other hand, excessive structure may impede genuine collaboration by interfering with teams' natural interactions (Bromme, Hesse, & Spada, 2005; Cohen, 1994; Dillenbourg, 2002). Since few studies have systematically examined supports for shared regulatory processes, we have little knowledge about how much support learners require or whether to provide this support at the individual level, the group level, or both.

Overall, CSCL tools offer exciting possibilities to support shared regulatory processes. However, research is needed to systematically examine how this may be achieved. Thus, the primary aim of the dissertation was to advance understanding of how groups construct shared task perceptions for regulating collaboration, and investigate how CSCL tools can be designed to support this complex process.

Methodological Considerations: Approaches and Challenges to Researching Shared Task Perceptions in Regulation of Collaboration

Designing evidence based tools to promote shared task perceptions hinges on the development of suitable methods for capturing and analyzing this process. However, conceptualizing regulation and regulatory processes *as* social poses methodological challenges for researchers (Hadwin et al., 2010; Volet & Vaurus, 2013). Therefore, a second purpose of this dissertation was to explore approaches for capturing and analyzing shared task perceptions in regulation of collaboration. In the following section, I explore the methodological implications of recent perspectives about regulation of collaboration. Second, I outline the methodological approaches of this dissertation in light of these demands.

Researching Regulation of Collaboration as Social

Research in this dissertation is grounded in the view that groups are systems of individuals who dynamically regulate their cognition, motivation, emotion, and behaviour both individually and together across time and tasks. Groups engage in shared regulatory processes (e.g. construction of shared task perceptions), while at the same time individually regulating their regulatory beliefs and engagement (Hadwin et al., 2011; Järvelä & Hadwin, 2013; Volet et al., 2009). From this perspective, three key issues are important to consider when adopting and adapting methodological approaches for researching shared task perceptions: (a) shared task perceptions are inextricably tied to context, and (b) shared task perceptions are socially-constructed by groups, and (c) shared task perceptions arise across the individual and group level.

Shared task perceptions in situ. Regulated learning has historically been considered a stable aptitude or trait. However, contemporary perspectives view regulated learning as an

adaptive event arising in context. For example, Winne and Hadwin (1998, 2008) posit that operations learners choose to undertake and the standards against which they evaluate them are framed by self, social, and physical contexts. Therefore, examining shared task perceptions means capturing how this process occurs in action in the context of authentic, challenging collaborative tasks that necessitate learners to interpret task features.

This calls into question the utility of self-report instruments characteristic of early research about self-regulated and organizational research about teamwork and team processes. For instance, self-reports have been used to capture regulated learning as a stable trait or aptitude. A prominent example is the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1993), which asks learners to report about their regulated learning at the subject level without specifying a particular episode or task.

Self-reports have also been used retrospectively to assess team processes that occurred during a specified task. Fransen, et al. (2011) exemplified this type of approach in their use of a self-report questionnaire to examine groups' shared mental models. After the task, individuals rated the degree to which their group achieved a shared mental model. Items were adapted from Edmondson's (1999) Team Survey Questionnaire and Van den Bossche et al.'s (2006) Team Learning Beliefs and Behaviors Questionnaire.

Self-reports instruments are feasible, provide easily quantifiable data, and have generated much understanding about cognitive, motivational, and metacognitive constructs in self-regulated learning. However, this type of 'offline' measurement is limited in its ability to capture regulatory processes as active and situated (Gress & Hadwin, 2010; Winne, 2010). Even when a specific timeframe is defined, self-reports rely on human memory. As such, they can be prone to bias and are often miscalibrated in terms of what actually occurred (Winne & Jamieson-Noel,

2002; Winne & Perry, 2000).

In light of these limitations, a key trend in research about regulated learning has been development of situation specific or event based measures that capture the dynamic and situated nature of this process. In research about self-regulated learning, these include think aloud protocols, trace data, and micro-analytic techniques (Cleary, 2011; Winne, 2010; Winne & Perry, 2000). For example, Greene et al. (2012) used think-aloud protocols to capture and code learners' task perceptions as they were constructed during a science education task.

Similar developments are taking place in research on shared regulation (Volet & Vaurus, 2013). For example, Perry and Winne (2013) described ways in which trace data can be used to examine shared regulation over time in the context. Other researchers are making use of observational methods, such as videotaping small groups, to explore and describe regulatory processes emerging during collaboration (e.g. Rogat & Linnenbrink, 2011). Finally, other approaches include situation specific questionnaires that assess regulation arising at specific points during collaborative learning (e.g. Järvelä, Järvenoja, & Näykki, 2013; Järvenoja, Volet, & Järvelä, 2013; Järvenoja & Järvelä, 2009). Overall, developing and adopting these types of techniques creates opportunities to understand how shared regulatory processes arise in situ in ways not possible with traditional self-report methods.

Shared task perceptions as socially constructed. While regulation can typically been considered as individual, social and shared aspects of regulated learning have become a central theme in recent research (Hadwin et al., 2010; Hurme and Järvelä, 2005; Iiskala, et al., 2011; Volet et al., 2009). In particular, defining regulation *as* shared means regulatory processes in collaboration are socially constructed by groups. As groups engage in collaborative tasks, they negotiate and co-construct shared interpretations about explicit and implicit task features of their

collaborative tasks. Drawing on Winne and Hadwin's model (1998, 2008), this occurs through co-constructive operations, such as exchanging ideas and knowledge and influencing one another through transactive social interactions (Barron, 2003; Roschelle, 1996, Teasley, 1997). Rather than knowledge belonging solely to individuals, groups are seen as entities that construct shared knowledge through social interaction and activity (Greeno, 2006, 2011). Therefore, while regulation has often been investigated as an individual process, researching shared regulation means capturing this process at a social level.

Individually focused data collection methods, such as self-reports and talk-aloud protocols, offer limited understanding of socially constructed regulatory processes. For example, individual measures provide little information about how groups engage in negotiation processes together. In addition, asking learners to report their groups' shared task perceptions requires learners to make judgments about their task perceptions in relation to those of multiple others they are not always able to directly observe. While member's self-reports can be aggregated to create a group level measure, variation is likely to exist among group members' ratings (e.g. they may perceive the degree to which their group attained shared task perceptions differently). Aggregating across this type of variation is problematic considering its very existence is indicative of a lack of shared task perceptions.

Therefore, researching shared task perceptions as co-constructed means moving beyond individual focused data collection methods to capture this process as socially constructed by groups. This means developing and adopting group level measures and process oriented approaches that capture both what is joint or shared by the group as well as how it is constructed.

Shared task perceptions as evolving across individuals and groups. In this

dissertation, regulation of collaboration is conceptualized as evolving across multiple social levels (Hadwin et al., 2011; Järvelä & Hadwin, 2013). Shared regulatory processes, such as shared task perceptions, emerge alongside and intertwine with individual regulatory processes (e.g. personal task perceptions). Drawing on Winne and Hadwin's (1998) COPES architecture, I suggest this occurs when: (a) the products of group members' self-regulation (e.g. individual task perceptions) become part of the conditions that frame groups' subsequent construction of shared task perceptions, and (b) the products of the group's shared regulation (e.g. shared task perceptions) become part of the conditions that frame individuals' task interpretations (Figure 2). Thus, shared task perceptions are not solely a group level phenomenon. Researching shared regulatory processes means adopting methods and analytical techniques that take into account the interplay between individual and group regulatory processes (Hadwin et al, 2011; Volet & Vaurus, 2013).

This is challenging for researchers. By nature, data sources tend to privilege access to either individual regulation (e.g. questionnaire data) or social regulation (e.g. observation data) (Järvelä et al., 2010). Furthermore, it is particularly difficult capture covert processes, such as individual task perceptions, in observation data (e.g. video data and chat records) because individuals do not always express these types of ideas during discussion.

A key trend in recent research has been combining findings obtained through different approaches to capture and compare regulation at individual and group level (e.g. Arvaja, Salovaara, Häkkinen, & Järvelä, 2007; Näykki and Järvelä, 2008). In terms of task perceptions, this means capturing (a) what individuals perceive about the task, (b) what groups understand about the task, and (c) how task perceptions are adapted or adopted across levels. Doing so provides ways to understand shared task perceptions in ways not possible from one perspective.

In sum, researching shared task perceptions in regulation of collaboration requires a more varied set of methodological and analytical techniques than is common in research about self-regulated learning to date (Perry & Winne, 2013). In particular, it requires adopting approaches that capture: (a) shared task perceptions as they are constructed in the context of authentic tasks, (b) shared task perceptions socially constructed by groups, and (c) shared task perceptions as they arise across the individual and group level.

CSCL Environments as a Methodological Solution

One potential solution lies in the design of CSCL environments that promote regulation, and at the same time, offer new avenues to research their emergence. As learners engage with CSCL supports in online environments, they generate valuable, contextualized data of their activities, perceptions, and interactions that can shed light on this complex phenomenon. In this dissertation, CSCL tools were used to collect four different types of data in each empirical manuscript (i.e. Miller, et al., 2015, Miller & Hadwin, 2015b). In the following section, I describe each data collection method. Ways in which each method addressed each of the above issues are summarized in Table 2.

Micro-scripting tools. In each study, two micro-scripts were used to promote learners and groups to construct task perceptions. The Individual Planning Tool (IPT) micro-scripted individuals to construct personal task perceptions for the collaborative task. This tool included two question prompts targeting explicit task requirements (e.g. “*Describe the collaborative task for this week.*”) and implicit task requirements (e.g. “*Why was this task chosen for this week?*”). The Shared Planning Tool (SPT) micro-scripted groups to construct shared task perceptions together using identical question prompts. However, these tools were also used as context specific measures capturing what individuals and groups believed about the task as they

completed it in context.

Chat records. In each study, groups completed the task using a text-based chat tool. Chat logs recorded by the online environment produced rich records of intra-group interaction about task perceptions. Chat records were used in three ways in this research. First, Miller et al., (2015) used chat records along with other data sources to create group profiles tracing how task perceptions were constructed during the task. Second, Miller and Hadwin (2015b) coded chat discussions in terms of the degree to which groups transactively built on one another's contributions to negotiate shared task perceptions. Third, in both studies, chat records were used as a complementary data source to identify groups' shared task perceptions. Because a group member could potentially complete the SPT alone without consulting others, chat discussions provided additional means to identify whether or not groups reached agreement on different ideas about the task.

Log file data. A unique feature of online environments is that they can produce precise, time stamped log file traces of learners' activities during collaboration (Hadwin, Nesbit, Code, Jamieson-Noel, & Winne, 2007; Perry & Winne, 2013). In this dissertation research, log file data were used in two ways. First, Miller et al., (2015) used log file data to (a) identify learners' planning activities (e.g. viewing task instructions, viewing the shared planning tool, editing shared planning tool, viewing edits in shared planning tool), and (b) situate when planning occurred in relation to work on the collaborative task. Second, in both studies, log files served, along with chat records, as a complementary data source to identify groups' shared task perceptions. For example, in situations where discussions were vague (e.g. *look at the idea I just added to the SPT*), log file data provided a way to identify what idea was being discussed as well as which group members were editing and viewing these ideas.

Table 2. *Methodological aspects addressed in each empirical manuscript*

Manuscript	Miller et al., 2015			Miller & Hadwin, 2015b		
Data Sources	Planning Tools (Micro-scripts)	Chat Records	Log Files	Planning Tools (Micro-scripts)	Chat Records	Log Files
Shared task perceptions as contextual	Learners completed the IPT and SPT during the collaborative task	Discussion about task perceptions during collaboration	Time stamped planning activities (e.g. view task instructions, edit planning tools)	Learners completed the IPT and SPT in dedicated planning phases for the task	Discussion about task perceptions during planning session	Time stamped instances where learners viewed and edited planning tools
Shared task perceptions as a group phenomenon	Groups' responses about what they believed about the task. (SPT)	Indications of agreement about task perceptions	Group level planning activities (e.g. contributing and viewing ideas in the SPT)	Groups' responses about what they believed about the task.(SPT)	Indications of agreement and quality of discussion about task perceptions	Tool use during group negotiation
Shared task perceptions across the individual and group level.	Comparison of shared task perceptions and individuals' task perceptions in the IPT; Integration of individuals' accurate task perceptions (IPT) in shared task perceptions	Discussion of individuals' IPT responses during chat	Individual vs. group planning activities	Integration of individuals' accurate task perceptions (IPT) in shared task perceptions	Discussion of individuals' task perception from IPT during chat	Viewing contributions to the shared planning tool

A Systematic Approach to Investing CSCL Tools and Shared Task Perceptions

Overall, this dissertation aimed to examine how CSCL environments could promote shared task perceptions, but also serve as a methodological solution for understanding this process. This focus on enriching theory and practice simultaneously is a key characteristic of the developing field of design-based research (e.g. Design Based Research Collective, 2003).

Stemming from the work of Brown (1992) and Collins (1992), design based research (DBR) pursues dual goals of “developing effective learning environments and using such environments as natural laboratories to study learning and teaching” (Sandoval & Bell, 2004, p. 200). A number of variants exist in the literature (Barab & Squire, 2004). These include design experiments (Brown, 1992; Collins, 1992), design research (Edelson, 2002), and development research (van den Akker, 1999). However, this approach can generally be defined as “a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories” (Wang & Hannafin, 2005, p. 6).

Specifically, DBR is often described as having five key characteristics (Wang & Hannafin, 2005). First, it is *pragmatic* in that it aims to refine both theory and practice. Second, DBR is *grounded*. It is anchored in theory, research, and is conducted in real word settings. Third, it is *interactive, iterative, and flexible*. Research is conducted collaboratively between researchers and practitioners and evolves in a tight iterative cycles of analysis, design, implementation, and redesign. Fourth, it is *integrative* in that both qualitative and quantitative methods are used and applied as needed in different phases as the focus of the research evolves. Fifth, DBR is *contextual*. Findings are

considered in relation to the design and the setting.

Taken together, DBR moves away from the investigation of specific variables in tightly controlled environments. Instead, it takes a more flexible and evolving approach to investigate phenomenon in real world contexts (Anderson & Shattuck, 2012; Design Based Research Collective, 2003). By bridging theoretical research and authentic contexts, DBR seeks to both advance understanding of how learning unfolds as well mobilize emergent findings in ways that improve educational practice.

While this dissertation in itself does not constitute DBR, it was conducted within a larger design based research project at the University of Victoria: Promoting Adaptive Regulation for 21st Century Success (PAR-21). PAR-21 investigated ways technology can support individuals and teams to: (a) strategically adapt in the face of challenge; (b) engage, sustain, and productively regulate themselves, each other and together during collaborative work; and (c) monitor and regulate cognitive, socio-emotional, and behavioural processes that are essential to maximizing success in a 21st-century learning-oriented workplace. The DBR methodologies of this larger project framed work in this dissertation in three key ways.

First, consistent with DBR, tools were incrementally developed, tested and refined across three studies. Findings of each manuscript informed design and analysis of the next (Figure 3). First, Miller and Hadwin (2015a, Manuscript 1) contributed to the theoretical groundwork for examining CSCL supports for regulation. The purpose of this conceptual paper was to (a) explore how a theoretical framework of regulation of collaboration could inform design of CSCL tools for supporting and researching regulation of collaboration, and (b) propose solutions using data driven examples. Next, Miller et al. (2015, Manuscript 2) further contributed to this aim by exploring how high vs. low accuracy groups provided with CSCL planning supports constructed shared task

perceptions for a collaborative task. By exploring the mechanisms that contributed to and constrained the development of shared task perceptions in this context, this study aimed to inform future development of CSCL supports. Finally, Miller & Hadwin (2015b, Manuscript 3) built on these findings to investigate the effectiveness of different levels of CSCL planning support on groups' shared task perceptions and collaborative products.

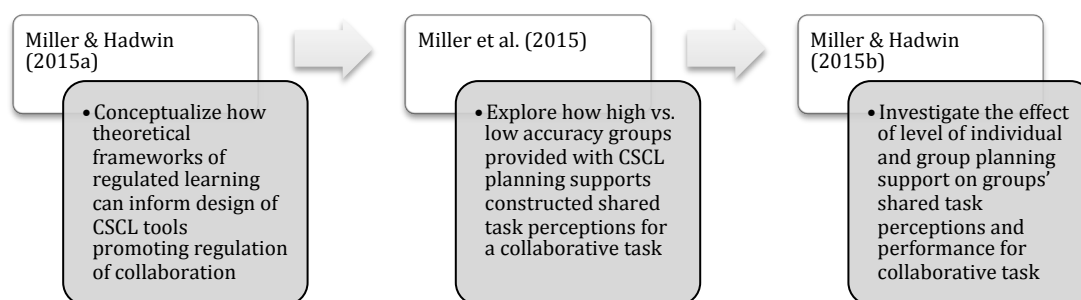


Figure 3. Progression of research aims across each manuscript

Second, CSCL supports were developed and researched in authentic and challenging collaborative tasks that afforded both the opportunity and the need to regulate collaboration. Removing groups from authentic, challenging tasks fundamentally changes the nature of their interaction and calls into question whether regulation is even required. Thus consistent with the larger DBR project, this research emphasizes investigation of processes situated in the rich social and environmental contexts in which they belong.

Miller et al. (2015) was conducted in a graduate course at the University of Oulu, Finland in which students worked on a complex collaborative case study assignment. Miller and Hadwin (2015b) was conducted in a first year elective course at the University of Victoria, Canada in which students worked on a similarly complex collaborative case study assignment. In both settings, at least one researcher was also the course instructor. This allowed invaluable knowledge of the context useful for

informing design of tailored supports as well as interpretation of findings. Furthermore, examining shared task perceptions across these contexts provided opportunities for international collaboration between research teams at the University of Victoria and the University of Oulu that facilitated theoretical and practical design of supports.

Finally, consistent with the integrative nature of DBR, methods and analytic approaches in each study were selected and applied on the basis of their utility to address the issue at hand. Two methodological approaches were used. The purpose of Miller et al. (2015) was to explore how shared task perceptions unfolded in the collaborative task and identify mechanisms that contributed to groups' accurate or inaccurate task perceptions. Thus, a case study method was selected due to its suitability for studies aiming to answer "how" and "why" questions in real contexts (Merriam, 1998; Yin, 2008). The purpose of Miller and Hadwin (2015b) was to examine the effect of different levels of support on shared task perceptions and collaborative outcomes. Thus, a causal comparative approach was selected. Although this type of quantitative factorial design is not typical of DBR, it enabled comparison of two iterations of tools at once among a large number of groups. A summary of the aims and methods of each manuscript is provided in Table 3 with more detailed descriptions found in each manuscript. Overall, by taking a systematic and contextualized approach, research in this dissertation targeted the dual goals of (a) advancing understanding of shared task perceptions as a critical aspect of regulating collaboration, and (b) developing practical solutions for supporting this process.

Table 3. *Overview of the aims and methods in each manuscript*

Dissertation Purpose	Investigate how CSCL tools can be leveraged to support and research shared task perceptions for socially shared regulation of collaborative learning		
Manuscript	Miller & Hadwin (2015a)	Miller et al. (2015)	Miller & Hadwin (2015b)
Research Aim	Conceptualize how theoretical frameworks of regulated learning can inform design of CSCL tools promoting regulation of collaboration	Explore factors that contributed to and constrained groups' construction of accurate shared task perceptions for a collaborative task	Investigate the effect of level of individual and group planning support on groups' shared task perceptions for regulating collaboration
Research Design	Theoretical	Qualitative Cross-Case Comparison	Quantitative Causal Comparative (factorial design)
CSCL Supports	Data driven examples of CSCL supports from a first year collaborative task (ED-D 101, University of Victoria)	<p>Macro-script loosely orchestrating engagement in regulation of collaboration</p> <p>Micro-script for individual task perceptions (Individual Planning Tool with open format question prompts)</p> <p>Micro-script for shared task perceptions (Shared Planning Tool with open format question prompts)</p>	<p>Macro-script orchestrating and sequencing engagement in regulation of collaboration.</p> <p>Micro-scripts for individual task perceptions providing a high or low level of support (Individual Planning Tool with pre-stocked answers vs. open format question prompts)</p> <p>Micro-scripts for shared task perceptions providing a high or low level of support (Shared Planning Tool with pre-stocked answers vs. open format question prompts)</p> <p>Group awareness tool in the Shared Planning Tool displaying group members' responses to the Individual Planning Tool</p>
Measures	N/A	Individual and Shared Planning Tool responses; log file data; chat discussions;	Individual and Shared Planning Tool responses; log file data; chat discussions; task performance
Analyses	N/A	Qualitative coding; Descriptive quantitative analysis; Case description	Qualitative coding; Quantitative coding, Statistical analysis (2X2 ANOVA)

Research Purpose and Overview

The purpose of this dissertation was twofold. First, while shared task perceptions play a foundational role in groups' shared regulation of collaboration, groups struggle with this process and report strategic planning challenges to be among the biggest difficulties encountered during collaboration (Hadwin, et al., 2011; McCardle et al., 2010; Miller & Hadwin, 2012). Thus, the first aim of the dissertation was to *investigate how CSCL tools can be designed to support shared task perceptions*. Second, while measures of shared regulatory processes are critical to understanding and designing tools for this process, investigating regulation as a shared phenomenon brings forth a wide array of methodological challenges (Vauras & Volet, 2013). Thus, a second aim of this dissertation was to *explore how CSCL tools can be used as a methodological solution for capturing this process*.

Towards these aims, this dissertation examined the problem across three separate, published (or under review) manuscripts. Miller and Hadwin (2015a, Manuscript 1) lay the theoretical groundwork for examining CSCL supports for regulation. The purpose of this conceptual paper was to (a) explore how a theoretical framework of regulation of collaboration could inform design of CSCL tools for supporting and researching this process, and (b) propose solutions using data driven examples. Miller, et al. (2015, Manuscript 2) explored how groups provided with CSCL planning supports constructed shared task perceptions for a collaborative task. By exploring the mechanisms that contributed to and constrained shared task perceptions, this study aimed to inform future development of CSCL supports. Miller and Hadwin (2015b, Manuscript 3) built on these results to further refine tools by examining the effects of different levels of CSCL support on shared task perceptions and performance. Across each manuscript, CSCL technology was used not only to promote shared task

perceptions, but also to explore ways of researching this process. A brief overview of each manuscript and its specific contribution to the global aims of the dissertation follows.

Manuscript 1: Miller M., & Hadwin, A. F. (2015a). Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Computers in Human Behavior*.

A key aspect of designing and examining CSCL tools for regulation involves development of solutions in a theoretical framework. Thus, the purpose of this conceptual paper was twofold. First, this paper extended previous work articulating the role of self-regulation, co-regulation, and shared-regulation in successful computer supported collaboration (Hadwin, et al., 2011; Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013). Second, this paper built on this theoretical foundation to introduce ways in which two types of CSCL tools could be leveraged to support regulation of collaboration: (a) scripts that structure collaboration by specifying, sequencing, and distributing activities and roles to be enacted in collaboration (Dillenbourg, 2002; Fischer et al., 2013), and (b) group awareness tools that use visualizations or graphical representations of group members' cognitive, behavioural, or social processes so group members can better access and use this information to collaborate (Bodemer & Dehler, 2011; Janssen & Bodemer, 2013). The potential of these tools for regulation was illustrated with examples of scripting and awareness tools designed as part of a larger design-based research project (PAR-21 Promoting Adaptive Regulation for 21st Century Success). This paper concluded by discussing future directions for research about regulation of collaboration and design of CSCL tools to support this process. Thus, this study contributed to the aims of this dissertation by establishing a theoretical basis upon which to anchor design of CSCL tools supporting shared task perceptions in regulation

of collaboration.

Manuscript 2: Miller, M., Malmberg, J., Hadwin, A. F., & Järvelä, S. (2015).

Examining the processes contributing to and constraining shared planning for regulating collaboration in a CSCL environment. *Manuscript in submission (1 round of reviews).*

While Miller and Hadwin (2015a) contributed to the theoretical groundwork on which to base CSCL tools for regulation, designing effective supports requires a great deal of knowledge of how these processes unfold. However, little is known about how groups successfully negotiate shared task perceptions or how computer supported collaborative learning (CSCL) technologies can support this process. Thus, this cross-case comparison compared groups with accurate or inaccurate shared task perceptions for an online collaborative task to explore how this process unfolded during collaboration. In doing so, this paper aimed to identify key mechanisms that contributed to or constrained successful development of shared task perceptions and inform further evidence-based design of CSCL planning tools.

Participants were 18 graduate students enrolled in a six-week course at the University of Oulu, Finland. As part of their coursework, participants worked in groups of three on three online collaborative assignments in the nStudy learning environment. Students completed each assignment using two types of scripting tools targeting regulation of collaboration integrated directly within the task in the online environment. The assignment was framed by an over-arching macro-script that loosely orchestrated engagement in regulation of collaboration by asking students to approach the assignment in four phases (i.e. individual planning, shared planning, task enactment, and reflection). Learners were also provided with two CSCL planning tools. The Individual Planning Tool (IPT) used open format question prompts to micro-script

individuals' construction of personal task interpretations. The Shared Planning Tool (SPT) used an identical set of question prompts to micro-script groups' construction of shared task perceptions. In the SPT, groups were tasked with co-constructing a single response for the group.

A cross-case comparison design was used to contrast situations where groups constructed accurate or inaccurate shared task perceptions. Three groups with most accurate SPT responses and three groups with the least accurate SPT responses were purposefully selected for analysis. Data sources included individuals' IPT responses, groups' SPT responses, chat discussion of task perceptions for the collaborative assignment, and log files of learners' planning activities recorded in the nStudy environment.

Analysis was completed in three phases. In the first phase, groups' shared task perceptions were examined in more depth. The purpose of this phase was to (a) verify whether task perceptions in the SPT were shared using chat discussion and log files of planning tool use, and (b) confirm categorization of cases as high vs. low accuracy groups. In the second phase, we integrated data sources to construct case descriptions of each group tracing how shared task perceptions developed throughout the task. In the third phase, we compared groups with accurate vs. inaccurate task perceptions in the interest of discovering similarities and differences in groups' construction of shared task perceptions.

Findings indicated that despite being provided with CSCL supports, no groups constructed highly accurate task perceptions. However, compared with low accuracy groups, moderate accuracy groups considered a wider breadth of explicit and implicit task features, engaged in both individual and group level planning activities, capitalized on group members' personal task perceptions, and constructed shared task perceptions

at multiple points throughout the task. This study contributed to the aims of this dissertation by advancing understanding of key mechanisms that contributed to successful construction of shared task perceptions and identifying key targets for refinement of supports.

Manuscript 3: Miller M., & Hadwin, A. F. (2015b). Comparing the effectiveness of CSCL supports for shared task perceptions in socially shared regulation of collaborative learning. *Manuscript in submission.*

While findings of Miller et al. (2015) indicated learners required more support to construct accurate shared task perceptions, we have little understanding of how much support individuals and groups require. Thus, the purpose of this study was to compare the effect of level of individual and group planning support on shared task perceptions and task performance. Building on findings of Miller et al. (2015), the effect of level of individual and group support in CSCL tools was examined in terms of (a) the accuracy of groups' shared task perceptions, (b) the extent to which groups capitalized on members' distributed task interpretations, (c) the degree to which groups transactively negotiated shared task perceptions during discussion, and (c) collaborative task performance.

Participants were 192 undergraduate students enrolled in an elective course at the University of Victoria, Canada. As part of their coursework, students worked in groups of four or five on an online collaborative assignment in Moodle (K=48). Students completed each assignment using two types of tools targeting shared regulation integrated directly within the task in the online environment. The assignment was framed by an over-arching macro-script that orchestrated learners' engagement in regulation of collaboration by requiring learners to approach the assignment in five phases (e.g. summary preparation, individual planning, shared planning, task enactment,

and reflection). Learners were also provided with two CSCL planning tools: (a) the Individual Planning Tool (IPT) that micro-scripted construction of personal task perceptions, and (b) the Shared Planning Tool that micro-scripted construction of shared task perceptions and provided groups with a group awareness tool displaying their IPT responses.

Groups were randomly assigned to one of four conditions differing with respect to the level of support provided in planning tools in a 2X2 factorial design: (a) Individual Planning Tool (high vs. low support), and (b) Shared Planning Tool (high vs. low support). Low support tools provided learners with open format question prompts. Question prompts in the high support tools were pre-stocked with potential responses. Data sources included individual and shared planning tool responses, log files of tool use, chat logs, and assignment grade. Shared task perceptions were identified using SPT responses, chat discussions during planning sessions, and log files of planning tool use. The extent to which groups capitalized on members' personal task interpretations was assessed using the proportion of accurate IPT responses groups' included in their shared task perceptions. Degree to which groups transactively negotiated shared task perceptions in chat discussion was assessed using a coding scheme developed for this study. Assignment grade was used as a measure of group performance.

Analyses of variance (2X2 ANOVAs) indicated that, regardless of level of individual support, a high level of support in the Shared Planning Tool, facilitated groups to construct more accurate shared task perceptions, capitalize on members' personal task perceptions, and engage in more transactive planning discussions. However, contrary to expectations, a high level of support in the Individual Planning Tool did not enhance these processes. Furthermore, benefits of support did not extend to group performance.

Ethics

Ethics were approved for each empirical study. Research for Miller et al. (2015) was conducted as part of a Finnish funded project at the University of Oulu, Finland. Participation for the study was voluntary and all procedures were in accordance with ethical standards of the institution, the Finnish Advisory Board on Research Integrity, and the National Advisory Board on Research Ethics.

Research for Miller and Hadwin (2015b) was conducted as part of a larger project on student regulation at the University of Victoria. Participants were informed of project aims and requirements, and the ability to withdraw participation at any point in the study and participants gave informed consent. Research was conducted in a university course and information on consent was withheld from course instructors until after final grades were submitted.

Discussion: Promoting and Researching Shared Task Perceptions

The purpose of my program of research was twofold. First, while shared task perceptions play a foundational role in groups' shared regulation of collaboration, groups struggle with this process and report strategic planning challenges to be among the biggest difficulties encountered during collaboration (Hadwin, et al., 2011; McCardle et al., 2010; Miller & Hadwin, 2012). Thus, the first aim of the dissertation was to *investigate how CSCL tools can be designed to support shared task perceptions*. Second, while measures of shared regulatory processes are critical to understanding and designing tools for this process, investigating regulation as a shared phenomenon brings forth a wide array of methodological challenges (Vauras & Volet, 2013). Thus, a second aim of this dissertation *was to explore how CSCL tools can be used as a methodological solution for capturing this process*. In the following section, I summarize the main findings of the dissertation in light of each of these aims. Subsequently, I discuss limitations, future avenues for research, and implications of findings for theory, research, and practice.

Aim 1: How can CSCL Tools be Designed to Support Shared Task Perceptions?

The potential of CSCL tools to support shared task perceptions was examined across one conceptual and two empirical studies. Findings of each manuscript built on the previous to create an integrated and systematic exploration of the problem.

Shifting the target of support. Miller and Hadwin (2015a) extended previous work articulating the important role of self-regulation, co-regulation, and shared-regulation in successful collaboration. Drawing on this theoretical framework, this paper proposed ways in which CSCL tools could be leveraged to support regulation of collaboration.

Two overarching principles were emphasized. First, leveraging CSCL tools for

regulation means shifting the target of support away from knowledge construction to directly support processes for regulation of cognition, motivation, emotion, and behaviour (Järvelä & Hadwin, 2013; Winne et al., 2013). These processes include (a) constructing representations of tasks and goals, (b) monitoring and evaluating progress and products, (c) selecting and adopting strategies for enacting the task, and (d) making changes when needed and persisting in the face of challenge. Second, considering groups as social systems that regulate individually as well as together means CSCL tools should target regulatory processes within and across multiple social levels (Hadwin et al., 2011; Järvelä & Hadwin, 2013). Specifically, tools should support learners to take control of their own regulation in the joint task (self-regulation), prompt and nudge one another's regulation (co-regulation), and collectively regulate together (shared regulation).

Drawing on examples from a first year undergraduate course, I illustrated how these theoretical conjectures could be embodied in CSCL macro-scripts, micro-scripts, and group awareness tools. Specifically, macro-scripts in collaborative learning typically take a pedagogical approach emphasizing the orchestration of activities and processes expected to enhance collaborative interaction and knowledge construction (Dillenbourg & Hong, 2008). However, using Winne and Hadwin's (1998, 2008) model of regulation, this paper exemplified how a regulation macro-script could specify a collaborative task as involving (a) multiple regulatory phases beyond simply completing the task (e.g. planning, monitoring and evaluating, and reflecting for adapting), and (b) both individual- and group-level regulatory processes (e.g. individual planning and shared planning).

Second, micro-scripts for collaboration typically support collaborative interaction and knowledge construction by providing more fine-grained guidance for the

specific activities in which learners need to engage (Jermann & Dillenbourg, 2003; Weinberger, et al., 2005). In this paper, I demonstrated how micro-scripts can provide individuals and groups with fine-grained support for engaging in different regulatory processes. For example, the Individual Planning Tool (IPT) micro-scripted solo planning using question prompts that helped learners thoroughly analyze explicit and implicit task features. In addition, the Shared Planning Tool (SPT) micro-scripted shared planning using an identical set of question prompts. However, groups were tasked with discussing each question and collating their personal task perceptions to co-construct a single response for the group.

Finally, group awareness tools typically help groups become aware of actions, thinking, knowledge, or social functioning (Bodemer & Dehler, 2011). By interpreting information provided in these tools, learners and groups can operate on this information to improve collaboration (Fransen et al., 2011; Janssen & Bodemer, 2013; Soller et al., 2005). In this paper, I demonstrated how group awareness tools can also be leveraged to support regulation of collaboration. Specifically, the Shared Planning Tool (SPT) was augmented with a group awareness tool that (a) captured group members' personal task perceptions as reported in their IPTs and (b) displayed them to the group in a graphic summary (i.e. a bar graph displaying the total number of people in the group who selected each of the options in the target questions).

Overall, this paper established a foundation for subsequent research in this dissertation by anchoring prototypes of CSCL tools in theoretical accounts of regulation of collaboration. Drawing on perspectives of regulation of collaboration, tools targeted regulatory processes (e.g. planning, monitoring and evaluating progress and products, and reflecting for adapting) at different social levels (e.g. individual and group level planning scripts) as well as *across* the individual and group level (e.g. supporting

groups to consider and make use of individuals' planning tool responses).

Exploring targets of support. While theoretical frameworks provide important guidance for designing CSCL supports for regulation, little is known about how groups successfully negotiate shared task perceptions in authentic collaborative tasks. Further research was needed in order to inform evidence-based CSCL supports. Therefore, Miller et al. (2015) compared groups with accurate and inaccurate shared task perceptions to examine how this process emerged during a collaborative task in a CSCL environment. In doing so, this paper aimed to identify key mechanisms that might contribute to or constrain this process.

Groups in this study were provided with a macro-script that loosely orchestrated regulation of collaboration by asking students to approach the assignment in four phases (e.g. individual planning, shared planning, task enactment, and reflection) (Figure 4). Learners were also provided with two planning tools to micro-script personal and shared task perceptions. The Individual Planning Tool (IPT) micro-scripted personal task perceptions using open format questions prompting learners to individually unpack the explicit task features (e.g. "*Describe the collaborative task for this week.*") and implicit task requirements (e.g. "*Why was this task chosen for this week?*"). The Shared Planning Tool (SPT) micro-scripted groups to construct shared task perceptions with an identical set of question prompts. Findings indicated that no groups constructed highly accurate task perceptions in this study. However, comparison of moderate and low accuracy groups revealed four key differences: (a) scope of task features, (b) planning as an individual and a group process, (c) capitalizing on group members' distributed task perceptions, and (d) planning dynamically at multiple points in the task.

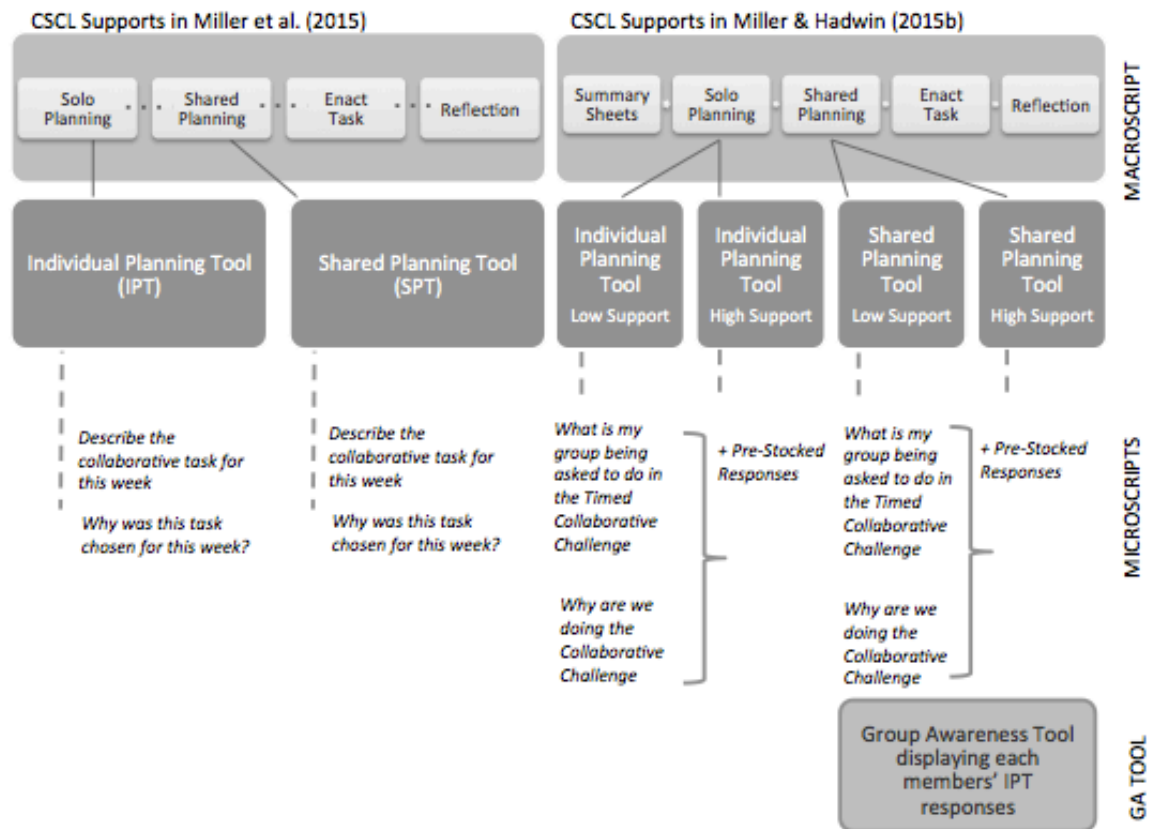


Figure 4. CSCL tools supporting regulation of collaboration in Miller et al. (2015) and Miller and Hadwin (2015b)

Scope of task features. A key difference between moderate and low accuracy groups concerned the scope of task information they considered. Constructing shared task perceptions that are effective for collaboration means deconstructing the multiple explicit and implicit layers of the task (Hadwin, 2006; Winne et al., 2013). However, not all groups actively engaged in this process. Moderate accuracy groups delved further into the multiple layers of task information and constructed shared task perceptions about both explicit and implicit task features. On the other hand, low accuracy groups' shared task perceptions were narrow in scope consisting of either explicit or implicit task perceptions rather than both. Thus, engaging in active and systematic analysis of task features appeared to be a key contributor to accuracy in this study.

Planning as an individual and group process. A second difference concerned the degree to which groups approached planning as a shared vs. individual process. Negotiating shared task perceptions establishes a foundation for subsequent regulation (Hadwin et al., 2011). However, examination of chat records and log files revealed that low accuracy group members planned mainly as individuals (e.g. by checking task instructions and viewing planning prompts). On the other hand, moderate accuracy groups planned both individually as well as together (e.g. by discussing plans in chat or exchanging ideas in the shared planning tool). It was through these interactions that groups were able to construct shared task perceptions. Thus, approaching planning both individually and together appeared to contribute to accuracy of shared task perceptions in this study.

Capitalizing on distributed task perceptions. A third difference was that moderate accuracy groups more often became aware of each other's personal task perceptions and integrated these in their shared task perceptions. In contrast, most low accuracy groups were generally unaware of how each other interpreted the task. Thus, capitalizing on one another's personal task interpretations appeared to facilitate groups to construct more accurate shared task perceptions. This finding is in line with previous research indicating that transactive social interactions in which group members become aware of and build on one another's thinking promotes shared knowledge construction (Teasley, 1997; Weinberger et al., 2006).

Dynamic planning. Finally, moderate and low accuracy groups differed in terms of *when* they constructed shared task perceptions during the task. Moderate accuracy groups constructed shared task perceptions at multiple points during collaboration. In contrast, most low accuracy groups did so at only one point of time. Therefore, in line with the notion that regulatory processes evolve over time (Winne & Hadwin, 1998,

2008), dynamically constructing shared perceptions throughout the task appeared to be important for constructing accurate shared task perceptions in this study.

These findings contributed to the emergent research by highlighting a number of mechanisms that facilitated construction of accurate shared task perceptions. However, despite being provided CSCL supports, it is important to note that all groups evidenced difficulties. For example, all groups overlooked key task features and their shared task perceptions were incomplete compared to the instructors' task specifications. Furthermore, individual planning activities tended to dominate across all cases. When shared planning did occur, interactions tended to be shallow with members simply accepting one another's contributions with little discussion. In addition, all groups evidenced instances where they ignored or overlooked members' personal task perceptions even when they were accurate for the task. Finally, few groups engaged in shared planning activities before jumping into the collaborative task. Thus, CSCL supports in this study appeared to inadequately support groups' construction of shared task perceptions.

Defining and refining levels of support. In light of these findings, Miller and Hadwin (2015b) further investigated ways in which CSCL tools could better support groups to construct shared task perceptions. Specifically, this paper investigated the extent to which level of support in individual and group CSCL planning tools facilitated (a) groups' construction of accurate shared task perceptions, (b) the degree to which groups capitalized on members' accurate task perceptions, (c) negotiation of shared task perception through transactive discussion, and (c) final performance on the task.

Groups in this study were provided with a macro-script that emphasized collaboration as involving multiple regulatory processes including individual and shared planning phases (Figure 4). The macro-script asked students to approach the assignment

in five phases (i.e. summary preparation, individual planning, shared planning, task enactment, and reflection). While the macro-script in Miller et al., (2015) loosely orchestrated engagement in these phases, the macro-script in this study more tightly sequenced learners' engagement in each step by including dedicated times for individual and group planning.

Learners were also provided with planning tools that further facilitated individual task perceptions (Individual Planning Tool, IPT) and shared task perceptions (Shared Planning Tool, SPT) (Figure 4). These tools micro-scripted learners to consider explicit and implicit task features. The SPT also included a group awareness tool displaying group members' personal task perceptions (IPT responses) during shared planning in order to facilitate groups to draw upon each member's ideas.

Furthermore, learners and groups received either high support or low support versions of these tools. Low support tools (IPT-LS, SPT-LS) scripted task perceptions using open format questions similar to those in Miller et al. (2015) (e.g. *what is my group being asked to do during the Timed Collaborative Challenge* and *Why are we doing the collaborative challenge?*). High support tools (IPT-HS, SPT-HS) pre-stocked questions prompts with potential answers. Five of the potential answers were accurate task features defined by the instructor. The other five were common misperceptions about the task identified in our past work (cf., Miller & Hadwin, 2012).

Findings indicated that a high level of support at the group level was beneficial for groups. Specifically, regardless of level of individual support, groups receiving the high support shared planning tool (SPT-H) constructed more accurate shared task perceptions compared to groups who received the low support version (SPT-L). Furthermore, these groups capitalized on a greater proportion of group members' accurate personal task perceptions during shared planning and engaged in more

transactive group planning discussion (e.g. by eliciting multiple viewpoints and evaluating them in consideration with which were a best fit for the task).

Contrary to expectations, a high level of individual support did not enhance these processes. Furthermore, there was no evidence that a high level of both individual and group support hindered construction of shared task perceptions, as might be expected from notions of over scripting in CSCL research (e.g. Dillenbourg, 2002). Finally, findings did not reveal any statistically detectable effect of CSCL planning support at the individual or group level on group task performance. Since shared task perceptions are posited to play a foundational role in regulating collaboration, I expected that CSCL tools supporting this process would positively influence task performance. However, this was not the case in this study. Thus, while CSCL group planning supports provided an effective method of facilitating shared task perceptions, further research is needed to examine how supports can better facilitate performance.

Summarizing principles for future design. Overall, these findings contributed to the emergent understanding of how groups construct shared task perceptions for socially shared regulation as well as how CSCL supports can facilitate this process. Considering these findings together, I suggest five overarching principles emerged concerning ways in which groups can be supported to construct shared task perceptions for regulating collaboration: (a) CSCL tools should support groups to systematically analyze tasks, (b) CSCL tools should facilitate learners to become aware of their own and one another's personal task perceptions, (c) CSCL tools should facilitate groups to transactively negotiate task perceptions, (d) CSCL tools should support groups to dynamically construct shared task perceptions, and (d) CSCL tools should facilitate groups to translate task perceptions into action.

Support groups to systematically analyze tasks. While accurate task perceptions

require groups to interpret multiple layers of task features (Hadwin, 2006), findings indicated that, without a high level of support, groups often approached collaborative tasks with partial or incomplete interpretations of task specifications. These findings add to the emergent research evidencing difficulties groups encounter with this foundational process (Hadwin et al., 2010; Miller & Hadwin, 2012). Therefore, a key way to support groups to construct shared task perceptions may be to explicitly prompt or guide learners to systematically consider multiple layers of explicit and implicit task information.

CSCCL scripts for regulation offer much promise towards this aim. Specifically, in this dissertation, micro-scripts were used to prompt analysis of explicit task criteria (e.g. *what is my group being asked to do*) and implicit task purpose (e.g. *Why are we doing the collaborative challenge*). In addition, findings across studies indicated that these supports were most effective when they provided groups with a high level of support (e.g. required groups to choose among pre-stocked answers listing the relevant task features among common misperceptions of the task).

Facilitate learners to become aware of task perceptions. In this research, the extent to which groups capitalized on members' personal task perceptions appeared to contribute to the accuracy of shared task perceptions (Miller et al., 2015). However, without a high level of group support, groups often overlooked members' personal task perceptions even when they were accurate (Miller et al., 2015; Miller & Hadwin, 2015b). These findings are in line with previous research indicating that although collaboration requires groups to regulate across the individual and group level (Hadwin et al., 2011; Järvelä & Hadwin, 2013), metacognitive knowledge does not always become shared within the group (e.g. Hurme, Merenluoto, & Järvelä, 2009). These findings indicate that a key target for supporting shared task perceptions is helping

groups to become aware of the range of task perceptions held by individual members. Facilitating groups to identify differences among their personal task perceptions might create opportunities for groups to leverage one another's interpretations thereby negotiating more accurate and complete shared task perceptions together.

Moving forward, I suggest group awareness tools, in particular, offer much promise for this purpose. For example, Miller and Hadwin (2015) provided groups with an awareness tool that displayed collective summaries or visualizations of individual's task perception ideas to the group. The tool aimed to facilitate learners' to see the full range of task perceptions in the group by displaying IPT responses as either a bar graph (frequency of different ideas) or a rudimentary text summary. However, visualization tools can be designed in a multitude of other ways towards this end. For example, groups could be provided with a simple visualization of all group members' task perceptions without frequency data or a cluster map of similar ideas and outliers. In addition, similar to metacognitive tools described by Soller et al. (2005), awareness tools could provide metrics about the overall accuracy or similarity of task perceptions within the group. Furthermore, while visualizations of task perceptions in this study were static, groups may find it helpful to see a map of each other's personal task perceptions that updates in real time as members construct and revise their interpretations of the task during collaboration.

Facilitate groups to transactively negotiate task perceptions. Constructing shared task perceptions demands that learners exchange and negotiate interpretations of the task through social interaction (Hadwin & Oshige, 2011; Hadwin et al., 2011). However, findings indicated that, without a high level of support, groups often (a) approached collaborative planning as an individual process (Miller et al., 2015), and (b) engaged in relatively shallow discussion of task features, such as by simply accepting

one another's statements without evaluating or building on these ideas (Miller et al., 2015; Miller & Hadwin, 2015b). Thus, findings indicate that an important aspect of supporting shared task perceptions is facilitating groups to transactively discuss and negotiate task perceptions.

While scripts in this dissertation targeted knowledge of task features, one possibility towards this end is shifting the target of scripts to transactive negotiation of shared task perceptions. For example, research in CSCL has evidenced the positive effects of social scripts that specify how learners interact in domain knowledge construction (e.g. Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2013; Weinberger, et al., 2005). Similarly, social scripts in regulation could be used to prompt groups to more transactively negotiate shared task perceptions. In this case, learners could be provided with sentence starters such as, "*This isn't clear to me yet, can you elaborate*", "*we have not reached consensus about...*" or "*my proposal for an adjustment of this interpretation is...*".

Support groups to dynamically construct shared task perceptions. Another key finding in this dissertation was that groups who constructed accurate shared task perceptions did so at multiple points throughout the task (Miller et al., 2015). This finding is in line with theoretical perspectives conceptualizing regulation to be a dynamic and recursive process that evolves over time (Winne & Hadwin, 1998, 2008). However, similar to previous research of shared planning indicating groups sometimes jump into tasks without discussing what is required (cf. Rogat & Linnenbrink, 2011), groups seldom discussed the task or planned collaboration before starting work on the collaborative task (Miller et al., 2015). Therefore, prompting or guiding groups to construct and revise task perceptions at different points during collaboration appears to be an important target for support. For example, drawing on experience sampling

methods, planning tools might prompt groups to consider task perceptions at different points in the task. These points could be defined on a time basis (e.g. after a certain amount of time or number of days has elapsed) or on an event basis (e.g. each time the group meets to work on the task or when learners meet a certain threshold in reported challenges related to planning).

Facilitate groups to translate task perceptions into action. Finally, shared task perceptions are posited to play a foundational role in regulating collaboration by setting the stage for effective planning and informing standards against which progress, processes, and products can be monitored and evaluated (Winne & Hadwin, 1998, 2008; Winne et al., 2013). Thus, it was expected that CSCL tools supporting this process would positively influence task performance. However, findings did not reveal any statistically detectable effect of CSCL planning support at the individual or group level on group task performance (Miller & Hadwin, 2015b). One explanation for this finding is that planning tools supported groups to construct task perceptions, but did not support groups to make use of these task perceptions to regulate collaboration.

While further research is needed to examine how planning tools impacted groups' engagement in the task, it is possible that an important target for CSCL tools is supporting learners to translate task perceptions into action. For example, scripts could be designed that more directly prompt consideration of what task specifications mean for the groups' engagement rather than or in addition to asking learners and groups to define the task specifications. For instance, prompts could target learners to consider task perceptions in relation to their prior knowledge or group work experience (e.g. *Based on experience with similar tasks, what important things should we consider in order to meet these task criteria*) or learners' strengths and weaknesses (e.g. *What strengths and weaknesses does our group have that will allow us to meet the task*

specifications).

Overall, by investigating how groups constructed shared task perceptions in authentic CSCL contexts, this research contributes to theoretical understanding of how this process evolves, while also providing evidence-based principles about how CSCL tools can support this process. In this way, findings allow readers to determine which insights may be relevant to development and implementation of supports in their own settings (cf., Linn, Bell & Davis, 2004; van den Akker, 1999).

However, a number of limitations are important to note. First, although CSCL supports enhanced groups' planning processes compared to the minimal amounts seen in previous research (Hurme et al., 2009), quality of these processes varied. In particular, no groups in Miller et al. (2015) constructed highly accurate shared task perceptions. Thus, research is needed to further explore how task perceptions successfully unfold in order to further inform design principles for CSCL supports.

Another limitation concerns the degree to which findings can be generalized beyond this context. Factors such as task characteristics (e.g. informal vs. formal) and learner and group characteristics (e.g. teamwork experience, domain knowledge expertise, group dynamics, and self-efficacy) provide the conditions that frame construction of personalized task perceptions for collaboration (Winne & Hadwin, 1998, 2008). Thus, research is needed to examine how shared task perceptions evolve in different types of tasks and teams to better understand how these factors influence the construction of shared task perceptions as well as the types of supports needed.

Aim 2: Leveraging CSCL Tools to Research Shared Task Perceptions

A second purpose of this dissertation was to explore methods for capturing and analyzing shared task perceptions. Conceptualizing groups as comprised of individual self-regulating agents who constitute a social entity that must also regulate together

requires a more varied set of analytical techniques than is common in research about self-regulated learning to date (Hadwin, et al., 2010; Perry & Winne, 2013; Vauras & Volet, 2013). In particular, it requires (a) researching shared task perceptions as a situated and contextual phenomenon, (b) capturing task perceptions as socially constructed by groups, and (c) capturing the ways in which shared task perceptions evolve across the individual and group level.

In this dissertation, I grappled with these challenges by using CSCL supports not only as a way to promote shared task perceptions, but also as a methodological solution. Specifically, CSCL tools and environments were used to collect three types of data: (a) individual and shared perceptions of the task reported in individual and shared planning tools, (b) chat records of groups' discussions about task perceptions, and (c) log files of planning activities (e.g. viewing or editing planning tools). In the following section, I discuss the strengths and weaknesses of this approach.

Researching shared task perceptions as a situated and contextual phenomenon. Contemporary perspectives view regulated learning as an adaptive and oriented event (Perry & Winne, 2013). Thus, a key focus in this dissertation was exploring methodological approaches for examining shared task perceptions as they arise in the context of specific tasks. To address this issue, the Individual Planning Tool and Shared Planning Tool were used as context specific measures of task perceptions. Question prompts scripting analysis of explicit and implicit task features provided a way to capture learners' and groups' perceptions of the task as it occurred. In addition, the CSCL environment recorded chat logs of group discussion about task perceptions as well as time stamped log file data about group members' planning activities in the task. While retrospective self-reported data is often flawed and miscalibrated in terms of what actually took place during learning (Winne, 2010), this approach provided

valuable insight into what learners believed about the task and how task perceptions were constructed at specific points during collaboration.

A limitation of this approach is that planning data alone provided limited information about how shared task perceptions were constructed in the context of other collaborative activities. Knowing something about the larger picture of how collaboration is unfolding within and across tasks is essential for better understanding how and why groups construct shared task perceptions at different points during their work together.

In particular, it would be fruitful to investigate situations where groups negotiate or revise shared task perceptions to overcome challenges during collaboration. These challenges may be directly related to disagreements or difficulties with task requirements (e.g. groups or group members are uncertain about what is required or received a poor grade on their previous task). Alternatively, challenges may also be related to other aspects of regulation. For example, groups may renegotiate task perceptions to overcome waning motivation in the group (e.g. to better understand why the task is important).

Capturing task perceptions as constructed at the group level. While research about self-regulated learning has typically focused on individual regulatory processes and factors, researching shared regulation brings the group into the foreground (Järvelä, et al., 2013b). Thus, capturing shared task perceptions as a social phenomenon requires extending beyond individually focused data collection methods to capture this process at the group level.

In this dissertation, groups' planning tool responses were used to capture groups' shared task perceptions. In Miller et al., (2015) and Miller and Hadwin (2015b), groups were provided with Shared Planning Tools (SPTs) scripting them to analyze the

task features. Groups were tasked with co-constructing a single response for the group. In this way, rather than aggregating individual reports across members, groups' SPT responses provided a valuable window into shared task perceptions constructed at the group level.

Interestingly, findings of Miller et al. (2015) revealed that SPT responses alone were inadequate for identifying groups' shared task perceptions. Specifically, SPT responses did not always represent the group since members sometimes completed tools individually without knowledge or participation of others. Thus, complementing SPT responses with other sources of data was critical for teasing out shared task perceptions. Specifically, in both Miller et al., (2015) and Miller and Hadwin, (2015b), SPT responses were used in concert with chat discussions about task perceptions and log files of how ideas were added and viewed in the SPT to identify shared task perceptions agreed upon by the group.

A limitation of this approach was that examining discussions and traces of planning activity raises questions about the degree to which task perceptions were truly 'shared.' Despite negotiating consensus, it is possible learners still diverged about what task perceptions mean for the task. For example, a group may agree the task requires them to *analyze* a case scenario, but group members may have different understanding about what an analysis entails. Alternatively, group members may agree with a suggested interpretation of the task simply to move the work along or to avoid disagreement. Future research would benefit from complementing traces of group planning with other measures to corroborate findings. These might include (a) self-reports or interviews about what group members perceive about their shared planning, and (b) traces or observations of how learners and groups put their task perceptions into action during collaboration.

Task perceptions across the individual and group level. In this dissertation, groups were viewed as comprised of multiple self-regulating individuals who at the same time regulate together (Hadwin et al., 2011; Järvelä & Hadwin, 2013; Volet et al., 2009). Thus, a third challenge to research about shared task perceptions is examining how this process evolves across the individual and group level. To address this issue, both Miller et al., (2015) and Miller and Hadwin (2015b) used CSCL tools to (a) capture group members' personal task perceptions reported in Individual Planning Tools (IPTs), and (b) identify groups' shared task perceptions in Shared Planning Tool (SPT) responses, chat discussions, and log file data of tool use.

Using CSCL tools to capturing task perceptions at both the individual and group level enabled examination how personal and shared task perceptions intertwined during collaboration in ways that would have been difficult to directly examine or observe otherwise. For example, because learners do not always make their perceptions of the task observable in group interactions, IPT responses were invaluable for capturing what each group member personally believed about the task. In addition, comparing personal and shared task perceptions allowed examination of how groups capitalized on members' different beliefs about the task. Specifically, Miller et al. (2015) used Venn diagrams in case profiles to represent individual and group task perceptions in each group. These were helpful for visualizing the differences remaining at the end of the task. Miller and Hadwin (2015) used comparisons more quantitatively by calculating the proportion of accurate task perceptions groups included in their shared task perceptions.

One limitation of this approach is that it rests on the assumption that group members accurately report their personal task perceptions in the IPT. However, describing task perceptions is a cognitively demanding process that may be affected by

factors including effort, writing ability, and time constraints. Individuals may not fully explicate their task perceptions in planning tools, forget task perceptions they generated when working alone, or change their minds in ways not observable in the data. Thus, complementing IPT responses with other methods, such as interviews, would be fruitful in future research. A second limitation concerns the cyclical and recursive nature of task perceptions. Macro-scripts in this research prompted learners to complete the IPT prior to completing the SPT. This provided limited information about how individual and shared task perceptions evolved reciprocally throughout the task. Future research would benefit from capturing and comparing shifts in task perceptions across the individual and group level at multiple points during collaboration.

Future Directions

In this program of research, I examined how CSCL tools can be leveraged to support and research shared task perceptions for shared regulation of collaboration. Findings shed light on how task perceptions evolved in collaboration as well as how CSCL tools can be designed to support these processes. Furthermore, as measurement of shared regulatory processes is critical for design and evaluation of CSCL supports, this dissertation also explored ways in which CSCL tools themselves can be used to capture this process. Moving forward, I suggest two major directions for future research: (a) research is needed to investigate and promote shared task perceptions as a dynamic and adaptive process that evolves across challenge episodes and tasks; and (b) further research is needed to examine and promote regulation of collaboration as multidimensional phenomenon occurring at multiple social levels.

Shared task perceptions as adaptive across time and task. Findings of this research advanced understanding about how shared task perceptions develop and can be supported in the context of a collaborative task. However, contemporary perspectives

posit that regulation implies adaptation and change over time (cf. Winne & Hadwin, 1998, 2008). Future research should investigate how groups dynamically adapt task perceptions in instances when they confront challenges and across multiple tasks. Critical questions include (a) how do groups recognize the need to adapt shared task perceptions, (b) what types of cognitive, motivational, emotional, behavioural and social challenges prompt groups to revisit shared task perceptions, and (c) how does adaptation of shared task perception arise across the individual and group level. Understanding how individuals and groups build on shared task perceptions to maximize their collaborative efforts is vital to supporting learners to gain 21st century skills for regulating collaboration.

Furthermore, from the view that regulating collaboration is a critical skill learners must be supported to develop, the ultimate goal of providing learners with CSCL supports is to facilitate their continued engagement in regulatory processes after supports are longer available as well as transfer these skills to other appropriate collaborative situations (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989; Winne, et al, 2013). Thus, I suggest a key avenue for future research is examining how tools can be designed to facilitate this process. This means exploring development of adaptive tools or agents that (a) provide as needed and calibrated support to groups, or (b) allow groups to adjust or select the level or type of support required. While research has begun to explore these types of tools for individual regulation (cf. Manlove, Lazonder & de Jong, 2007; Winters & Azevedo, 2005), the question of how this might occur for shared regulation or shared metacognition has only recently emerged (e.g. Molenaar et al., 2012; Järvelä, et al. 2014).

Supporting regulation of collaboration as a multi-faceted. A second avenue for research concerns the multidimensional nature of regulation. Findings in this

dissertation indicated CSCL tools can be designed to facilitate shared task perceptions. However, regulation of collaboration is a complex multifaceted process in which learners engage in self-, co-, and shared regulation of their cognition, behaviour, motivation, and emotions in collaborative tasks (Hadwin et al., 2011; Järvelä & Hadwin, 2013). Thus, research is needed to investigate regulation as a dynamic collection of interrelated processes across social levels.

Moving forward, one line of inquiry should investigate how shared task perceptions evolve with subsequent regulation and how CSCL tools facilitate this process. Winne and Hadwin (1998, 2008) note that the products of one phase become the conditions of future phases. Thus, groups' shared task perceptions and tools promoting this process can influence a wide array of outcomes beyond planning. For example, these might include groups' engagement in subsequent phases of shared regulation (e.g. shared goals and plans and strategic enactment of the task). Other outcomes may include challenges individuals and groups encounter working together, such as difficulties with domain knowledge construction or difficulties in emotional, motivational or social aspects of teamwork. Finally, because conditions include groups' knowledge and beliefs about themselves as learners (Winne & Hadwin, 1998, 2008), shared task perceptions and CSCL supports may also influence factors such as groups' perceptions of their strengths and weaknesses and their motivation and drive to get the work done.

In addition, when groups collaborate, individual and shared regulation intertwine. The products of shared regulation (e.g. shared task perceptions) update conditions of future individual regulation (See Figure 2). In this way, shared task perceptions and planning tools facilitating this process may also influence facets of individual regulation. These might include (a) learners' subsequent engagement in

phases of self-regulation (e.g. personal goals and strategies for contributing to the joint task), (b) personal challenges encountered, and (c) personal knowledge and beliefs about themselves as collaborators (e.g. their self-efficacy for the collaborative task and beliefs about working with others).

A second line of inquiry concerns how tools can be designed to promote the multifaceted nature of regulation. Tools in this research prompted learners to consider task features (e.g. analysis of task explicit and implicit task features). However, future research could investigate supports that directly facilitate learners to consider what task perceptions mean for regulating in the task. For instance, scripting tools could prompt learners and groups to consider how task perceptions may carry forward to shape their engagement (e.g. *what goals should we set in light of these task features and specifications*). Alternatively, tools might prompt or facilitate learners and groups to consider themselves in relation to task. For instance, group awareness tools might be used to reflect members' perceptions of their individual and collective strengths and weaknesses in relation to task demands. Doing so may facilitate groups to use this information to direct their goals, plans, and strategic engagement. Finally, it may be useful for tools to target the intersect between individual and shared task perceptions. For example, as previously discussed, social scripts in regulation could be used to prompt more transactive forms of negotiation in which learners articulate and elicit one another's points of view and integrate and build on them to co-construct shared task perceptions.

However, shared task perceptions are only one aspect of regulating collaboration. To drive theory, practice, and research, we need to understand how regulation of collaboration unfolds through self-, co-, and shared regulation and across all phases of regulation. Thus, attention needs to be turned to investigating and

supporting regulation of collaboration as a whole. While capturing and supporting all aspects of regulation across all social levels is exceptionally challenging, research integrating these different facets and levels of regulation is key for understanding how regulatory processes work together to facilitate successful collaboration.

Conclusions

In both academic and work contexts, learners are increasingly required to work collaboratively and make use of technologies for teamwork. However, collaboration is challenging, and many learners lack skills for regulating this process. Research in dissertation this took steps towards understanding how learners can be supported to gain these critical skills by investigating how CSCL tools can be leveraged to support and research shared task perceptions for regulating collaboration. Findings have a number of implications for theory, research, and practice.

This dissertation contributes to emergent conversations about self-, co-, and shared regulation. In recent years, discussion of social aspects of regulation has become increasingly prevalent; however, inconsistency remains in how these terms are operationalized and defined (Hadwin et al., 2011; Järvelä & Hadwin, 2011; Volet et al., 2009). Thus, research in this dissertation contributes to theoretical development in the field by further conceptualizing how these processes can be modeled and defined.

Specifically, in this dissertation, Winne and Hadwin's (1998, 2008) model of self-regulated learning provided a useful framework to consider the ways in which these processes intertwine. In particular, extending the COPES architecture to account for shared regulatory processes allowed for a detailed account of how shared task perceptions might evolve reciprocally between individuals, groups, and the physical and social context. Moving forward, I suggest it can also provide a useful framework for investigating other aspects and facets of regulation of collaboration. These might

include the ways in which groups negotiate shared goals and standards, select and adapt strategies for regulating their thinking, motivation, emotion, and behaviours, and share in the monitoring and evaluating of their progress and products.

The emergent nature of this field also means empirical research is scarce (Panadero & Järvelä, 2015). While prior studies have often focused on identifying episodes of shared regulation and distinguishing self- and social aspects of regulation, findings of this research shed light on how groups construct shared task perceptions during collaboration as well as factors that contribute to this process. In addition, this research takes steps towards supporting this process by (a) proposing ways in which CSCL tools anchored in theory can support shared task perceptions in shared regulation of collaboration, and (b) generating evidence based principles for future design of CSCL tools. Finally, by using CSCL tools to both promote and research shared task perceptions, this dissertation explored methodological solutions for capturing, analyzing, and representing this process. In particular, making use of multiple sources of individual and group level data generated as learners interacted with the CSCL environment provided valuable insight into how task perceptions unfolded across the individual and group level in the context of real collaborative tasks and situations.

In practice, findings bring new knowledge and opportunities to facilitate learners to develop skills for regulating teamwork. The close tie between research and practice in this dissertation means findings provide insight into how instructors can facilitate learners to construct shared task perceptions in collaborative tasks. In addition, this research produced a number of concrete design artifacts that can be further implemented, tested and refined by practitioners in wide range of learning situations. Finally, while CSCL research often uses specialized technologies, tools in this dissertation were also designed in Moodle, an open source platform widely available to

instructors in post-secondary institutions.

Overall, findings in this dissertation advance understanding about how shared task perceptions unfold in collaboration and how learners can be supported to engage in this process. However, further investigation is required if we are to support learners to gain 21st century skills for regulating collaboration. As the field progresses, research is needed to examine and support regulation as a multi-faceted process that dynamically unfolds over time across multiple social levels. While this is a challenging endeavour for researchers, both theoretically and methodologically, it offers great potential to facilitate learners to gain the often overlooked regulatory skills quintessential for collaboration in today's knowledge economy.

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Manuscripts

Manuscript 1: Miller M., & Hadwin, A. F. (2015a). Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Computers in Human Behavior.*

Abstract

This conceptual paper addresses the need to design tools for supporting regulation in computer supported collaborative learning (CSCL). First, we extend previous work articulating the important role of self-regulation, co-regulation, and shared-regulation in successful collaboration (Hadwin, Järvelä, & Miller, 2011; Järvelä & Hadwin, 2013). Second, we draw on this theoretical framework to address the capacity of CSCL environments to support regulation of collaboration in the form of two types of tools: (a) Scripting tools that structure and sequence collaborative interactions, and (b) group awareness tools that collect, aggregate and reflect information back to learners to facilitate collaboration. Finally, directions for future research of regulation of collaboration and CSCL regulation tools are discussed.

Introduction

In today's global distributed economy, the ability to work productively, innovatively, and efficiently in teams is becoming a necessary skill. Whether one is working as part of a distributed team developing software, researching new technologies for learning, designing new energy systems, or writing policy briefs for government, there is a need to be able to draw upon tools and technologies for communicating productively and constructing innovative knowledge solutions.

This type of collaboration involves more than just coordinating tasks and distributing work across people and sites (Dillenbourg, 1999). It involves regulating collaboration through (a) intentionally negotiating task goals and standards, (b) strategically using tools and strategies, (c) monitoring progress and intervening if needed, and (d) persisting in the face of challenges (Hadwin & Winne, 2012) ideally producing something better than any individual on the team could either conceive of or produce alone (Johnson & Johnson, 1989). Although regulation has been increasingly recognized as important for successful collaboration (Hadwin et al., 2011; Janssen, Erkens, Kirschner, & Kanselaar, 2012; Volet, Summers, & Thurman, 2009; Volet, Vauras, & Salonen, 2009), many learners lack the regulatory skills required for complex solo and collaborative tasks and often fail to interact productively in groups (Järvelä, Järvenoja, Malmberg, & Hadwin, 2013; Strijbos, Kirschner, & Martens, 2004; Winne, Hadwin, & Perry, 2013). Thus, post-secondary education has a responsibility to prepare students for the contemporary world beyond academia. This means ensuring students have developed skills and strategies to collaborate effectively and to make productive use of technologies and tools to support that collaboration.

Learning technologies themselves offer promise in remediating these difficulties (Järvelä & Hadwin, 2013; Morris et al., 2010). The past two decades have witnessed an explosion of computer supported collaborative learning (CSCL) technologies supporting shared knowledge construction and productive interactions (Resnick, Levine, & Teasley, 1991; Roschelle & Teasley, 1995) as well as individual and collective outcomes (Salomon, Perkins, & Globerson, 1991). While CSCL tools often target productive interaction or functional coordination in the aim of domain knowledge

construction, their capacity to support regulation has been largely overlooked (Järvelä & Hadwin, 2013).

As such, the purpose of this paper is twofold. First, we begin by extending our previous work articulating the role of self-regulation, co-regulation, and shared regulation in successful computer supported collaboration (Hadwin, Oshige, Gress, & Winne, 2010; Järvelä & Hadwin, 2013; Winne, Hadwin, & Perry, 2013). Despite increased focus on the shared or social nature of regulation, inconsistency remains in how shared or social regulatory constructs are defined and operationalized in the current literature (Hadwin et al., 2011; Volet, Vauras et al., 2009). We aim to further define these processes in the interest of establishing a theoretical foundation on which CSCL tools for promoting regulation can be based.

Second, we build on this theoretical foundation to introduce innovative ways in which two types of CSCL tools can be leveraged to support regulation of collaboration: (a) scripts that structure and guide collaboration by specifying, sequencing, and distributing activities and roles to be enacted in collaboration (Dillenbourg, 2002; Fischer, Kollar, Stegmann, & Wecker, 2013), and (b) group awareness tools that use visualizations or graphical representations of group members' cognitive, behavioural, or social processes so group members can better access and use this information to coordinate collaboration (Bodemer & Dehler, 2011; Janssen & Bodemer, 2013). To illustrate the potential of these tools for regulation, we provide examples of scripting and awareness tools designed as part of a larger design-based research project (PAR-21 Promoting Adaptive Regulation for 21st Century Success). Finally, we conclude by discussing directions for future research of regulation of collaboration and how CSCL tools can support this process.

Regulation of Collaboration

Grounded in early conceptualizations of self-regulated learning (SRL) (Zimmerman, 2008), regulation of collaboration can be defined as an intentional, goal directed metacognitive activity in which learners and groups take strategic control of their actions (behaviour), thinking (cognitive), and beliefs (motivation, and emotions) in the context of dynamic social interactions (Hadwin et al., 2011; Iiskala, Vauras, Lehtinen, & Salonen, 2011; Volet, Summers et al., 2009; Volet, Vauras et al., 2009). Specifically, it requires learners and groups to (a) intentionally set and negotiate task goals and standards to guide work, (b) strategically adopt and adapt tools and strategies to optimize task performance and learning, (c) monitor progress and intervene if results deviate from plans, and (d) persist and adapt in the face of challenges (Winne & Hadwin, 1998; Zimmerman, 1989).

What is Regulation of Learning?

To frame our subsequent discussion of how regulation may occur in collaboration and how tools can be designed to support it, we first outline four widely accepted assumptions about regulated learning (cf., Hadwin et al., 2011; Järvelä & Hadwin, 2013).

Regulated learning is intentional and goal directed. Regulated learners set and commit to goals for their learning. Goals translate learners' interpretations of the task into specific strategic aims and directions (Winne & Hadwin, 1998, 2008). Goals can vary in specificity, proximity, hierarchical nature, congruence, difficulty, and process/product orientation (cf. Locke & Latham, 2002; Zimmerman, 2008). However, goals are fundamental for regulation because they serve as standards against which learners can monitor and evaluate progress, and products.

Regulated learning is metacognitive. Metacognitive planning, monitoring and control are central components in theories of regulated learning. Monitoring involves

(a) comparing a current state with a desired state (goal standard), and (b) making a judgment (evaluation) about goal attainment. When a discrepancy is perceived, it provides learners with an opportunity to strategically adapt their thinking, feelings, or actions.

Regulated learning is strategic control of behaviour, cognition, motivation, and emotion. Regulation is about monitoring and controlling thinking (cognition), actions (behaviours), and beliefs (motivation and emotion) in pursuit of a goal. In collaborative contexts, an important distinction can be made between groups' knowledge construction (shared cognition) and their regulatory processes (Järvelä & Hadwin, 2013). A fundamental difference between these processes is the target information (Winne et al., 2013). In shared knowledge construction, the focus is on knowledge constructed about the domain (e.g. argumentation and elaboration of domain knowledge). In shared regulation, the focus is on constructing metacognitive, meta-motivational, and meta-emotional knowledge about the collaborative learning processes (e.g. negotiating and aligning representations of tasks and goals, selecting tools and strategies for working and learning together, and monitoring and evaluating progress and products in light of these goals). In this way, regulation can be conceptualized as providing the underlying mechanisms that enable groups to successfully engage in shared knowledge construction during collaboration.

Regulated learning is social. Although social context has historically been viewed as an external influence on collaboration, the fundamentally social nature of regulation has become increasingly emphasized in recent years (Hadwin & Oshige, 2011; Hadwin et al., 2011; Volet, Vauras et al., 2009). Whether regulation is seen as developing through external environmental supports, appropriated within social interactions, or situated in social activity systems, consideration of the social surround and interplay is key.

Three Types of Regulation in Collaboration

Recent perspectives suggest three types of regulation are required for successful collaboration (see Hadwin et al., 2011; Järvelä & Hadwin, 2013): (a) self-regulated learning (SRL) in which individuals take responsibility for regulating their own thinking, behaviour, motivations and emotions in a collaborative task (e.g. Winne & Hadwin, 1998, 2008), (b) co-regulated learning (CoRL) in which group members support others to engage in regulation of their own learning often in the service of the collaborative task (Hadwin & Oshige, 2011; Hadwin et al., 2011), and (c) shared regulation of learning (SSRL) in which groups collectively regulate their behaviour, motivations, and emotions together in a synchronized and productive manner (Hadwin et al., 2011; Järvelä, Järvenoja, & Näykki, 2013). From this perspective, regulating collaboration is a social endeavour. Shared regulation emerges alongside self and co-regulation and these three forms of regulation work together as a basis for successful collaboration.

Table 1. *Three Types of Regulation in Collaboration*

	Self-regulated learning (SRL)	Co-regulated learning (CoRL)	Shared regulation (SSRL)
Who regulates	Oneself (I/My perspective)	Other(s) (You perspective)	Group (We perspective)
Regulatory constructs	An individual regulates his/her own their thinking, behaviour, motivation, and emotions in the joint task	Individual(s) temporarily guide, prompt, nudge and support each other's self-regulation in the joint task	The group collectively regulates their thinking, behaviour, motivation, and emotions in the joint task
<i>Regulatory processes</i>			
Whose task understanding	Mine: Monitoring, evaluating, and adapting my: (a) personal perceptions of task requirements, purpose, and social context; (b) knowledge and beliefs about my own strengths & weaknesses and responsibilities with respect to this task	Each other's: Supporting each other to accurately monitor, evaluate and adapt (a) personal perceptions of task requirements, purpose, and social context, (b) knowledge and beliefs about strengths, weaknesses, and responsibilities we bring to the task	Ours: Aligning individual task perceptions, beliefs and self-knowledge to negotiate shared: (a) perceptions of task requirements, purpose and social context, and (b) awareness of our collective strengths, weaknesses and task responsibilities
Whose goals (standards) and plans	Mine: Goals and task standards I hold for myself in this joint task and plans for approaching & contributing to the joint task (including standards about motivational and emotional states and task process and product)	Each other's: Awareness and support for each other's task goals and standards (including awareness of motivational and emotional states and standards)	Ours: Aligning personal goals and standards to negotiating consensus around joint goals, standards and plans to guide our collective task completion
Whose strategic task enactment	Mine: Selecting, adapting and generating tools and strategies to help me attain task goals and standards, maintain motivational engagement, and mediate socio-emotional challenges	Each other's: Guiding and supporting each other to select, adapt, and generate productive strategies and approaches to attain task goals and standards, maintain motivational engagement, and mediate socio-emotional challenges	Ours: Negotiating and co-constructing strategies and approaches to attain shared task goals and standards, maintain motivational engagement, and mediate socio-emotional challenges
Whose monitoring and evaluation	Mine: Monitoring and evaluating own progress and products in relation to individual and/or joint goals. Individual process and product awareness and responsibility	Each other's: Supporting each other to monitor and evaluate individual progress with respect to individual and/or joint goals. Awareness and responsibility for each other's contributions and progress	Ours: Monitoring and evaluating our joint progress towards goals; Making collective decisions about progress/products. Collective process and product awareness – joint responsibility
Whose adapting	Mine: Making a change when my task perceptions, goals, plans, strategies are not working for the current task or future tasks; Persisting in the face of challenge	Each other's: Supporting and prompting each other to make changes when task perceptions, goals, plans, strategies are not working for the current task or future tasks. Helping others to persist in the face of challenge	Ours: Collectively driving or making changes to joint task perceptions, plans goals, plans when needed for the current task or future tasks; Collectively persisting and finding solutions in the face of challenge

In our work, we have modelled these forms of regulation using Winne and Hadwin's (1998, 2008) model of self-regulated learning. Table 1 contrasts self- co- and shared regulation in a collaborative task from this perspective. While several models of self-regulation have been developed over the past decades (e.g. Pintrich, 2000; Zimmerman, 1989, 2000), we selected Winne and Hadwin's (1998, 2008) model for three reasons. First, by conceptualizing SRL as a recursive process with weakly sequenced phases that learners may cycle through multiple times during a task, this model allows for a nuanced and detailed understanding of when and how regulation unfolds within and across tasks (Greene & Azevedo, 2007). Second, Winne and Hadwin's model separates task planning into two separate phases: task understanding and goal setting. This explicit recognition of task understanding as a critical phase of regulation complements the broader literature of collaboration emphasizing the importance of a common understanding of the task as key aspect of teamwork. Finally, by emphasizing that conditions, both external and internal, are intertwined with learners' regulatory choices in each phase, Winne and Hadwin's model is well positioned to explain regulation as historically and culturally situated as well as occurring at multiple social levels.

Self-regulation of collaborative learning. Over two decades of research indicate successful students self-regulate in solo tasks (Winne & Hadwin, 1998, 2008; Zimmerman, 1989). Contemporary perspectives further posit SRL to be important for working and learning with others in complex collaborative tasks (Hadwin et al., 2011). When individuals self-regulate in collaboration, they deliberately plan, monitor, and regulate their own cognition, behaviour, motivation, and emotions. Specifically, the learner takes responsibility for setting goals and standards for his/her own contributions to the group and monitoring and regulating his/her own actions, beliefs and attitudes towards the task.

Winne and Hadwin (1998, 2008) conceptualize SRL as unfolding over four loosely sequenced and recursively linked phases. In the first phase, individuals construct interpretations of the collaborative task (Phase 1: Task understanding). Based on these task perceptions, learners set personal goals and standards to attain during collaboration as well as plans for strategically approaching the collaboration task (Phase 2: Goal setting and planning). In Phase 3 (Task enactment), learners draw flexibly upon a range of strategies to achieve these goals in the task. Throughout this process learners metacognitively monitor and evaluate processes, progress, and products. By doing so, they can strategically adapt their task perceptions, goals, and engagement to optimize their engagement in collaboration in the current and future tasks (Phase 4: Small and large scale adaptation).

Figure 1 provides three examples of group members self-regulating 'out loud' in a group chat, although it is important to note that individuals do not always make SRL visible to others in this way. In example 1, Megan is regulating her thinking by using a cognitive strategy (creating a compare/contrast table) to help her organize her ideas for the group's answer. In example 2, Cam is regulating his behaviour by monitoring his approach (typing out the group's answers) and evaluating this approach as inefficient because it is wasting time. In example 3, Rachel is regulating her emotions and her cognition. She is experiencing an emotion challenge (feeling frustrated) and a cognitive challenge (coming up with good ideas). She adapts to fix both problems by asking another person to take over her role as editor (behavioural strategy). Rachel's example is not unusual in our data. Many times different targets of regulation (e.g. emotion and cognition) are woven together and not clearly separable. In all cases, the group

member's regulation is primarily directed towards his/her own engagement (SRL), but is indirectly in service of the group.

While self-regulation alone is not sufficient for successful collaborative learning, we suggest that productively self-regulating oneself in a group task is a necessary condition to this end. Taking responsibility for one's own learning is an important aspect of working with others whether by contributing in a timely and productive manner or dealing with the unexpected hurdles that can arise in group learning situations.



Example 1	
Megan:	Sorry I'm so quiet. I'm trying to figure out how include [domain concept] in our answer, I think it relates to what we have.
Adam:	That's okay. Do you think it's important?
Megan:	I'm making a compare/contrast table - just a second. That usually helps me organize stuff in my head.
Adam:	Oh nice. Yeah it would be good to include [domain concept] actually
Example 2	
Cam:	I'm not sure how I'm doing this is the best
Lisa:	What do you mean?
Cam:	Well I'm typing all our final answers from chat out again into our assignment
Cam:	Yeah this is taking up too much time. Sorry guys. I'm thinking I should I copy and paste
Taylor:	You're typing everything out again?
Example 3	
Rachel:	ughh guys I'm really frustrated right now. Being the editor is giving me less time to think of good ideas to add. I was wondering if anyone else wants to take over?
Sachi:	I can do the editing.
Rachel:	Ok great thank you!
Andrea:	Okay that'd be great Sachi
Sachi:	Yeah no problem.

Figure 1. Self-regulation of collaborative learning

Co-regulation of collaborative learning. Co-regulation (CoRL) of collaborative tasks occurs when individuals' regulatory activities are guided, supported, shaped, or constrained by and with others in the group (Hadwin & Oshige, 2011; Hadwin et al., 2011). Group members (a) become aware of one another's goals and progress and consider these in relation to the shared task, and (b) actively support, monitor, and regulate each other's self-regulation through questioning, prompting and restating. CoRL indirectly supports teamwork as individuals in the group are temporarily supported to take personal responsibility for directing and adapting their behaviour, cognition, motivation, and beliefs in ways that leverage the collective potential of the group.

We acknowledge, based on data-based observations, that CoRL can take multiple forms. A first form may involve one (or many) group members temporarily prompting or supporting a single member to contribute more effectively to the group. Figure 2 provides two examples of this form. In example 1, one group member (Heng) co-regulates a single group member's approach to the task (Cayley). Cayley was responsible for creating a summary sheet about SRL to help the group conduct their analysis. When Cayley has difficulty contributing information about this topic, Heng

successfully prompts her to use her summary sheet so she can bring that knowledge or expertise to the group discussion.

In example 2, Darren is feeling stressed and is having difficulty contributing to the group's answer. Group members support Darren to regulate his emotions by suggesting different strategies he can use to calm down. In both examples, individuals are supported to proactively self-regulate their own cognition, behaviour, motivation, or emotions in ways that are indirectly in service to the group task and goals. Members of the group recognize that if Cayley cannot remember or Darren panics, it will have a negative impact on the group process and product.

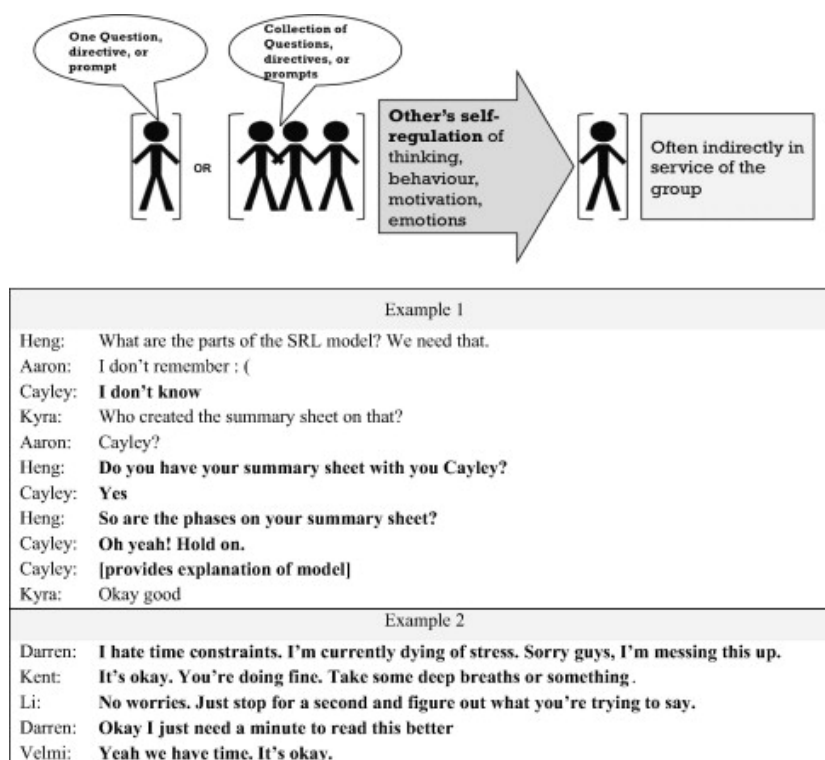


Figure 2. Co-regulation of collaboration (single group member)

A second form of CoRL occurs when one (or many) group members support or prompt multiple other group members to regulate some aspect of their individual engagement. Figure 3 shows two examples of this form. In example 1, the group is debating on what the task requires of them (e.g. the type of content required in each major section). Nina co-regulates all other group members by prompting them to open the group wiki space where the instructions are. In example 2, the group is discussing how they might go about the assignment better next time. Colbi co-regulates all other group members by suggesting each person prepare better for the assignment in advance so the group can work better together. Nala builds on this by suggesting each person have a better understanding of the task coming into the group assignment.

In both cases, individuals help and support one another to successfully self-regulate in the joint task in ways that are necessary for the group to develop shared processes and products. In order for this type of co-regulation to emerge, individuals need to be actively aware of each other's engagement, beliefs, and contributions and be willing to step in with guidance or prompts when individuals derail. This involves more than taking personal responsibility for the process. It requires individuals to assume responsibility for one another. Thus, although the co-regulation targets self-regulation

of others, that regulation is in the service of the group as it enables the group to capitalize on the strengths of individual group members. Without CoRL, opportunities for shared regulation, group innovation, and successful task completion are limited.

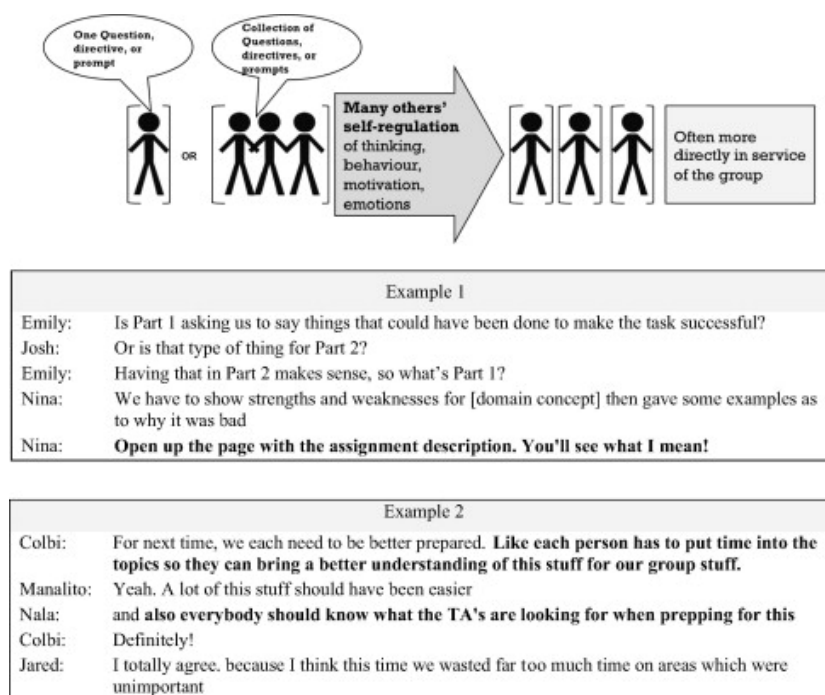


Figure 3. Co-regulation of collaboration (multiple others)

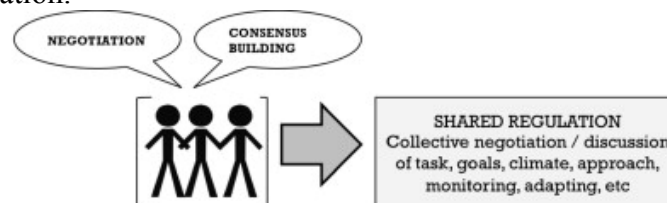
Shared regulation of collaborative learning. Shared regulation (SSRL) occurs when groups regulate as a collective, such as by construction and maintenance of interdependent or collectively shared regulatory processes, beliefs, and knowledge (e.g. task perceptions, goals, strategies, judgments of progress or performance, motivation to get the job done, and metacognitive decision making) orchestrated in the service of a co-constructed or joint outcome (Hadwin et al., 2011; Järvelä et al., 2013; Winne et al., 2013). In this case, goals and standards are co-constructed, and regulation is distributed and shared with multiple ideas and perspectives being weighed and negotiated. Shared regulation utilizes negotiation and consensus-making to change metacognitive and motivational awareness, knowledge and processes necessary for the strategic group functioning.

Winne and Hadwin's (1998, 2008) model provides a useful framework for modelling shared regulation. In phase 1, groups co-construct shared perceptions of the collaborative task as well as their motivational, cognitive, behavioural and socio-emotional strengths and weaknesses with respect to that task (Phase 1: Shared task understanding). The collective awareness of task conditions, contexts, and target outcomes created during shared task understanding creates a foundation for negotiating shared goals, standards, and plans for strategically approaching the task (Phase 2: Shared goal setting and planning). In Phase 3 (Task enactment), groups coordinate their strategic task engagement, collectively and flexibly drawing upon a range of cognitive, socio-emotional, behavioural and motivational strategies. Strategies in shared regulation are co-constructed and distributed in ways that leverage individual metacognitive and meta-motivational knowledge and capacities for the greater good of the group. Throughout these regulatory cycles collective monitoring, awareness, and evaluation

emerge to guide team decision-making and adaptation of collaborative processes, progress, and products. From this perspective, shared regulation implies strategically adapting shared task perceptions, goals, and engagement to optimize collaboration in the current and future tasks (Phase 4: Small and large scale adaptation).

Figure 4 provides three examples of groups engaged in shared regulation. In example 1, Anna, Cody, Kadija and Tyler work together to collectively monitor and evaluate part of their task product. As it becomes clear their answer falls short of what is needed, the group adapts by negotiating a different strategic approach to the task (discussing each question as a group).

In example 2, Manda, Shay, and Riley work together to make plans for approaching their assignment. They evaluate their approach to Assignment 1 (splitting up the work) and decide a change is needed. They then decide to adapt their approach for Assignment 2 (work together). Through this type of regulation, this group engages in a collective form of evaluating and large scale adapting. Similarly, in example 3, Jake, Bri, and Cam discuss their poor grade on the first assignment, read the feedback received, and adapt their perceptions of the task (it required analysis rather than description). Overall, while self-and co-regulation can assist group members to engage productively in group tasks, shared regulation is key for optimizing collaboration as it allows groups to draw on their individual members to collectively plan, monitor, and evaluate collaboration.



Example 1	
Anna:	Okay i did the first question please read and see how it is and I'll go on to question 2
Cody:	Oh wow way ahead of us
Tyler:	Do you guys think we need some details?
Kadija:	Yeah. Anna, that's really good but why don't we do a group discussion on each question – we need to make sure we don't miss anything? Great job though!
Anna:	Just wanna keep a good time going.
Cody:	Question 1 seems good to me but it's missing [domain concept]
Kadija:	Well, respectfully I think we should still all discuss each segment because while you've done an excellent job, there may be more things missing we should include
Anna:	Okay sure no problem.

Example 2	
Manda:	What's our plan for this assignment? Last time [assignment 1], we split it up. Are we doing that again?
Riley:	We all contributed really well last time but each did very individual work. We need to do a more effective job of working together this time
Shay:	We didn't really change anyone's parts. I think since we didn't read what people did, we missed out on a chance to pool our knowledge and do better.
Manda:	Okay, so let's make sure we give feedback on each other's answers in order to use all our knowledge in solving the problem

Example 3	
Jake:	Do you want to talk about the first assignment now?
Bri:	Sure.
Bri:	Wow we got 4.5 out of 10.
Jake:	Yeah didn't you know that?
Cam:	Obviously we know more than 45%. I'm opening up the comments right now
Cam:	Okay so, we needed to analyze things not describe them
Bri:	Pretty much. We didn't even touch on strengths/weaknesses.
Jake:	Yup. We needed to bring up the main points and then break them down in full detail.
Cam:	Yeah that was more than I was expecting.
Bri:	Yeah I am surprised too.

Figure 4. Shared regulation of collaboration.

Supporting Regulation of Collaboration

As collaborative learning often falls short of expectations with respect to co-constructing innovative knowledge solutions that extend beyond those of any single individual in the group (Kirschner & Erkens, 2013; Lou, Abrami & d'Apollonia, 2001; Strijbos et al., 2004; Winters & Alexander, 2011), ensuring that students develop regulatory skills and strategies necessary for productive collaboration is paramount (Järvelä & Hadwin, 2013). Regrettably, regulation of collaboration is unlikely to emerge without scaffolding or support (Hadwin et al., 2010; Winne et al., 2013). At an individual level, research consistently indicates undergraduates misinterpret academic tasks, set weak goals, and persist in maladaptive motivational cycles limiting their opportunities to optimize their learning (Butler & Cartier, 2004; Hadwin, Oshige, Miller, & Wild, 2009; Hadwin & Winne, 2012). Working collaboratively can further amplify challenges as group members misalign task perceptions and goals, experience different challenges than collaborators, and have inadequate strategies to adapt (Hadwin et al., 2011; Järvelä et al., 2013; Winne et al., 2013).

In particular, a consistent finding in our emergent research is that learners and groups struggle to construct task perceptions from which to launch engagement and future regulation (Hadwin, Malmberg, Järvelä, Järvenoja, & Vainiopää, 2010; Miller & Hadwin, 2012; Winne et al., 2013). Moreover, groups sometimes pay scant attention to this facet of regulation simply jumping into task completion with little attention to what is required (Rogat & Linnenbrink-Garcia, 2011).

While task perceptions provide foundational metacognitive knowledge for regulation (Winne & Hadwin, 1998), this shared regulatory process can be demanding for two reasons. First it requires that groups (a) become mutually aware of potential differences in their individual task perceptions, and (b) negotiate consensus or a joint representation of the task at hand. This is not to say group members must agree on one single path to achieve optimal task success. Rather, developing a common understanding of the target task features, purposes and specifications lays a solid foundation upon which to collectively monitor and evaluate joint processes and products, and negotiate strategic decisions about how to progress forward.

Second, groups' shared task perceptions are only effective for guiding collaboration if they are accurate and complete. Most complex tasks that warrant collaboration by design are layered with information and meaning extending beyond specific task instructions. Hadwin (2006) proposed at least two types of information are essential for deconstructing the details and nuances of tasks: explicit and implicit task information. Explicit task information concerns specific task requirements and standards that are often presented overtly by an instructor or client. Implicit task information is less overt and must often be inferred by putting tasks and activities in context or considering the bigger purpose or meaning. In academic work, implicit task information is often embedded in course objectives and descriptions, or in the social, conceptual or physical resources that are accessible within the context of the work. Overall, without negotiating accurate and complete interpretations of multiple layers of task information, groups may forge forward in directions that are ill advised or poorly matched to task demands or specifications.

Introducing CSCL Scripts and Awareness Tools for Regulation

Technological environments and tools offer great potential to support learners and groups gain the skills required to regulate collaboration. Carefully designed CSCL tools provide rich contexts for supporting functional coordination and knowledge construction (Dillenbourg, Järvelä, & Fischer, 2009; Koschmann, 1996; Soller,

Martínez-Monés, Jermann, & Muehlenbrock, 2005). Furthermore, technology tools and scaffolds have been used to support individual regulatory skills, processes, and engagement (Aleven, Roll, McLaren, & Koedinger, 2010; Azevedo & Hadwin, 2005; Dabbagh & Kitsantas, 2005; Perry & Winne, 2006). However, little attention has been paid to how CSCL tools can be leveraged to support learners and groups to regulate collaboration (see Järvelä & Hadwin, 2013; Järvelä et al., 2014; Lajoie & Lu, 2012).

We suggest CSCL tools can be leveraged to support regulation of collaboration when the target of support is shifted from communicative-coordination processes for knowledge construction to self-co-and shared regulatory processes such as: (a) negotiating and aligning task perceptions and goals, (b) constructing strategies for working effectively and efficiently in the collaborative task, (c) monitoring and evaluating progress, and (d) making changes when needed within and across tasks (see Table 1).

To demonstrate this potential, we next provide select examples of how we have leveraged two types of CSCL tools to support regulation of collaboration as part of a larger design-based research project investigating technological supports for self-, co-, and shared regulation of learning: (a) scripts that structure and guide collaboration by specifying, sequencing, and distributing activities and roles to be enacted (Dillenbourg, 2002; Fischer et al., 2013), and (b) group awareness tools that help group members to access information about behaviour, knowledge, or social aspects so that they can use this information to coordinate collaboration (Bodemer & Dehler, 2011; Janssen & Bodemer, 2013).

As such, rather than presenting an empirical study, this conceptual paper aims to demonstrate how theories of regulated learning can inform design of CSCL tools supporting regulation of collaboration. The instructional context in which tools were designed was an undergraduate first year course (400 students/yr) at a university in Western Canada. As part of their graded coursework, students worked in groups of four in two complex collaborative assignments called “Collaborative Challenges.” Both assignments required group members to share expertise, blend their knowledge, and aptly pool their resources to analyze and solve a case depicting a student encountering difficulties in an academic task (i.e. studying for an exam). Groups synchronously completed the assignments in a widely available online learning management system, Moodle (Modular Object-Oriented Dynamic Learning Environment; Dougiamas, 2001) and communicated with each other using a text-based chat tool. Because our previous research has indicated individuals and groups struggle to effectively plan, monitor, and adapt collaboration, these aspects of regulation are particularly emphasized in the following examples. Thus, it is important to note these examples are illustrative rather than exhaustive in terms of the many possibilities of leveraging CSCL tools for regulation.

Leveraging CSCL Scripts for Regulation

Typically, collaboration scripts in CSCL support collaborative processes by specifying, sequencing, and distributing activities learners are expected to engage in during collaboration (Dillenbourg, 2002; Kollar, Fischer, & Hesse, 2006; O’Donnell & Dansereau, 1992). While scripts vary widely in terms the objectives or aims, methods of delivery or utilization, and the types of activities they support (Kobbe et al., 2007), they have evidenced positive effects on both domain specific knowledge outcomes as well as domain general skills, such as argumentation (Rummel & Spada, 2005; Stegmann, Weinberger, & Fischer, 2007; Weinberger, Stegmann, & Fischer, 2010). To leverage scripts for regulation, we provided learners and groups with two levels of scripting that differed in terms of the granularity of support: (a) a macro-script that loosely

orchestrated engagement in phases of regulation in and across assignments, and (b) micro-scripts that provided more fine-grained support of regulatory processes in each phase.

Macro-scripting regulation. In collaborative learning contexts, macro-scripts typically take a pedagogical approach emphasizing the orchestration of activities and processes expected to enhance collaborative learning without providing further support on how to enact these activities (Dillenbourg & Hong, 2008; Suthers, 2003). For example, Dillenbourg and Jermann (2006) developed the ArgueGraph macro-script that specifies and sequences general phases in a classroom argumentation task. This script first asks learners to individually express their opinion on a controversial topic by completing a questionnaire. Students with conflicting opinions are then placed in dyads and answer questionnaire again with the task of coming to consensus on how to answer the questions. Subsequently, the instructor reviews and discusses dyads' responses to help groups elaborate on and revise their arguments. Finally, each student is assigned a question and synthesizes all arguments for that question (Kobbe et al., 2007).

To support regulation of collaboration, we used Winne and Hadwin's (1998, 2008) model of regulation to develop a regulation macro-script that specified collaborative tasks as involving (a) multiple regulatory phases beyond simply completing the task, and (b) both individual-and group-level regulatory processes (Hadwin et al., 2011; Järvelä & Hadwin, 2013). Specifically, the macro-script broke the task down into five key steps (Figure 5): (a) planning (Steps 1–3), (b) monitoring, evaluating (Steps 3 and 4), and (c) reflecting for adapting (Step 5). Steps were loosely sequenced meaning that students moved through the steps in order, but could return and revise work from previous steps at any point before completing the task. Groups then cycled through the same five steps in the second collaborative task.

Collaborative Assignment 1

The Collaborative Assignment asks you to work in groups to systematically analyze a problem case scenario, identify the root of the student's problem, and back up your group's decision with evidence. There are 5 steps to the assignment: All activities are required. You can access them in the links below.

Step 1	Step 2	Step 3	Step 4	Step 5
<p>Summary Sheet</p> <p>Assign each other topics & create your summary sheets to help solve the assignment (Due Oct 18)</p>	<p>Solo Planner</p> <p>Get ready for the assignment by figuring out what your group needs to do, why & how. (Due Oct 18)</p>	<p>Group Planner</p> <p>Before you start, get on the same page about what your group needs to do, why & how in the assignment (Oct 21)</p>	<p>Complete the Assignment</p> <p>Your group has 90 minute to complete the assignment (Oct 21)</p>	<p>Solo Reflection</p> <p>Analyze what went well and what didn't in order to improve in the next assignment (Due Oct 25)</p>



Figure 5. Macro-script structuring regulation of a collaborative assignment in the Moodle environment

Step 1 (Preparatory Expertise) occurred prior to the collaborative task and served as concept review and preparation. Each group member (a) selected one of four course topics taught and tested earlier in the course, (b) reviewed critical information, and (c) constructed a summary sheet resource to bring to the collaborative task.

In Step 2 (Solo Planning), students were prompted to actively plan for the collaborative task by (a) reviewing the assignment description and instructions, (b) constructing personal task perceptions, goals, and plans for the collaborative task, and (c) considering potential socio-emotional challenges and ways to overcome or

circumvent these difficulties.

Step 3 (Group Planning) was a dedicated group planning session occurring immediately prior to the collaborative task. Group members were encouraged to collectively plan for the collaborative task by (a) discussing the assignment description and instructions, (b) co-constructing task perceptions, goals, and plans for the collaborative task, and (c) discussing and considering potential socio-emotional challenges as well as ways to ameliorate those challenges. This step built on Step 2 to emphasize the importance of bringing together individual perspectives to ‘get on the same page’ as a group, and preceded task enactment to prompt students to actively plan before jumping into the task.

Step 4 (Task Enactment) was the actual collaborative task. Groups were asked to solve a case-based scenario. They were provided with (a) a complex scenario, (b) questions to answer about the scenario in a shared wiki space, and (c) a text-based group chat tool for discussing and collating answers.

In Step 5 (Solo Reflection), group members were encouraged to individually reflect on the collaboration by identifying individual and team-based strengths, weaknesses, challenges, and potential improvements for a future collaborative task. This step set the stage for large scale adaptation by prompting students to metacognitively reflect and plan forward towards their next collaborative assignment.

Micro-scripting regulation. We further supported regulation of collaboration by integrating micro-scripts into each step of the assignment macro-script. Typically, micro-scripts for collaboration provide more fine-grained guidance for the specific activities learners need to engage in during collaboration (Dillenbourg & Jermann, 2006). For example, in their investigation of online peer discussion, Weinberger, Ertl, Fischer, and Mandl (2005) micro-scripted negotiation and elaboration of domain concepts by providing learners with sentence openers prompting them to contribute domain content and critique one another’s contributions (e.g. my proposal for an adjustment of the analysis is...).

To support regulation of collaboration, we augmented the planning, enactment, and reflection phases of the macro-script with four micro-scripts (see Figure 6). Micro-scripts consisted of question prompts and sentence starters that gave individuals and groups more fine-grained support about how to go about these regulatory processes.

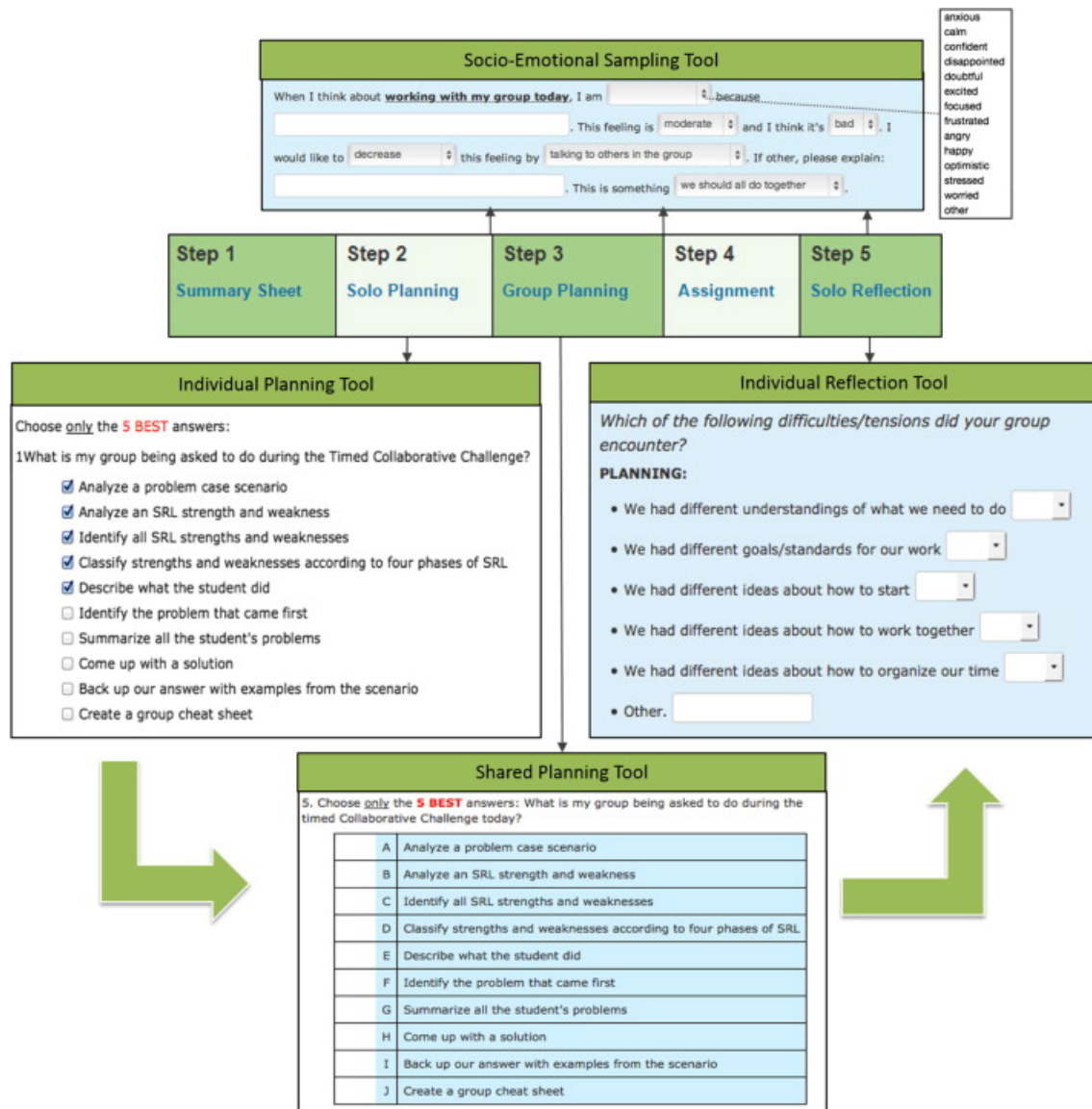


Figure 6. Sample items in micro-scripts of individual planning (IPT) (left), shared planning (SPT) (bottom), emotion regulation (top), and reflection on collaboration (IRT) (right).

Individual Planning Tool (IPT). The Individual Planning Tool (IPT, Miller, Webster, & Hadwin, 2012, 2013) was provided to learners during Step 2 of the assignment to further support learners’ personal planning (Figure 6, left; Appendix A). The IPT micro-scripted planning using question prompts that helped learners thoroughly analyze the task by considering explicit task features, such as task components (i.e. what is my group being asked to do in the Collaborative Challenge), as well as implicit task features often overlooked by learners, such as task purpose (i.e. why are we doing the Collaborative Challenge). The IPT also prompted individuals to set goals for the assignment (i.e. what things are MOST important to me during the Collaborative Challenge), and make plans for working together (i.e. how do I think my group should go about completing the Collaborative Challenge in the short time we have). Finally, during the second assignment, the IPT guided students to reflect on challenges they encountered and identify ways to improve on them (i.e. in assignment 2, we need to do a better job of...).

Shared Planning Tool (SPT). The second micro-script, the Shared Planning Tool (SPT, Hadwin, Miller, & Webster, 2012, 2013), was provided to groups during Step 3 of the macro-script (Figure 6, bottom; Appendix A). The SPT contained the same question prompts as the IPT. However, groups were tasked with discussing each question and collating their personal task perceptions, plans, goals, and perceptions of potential challenges to co-construct a single response for the group.

An important aspect of designing these tools involves examining how much support individuals and groups require for regulating the collaborative task. Thus, we developed two versions of the IPT and SPT tools that differed in level of support. The low support versions consisted of open-ended questions prompts (e.g. what is my group being asked to do in the Collaborative Challenge). In the high support versions, question prompts were pre-stocked with a checklist of ten potential responses (see Figure 6). Five were a direct match with the task at hand, and five were common misperceptions about the task observed in our past work (cf., Miller & Hadwin, 2012). Students were asked to identify the correct task requirements and purposes among the possible choices. Providing potential responses to each question supported planning by helping learners and groups evaluate the relevance of task features they may not have otherwise considered or generated on their own.

Socio-Emotional Sampling Tool (SEST). The third micro-script, the Socio-Emotional Sampling Tool (SEST, Webster & Hadwin, 2012) was provided to individual group members at the beginning, middle, and end of the collaborative task (Step 4). This tool prompted learners to briefly record in-the-moment feelings about the collaborative task and collaborative climate (cf., Järvenoja & Järvelä, 2009). Specifically, learners completed a statement about feelings they were experiencing at that particular point of the task using a series of drop down fields and short text boxes. The tense and phrasing was adjusted to match timing (before, during or after collaboration). In this statement, learners identified a salient in emotion they were currently experiencing about the task (e.g. when I think about how things are going with my group today, I feel...), a goal for the emotion (e.g. increase, decrease, maintain), and a strategy for attaining this goal. Furthermore, they identified whether this strategy would be something (a) they do on their own, (b) other group members would do, or (c) the group members would do together.

Individual Reflection Tool (IRT). The fourth micro-script, the Individual Reflection Tool (IRT, Hadwin & Miller, 2013) was provided to individuals during Step 5 of the macro-script. This tool prompted self-evaluation, self-reflection, and self-awareness about the regulatory processes comprising their recent collaboration (Figure 6, right; Appendix B). Question prompts guided students to evaluate and reflect on (a) planning (e.g. agreement and relevance of task perceptions, goals, and plans for the task) (b) how they completed the task (e.g. task completion strategies and approaches), (c) challenges or difficulties encountered during collaborative work, and (d) salient emotional or socio-emotional challenges encountered during teamwork. Importantly, learners were encouraged to draw upon their IPT, SPT, and SEST responses during reflection. As such, consistent with Winnie and Hadwin's (1998, 2008) model of regulation, evaluations of past experiences were paired with guided opportunities to reflect on regulatory responses with an eye to future collaboration.

Group awareness tools for regulation. The second type of CSCL tool we leveraged to support regulation was group awareness tools. Group awareness tools have garnered attention in the CSCL literature as an alternative or complementary approach for supporting collaboration. Typically, these tools have been used to help learners display and become aware of actions, thinking, knowledge, or social functioning in

order to enhance collaborative processes and outcomes (Bodemer & Dehler, 2011). As such, while scripting provides more directive guidance for collaboration (Dillenbourg, 2002), group awareness tools take a more non-directive or reactive approach placing the locus of control in the hands of the learners (Fransen, Kirschner, & Erkens, 2011; Janssen & Bodemer, 2013; Soller et al., 2005). By interpreting information provided in these tools, learners and groups can operate on this information to improve collaboration without being explicitly instructed on how to collaborate.

The emergent research of this type of support suggests tools promoting group awareness of behaviour, knowledge, and social aspects of collaboration can benefit a wide array of collaborative processes including discussion, interaction, and group performance (Janssen & Bodemer, 2013; Janssen, Erkens, & Kirschner, 2011; Phielix, Prins, Kirschner, Erkens, & Jaspers, 2011). For instance, Sangin, Molinari, Nüssli, and Dillenbourg (2011) investigated the effects of a knowledge awareness tool (KAT) on learners' collaborative processes and outcomes. The KAT facilitated dyads' awareness of knowledge differences and gaps by providing them with a visual representation of their pre-test scores during collaboration. Findings indicated this tool triggered negotiation, elaborative talk, and learning gains. In comparison, learners who did not receive this tool focused on known concepts, fast consensus building, and quick task completion.

However, these tools offer similar potential to support regulation when the target of awareness is shifted to factors such as differences or gaps in strategy use, plans, monitoring and evaluations of progress and products (Järvelä & Hadwin, 2013; Järvelä et al., 2014). Currently, we have begun to make use of these types of tools to support shared planning of collaboration. Specifically, we augmented the shared planning (SPT) micro-script with a group awareness tool that (a) captured the personal task perceptions, goals, and plans each group member reported in their IPTs and (b) displayed them to the group in a graphic summary (i.e. a bar graph displaying the total number of people in the group who selected each of the options in the target questions).

As part of SPT micro-script, groups were instructed to view the “summary of what we each said in our solo planning tools,” and “use this summary to help complete the questions.” This visualization aimed to trigger (a) shared awareness of the extent to which group members' task perceptions and goals (standards) were aligned across group members, and (b) discussion necessary for resolving differences and constructing shared task perceptions and plans maximally appropriate for the task at hand. For example, Figure 7 illustrates how the group awareness tool was paired with micro-scripts for one group. A sample item on the IPT is provided in the top left. The bottom left shows a graphic representation of IPT responses from all group members. On the right is the SPT micro-script that prompts group members to consider the visualization as they discuss each question. In this example, the group awareness tool shows that members had differences in what they believed the task was asking them to do. For instance, while everyone indicated the group needed to analyze all strengths and weaknesses in the case (100%), the group was divided on whether or not they needed to also summarize all the student's problems (50%).

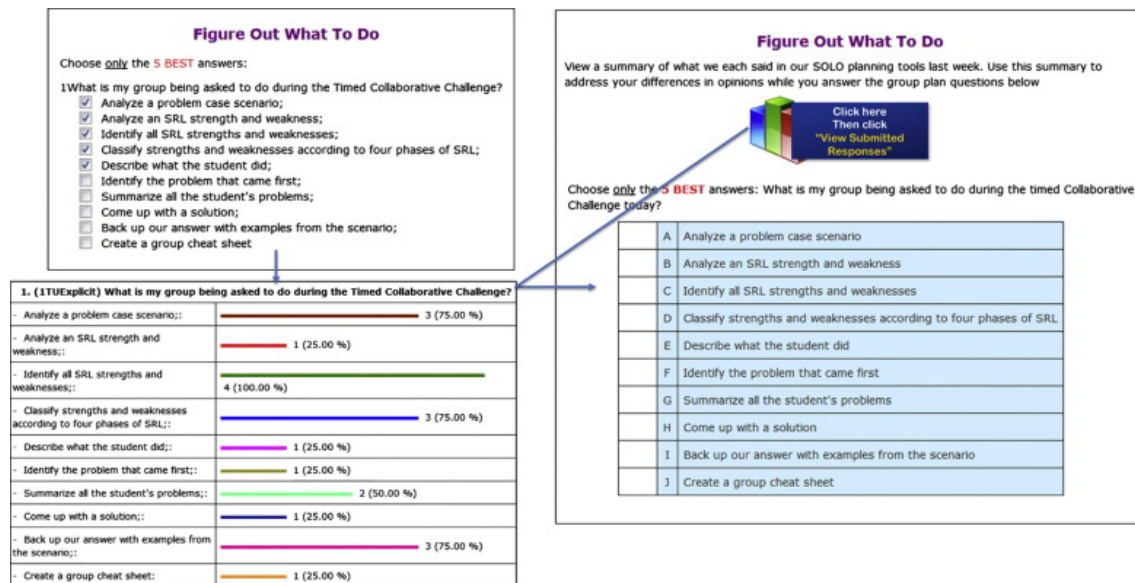


Figure 7. Example item in one group's Individual Planning Tool (top left), group awareness tool (bottom left), and Shared Planning Tool (right).

Design Rationale of Regulation Tools

Overall, our goal in designing these CSCL supports was to promote individual and group regulation of the collaborative assignments as well as ultimately foster the development of skills for regulating collaboration in future tasks. To inform our design of specific CSCL supports for this purpose, we drew on theories of regulation in collaboration in two major ways.

First, while CSCL tools typically target communicative-coordination processes for knowledge construction, the primary target of support of these tools was regulation of cognition, behaviour, motivation, and emotion in the collaborative task including (a) constructing representations of task requirements and goals, (b) monitoring and evaluating progress, (c) constructing strategies for working effectively and efficiently in the collaborative task, and (d) making changes when needed within and across tasks.

Second, as collaboration is posited to require self-, co-and shared regulation, these tools aimed to support collaborators to take responsibility for their own regulation (self-regulation), prompt and nudge one another's regulation (co-regulation), and collectively regulate together in the task (shared regulation). Furthermore, by having tools build on one another, we aimed to support learners to self-regulate their own engagement as a basis for helping the group regulate together during the task.

Scripts and group awareness tools were used as complementary approaches towards these aims. Specifically, macro-and micro-scripts structured the task in ways that explicitly prompted or guided learners to engage in different aspects of regulation. For instance, individuals were explicitly prompted to take stock of their experiences, identify challenges, and find ways to circumvent difficulties across tasks. On the other hand, group awareness tools took a less directive approach by displaying regulatory information to the group in ways that could trigger groups to regulate collaboration. By providing groups with a visualization of each other's personal task perceptions and goals, this tool facilitated groups to monitor and evaluate the extent to which their plans were aligned with each other and appropriate for the task specifications.

Discussion: Exploring Possibilities for Future Research

The purpose of this conceptual paper was to contribute to the emerging

discussion of regulation of collaboration and introduce ways in which theories of regulated learning can inform design of technological supports to bootstrap successful collaboration. As such, consistent with design-based methodology, these prototypical supports will be empirically investigated then revised and extended (Design-Based Research Collective, 2003).

As research of regulation of collaboration is emergent, a key direction for future research is how and when these processes are activated by learners and groups, how individual and social aspects of regulation intertwine, and under what conditions they can be best supported. Furthermore, much remains to be understood regarding the types and configurations of support that best promote regulation of collaboration. For instance, it is unclear how much support learners require at the individual or group level, in what kinds of tasks or learning situations, and whether too much support may impinge on interaction and team processes learners as has been suggested in other aspects of collaboration (Dillenbourg, 2002). Similarly, research is needed to investigate how different visual representations of regulatory processes in group awareness tools facilitate groups' recognition of situations where regulation is required. Finally, as the ultimate goal of CSCL regulation tools is to promote development of these critical skills, research of how tools can facilitate regulation once tools are no longer available and as well as in other collaborative situations would be fruitful.

A considerable challenge in this research is that conceptualizing regulation as social brings forth a number of methodological difficulties and requires a more varied set of analytic approaches than is common in current SRL research (Järvelä et al., 2013; Volet, Vauras et al., 2009). Fortunately, CSCL scripts and awareness tools themselves provide exciting opportunities to, not only support regulation of collaboration, but also investigate this complex phenomenon.

On a practical level, tools specifically designed to elicit regulation at different points during collaboration facilitate investigation of this process by increasing the prevalence of regulation as compared to the minimal amounts observed in other studies (e.g. Hurme & Järvelä, 2005; Hurme, Merenluoto, & Järvelä, 2009; Hurme, Palonen, & Järvelä, 2006). Moreover, as students make use of CSCL tools for regulation, they generate contextualized trace data charting how regulation evolves over time (Järvelä et al., 2013). For example, in our current research we are making use of learners' micro-script responses and discussions as they interact with tools to identify rich episodes of self, co-, and shared regulation as they emerge at different points during and across tasks. We suggest these contextualized traces have enormous potential to shed light on the task perceptions, goals and plans learners and groups construct for collaborative tasks, as well how strategies are dynamically adopted and adapted over time (Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007).

Similarly, regulation tools can provide opportunities to identify points in time when learners or groups get stuck and attempt to overcome difficulties by prompting learners to make challenge episodes visible in and across collaborative tasks. As regulation implies strategic adaptation, identifying instances where regulation is systematically activated in response to challenge is central for examining this process (Hadwin et al., 2011; Järvelä, Volet, & Järvenoja, 2010; Winne & Perry, 2000). For example, Webster and Hadwin (2013) used learners' responses to the SEST micro-script to examine (a) emotions learners experienced before, during and after each assignment, and (b) learners' goals and strategies for regulating these emotions. Findings indicated learners set goals for maintaining positive emotions, such as optimism and confidence, and decreasing negative emotions such as anxiety and stress at different points during collaboration. Similar to previous research emphasizing shared

regulation in the face of socio-emotional challenges (Järvenoja & Järvelä, 2009), a large proportion of students indicated that enacting strategies for regulating emotion was something the group should do together rather than individually.

Finally, CSCL tools can enable more fine-grained analysis of how regulation evolves across the individual and group level. For example, in a recent case study, Miller and Hadwin (2012) traced how shared task perceptions and goals developed across the individual and group level using learners' IPT and SPT micro-script responses, log file traces of planning tool use, and chat discussions. Findings indicated groups often constructed inaccurate or incomplete interpretations of the task and rarely systematically solicited or discussed individuals' personal task interpretations.

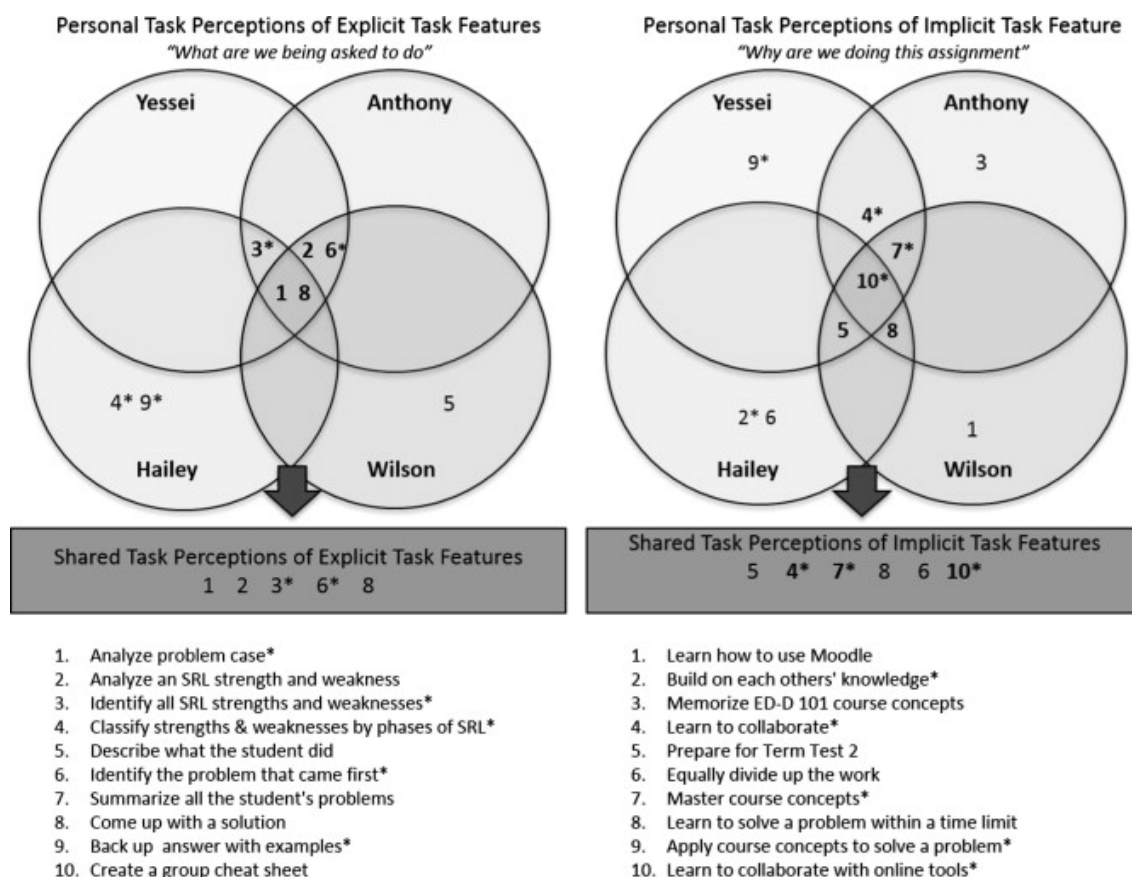


Figure 8. Profile of one group's personal and shared task perceptions of explicit (left) and implicit (right) task assignment features. *denotes accurate task features.

Figure 8 provides one example of a group profile integrating these data sources. As illustrated by shared task perceptions provided in the dark grey rectangles, this group negotiated inaccurate interpretations of the task which included only 50% of the explicit and implicit task information. One issue encountered by this group was that they did not capitalize on one another's understanding of the task (individual task perceptions of each member are denoted in light grey circles). For instance, Hailey individually believed a task component was to classify strengths and weaknesses by phases of SRL, but the group overlooked this idea when defining the task together. While this example focuses solely on shared planning, we suggest that CSCL tools provide exciting opportunities to systematically investigate (a) calibration among individuals' task perceptions, goals, strategic approaches, monitoring evaluating of the task, and perceptions of challenges, and (b) how self-, co-and shared regulation evolve and shape one another

during collaboration.

Overall, from the view that regulating collaboration is an essential 21st century skill, developing tools that support learners and groups to regulate collaboration is paramount. While examples in this paper provide a snapshot of the multiple ways CSCL tools could be leveraged for this purpose, further research is needed to systematically investigate how regulation of collaboration emerges and how CSCL tools can be best designed to support these processes. Happily, CSCL tools themselves offer unique opportunities towards this end.

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Appendix A

Individual Planning Tool (left) and Shared Planning Tool (right).

Individual Planning Tool (left) and Shared Planning Tool (right)

Solo Planning Tool

Choose only the **5 BEST** answers:

1 What is my group being asked to do during the Timed Collaborative Challenge?

- Analyze a problem case scenario
- Analyze one SRL strength in adapting
- Identify all SRL weaknesses in planning and enacting
- Define the four phases of SRL
- Describe what the student did
- Identify the problem that came first
- Explain a notetaking/reading strategy that works for you
- Describe two strategies for the student
- Back up our answer with examples from the scenario
- Explain why the strategy(ies) will work

Choose only the **5 BEST** answers:

2 Why are we doing the Collaborative Challenge?

- To learn to use CourseSpaces
- To build on each others' knowledge
- To memorize ED-D 101 course concepts
- To learn to collaborate
- To prepare for the final exam
- To equally divide up the work
- To master course concepts
- To learn to solve an academic problem within a time limit
- To apply course concepts to solve a problem
- To learn to collaborate with online tools

3 Which of the following is most important to me during the Collaborative Challenge?

↓

4 This is important to me because

5 In Collaborative Challenge 2, we need to do a better job of

↓

6 How do I think my group should go about completing the in-class Collaborative Challenge in the short time we have?

Our Group Planner

5. Choose only the **5 BEST** answers: What is my group being asked to do during the timed Collaborative Challenge today?

A	Analyze a problem case scenario
B	Analyze one SRL strength in adapting
C	Identify all SRL weaknesses in planning and enacting
D	Define the four phases of SRL
E	Describe what the student did
F	Identify the problem that came first
G	Explain a notetaking/reading strategy that works for you
H	Describe two strategies for the student
I	Back up our answer with examples from the scenario
J	Explain why the strategy(ies) will work

6. Choose only the **5 BEST** answers: Why are we doing the collaborative challenge?

A	To learn to use coursespaces
B	To build on each others' knowledge
C	To memorize ED-D 101 course concepts
D	To learn to collaborate
E	To prepare for ED-D 101 Quizzes
F	To equally divide up the work
G	To master course concepts
H	To learn to solve an academic problem within a time limit
I	To apply course concepts to solve a problem
J	To learn to collaborate with online tools

7. Identify the **TOP THREE** things that are MOST important to us during the collaborative challenge. Rank as 1 = most important, 2 = second most important, and 3 = third most important.

8. In Collaborative Challenge 2, we need to do a better job of

↓

9. How should we go about completing the Collaborative Challenge today in the short time we have?

I should do individually
I should help others in my group do
others in my group should help me do
we should do as a group

To avoid this difficulty/tension from happening again in Collaborative Challenge 2, I want to develop a positive group climate (e.g., trust, openness, comfort) . If other, explain here:

. This is something

I think the main thing I need to do differently in the future in order to be a better group member is

Paragraph B I [List icons]

Path: p

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

Paragraph B I [List icons]

Path: p

positive
negative

very strong
strong
moderate
weak
very weak

During this experience, I was . This feeling was .

anxious
calm
confident
disappointed
doubtful
excited
focused
frustrated
angry
happy
optimistic
stressed
worried
other

increased my feeling
decreased my feeling
switched my feeling to something else
maintained my feeling
did not affect my feeling at all

do the same thing
do something different

What did I do when I felt this way?

- Doing this . Therefore, doing this was .
- Doing this made it to complete the Timed Collaborative Challenge.
- Next time, I should . If different, what could I do?

helpful
not helpful

a lot harder
a little harder
neither harder nor easier
a little easier
a lot easier

my other group members did
each of us did
we all did together
N/A (my group didn't do anything)

What did my group do when I felt this way?

- This was something .
- Doing this decreased my feeling . Therefore, doing this was helpful .
- Doing this made it a little easier to complete the Timed Collaborative Challenge.
- Next time, my group should do the same thing . If different, what could my group do?

Manuscript 2: Miller, M., Malmberg, J., Hadwin, A. F., & Järvelä, S. (2015). Examining the processes contributing to and constraining shared planning for regulating collaboration in a CSCL environment. *Manuscript in submission.*

Abstract

Shared task perceptions provide the foundation on which groups regulate collaboration. However, little is known about how groups successfully negotiate shared task perceptions or how computer supported collaborative learning (CSCL) technologies can support this process. This cross-case comparison examined shared planning processes in groups with accurate or inaccurate shared task perceptions for an online collaborative task. In doing so, we aimed to identify key mechanisms that contributed to or constrained the development of shared task perceptions for collaboration. Data included individual and group statements of task perceptions, chat discussions, and log file data of group member planning activities. Findings indicated no groups constructed highly accurate shared task perceptions. However, compared with low accuracy groups, moderate accuracy groups considered a wider breadth of explicit and implicit task features, engaged in both individual and group level planning activities, capitalized on group members' personal task perceptions, and constructed shared task perceptions dynamically throughout the task. Implications for design of CSCL supports are discussed.

Introduction

Collaboration has become increasingly required in academic and work contexts, and the ability to work productively, innovatively and efficiently in teams is a critical skill for 21st century learners. However, collaboration involves more than coordinating tasks and dividing the labour (Dillenbourg, 1999). It requires groups to coordinate engagement across individuals with potentially diverse perspectives to construct shared knowledge products and solutions beyond what any group member could accomplish alone (e.g. Barron, 2003; Johnson & Johnson, 1989; Roschelle & Teasley, 1995).

Recent perspectives emphasize achieving this kind of productive collaboration requires regulation at both the individual and group level (see Hadwin, Järvelä, & Miller, 2011; Järvelä & Hadwin, 2013). This means group members must individually self-regulate their thinking, behaviour, motivation, and emotions in the task, while also collectively regulating together through socially shared regulation (Hadwin, et al., 2011; Järvelä & Hadwin, 2013; Volet, Vauras, & Salonen, 2009). In particular, shared task perceptions are a vital aspect of socially shared regulation. Shared task perceptions refer to groups' negotiated or co-constructed interpretations of the externally assigned task. These shared interpretations provide the foundational metacognitive knowledge on which groups can set shared goals, and create shared standards against which to monitor their progress and products. Unfortunately, learners often lack the skills needed to successfully engage in this type of shared regulatory process, and commonly report encountering difficulties with strategic planning (McCardle, Helm, Hadwin, Shaw, & Wild, 2011).

Computer supported collaborative learning (CSCL) technologies offer much potential to support shared regulatory processes (Hadwin, Oshige, Gress, & Winne, 2010; Järvelä & Hadwin, 2013; Miller & Hadwin, 2015). However, we have limited understanding about how groups successfully negotiate shared task perceptions in order to inform design of CSCL supports for this purpose. To address this gap, this study examined how groups constructed shared task perceptions for an online collaborative task. Specifically, we aimed to identify key mechanisms that contributed to or

constrained groups' development of accurate shared task perceptions. This step is essential for informing future design of CSCL tools with potential to support group planning processes.

Regulation of Collaborative Learning

More than two decades of research indicate successful students self-regulate their learning by deliberately planning, monitoring, and regulating their cognition, behaviour, motivation, and emotions in a task (Winne & Hadwin, 1998; Zimmerman, 1989). Recent perspectives have extended emphasis beyond individual regulation (SRL) to suggest effective collaboration also requires groups to regulate together through socially shared regulation (SSRL, Hadwin et al., 2011; Järvelä & Hadwin, 2013). In this way, groups can be conceptualized as social systems consisting of individual self-regulating agents who also regulate collectively (Volet, et al., 2009).

When groups engage in socially shared regulation, they construct and maintain shared regulatory processes, beliefs, and knowledge orchestrated in the service of a co-constructed or shared outcome (Hadwin, et al, 2011; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013; Winne, Hadwin, & Perry, 2013). Specifically, it requires groups to co-construct task perceptions and goals for approaching the task, coordinate engagement through strategically adopting and thoughtfully adapting tools and strategies for the task, share in monitoring and evaluating of progress and products, and intervene if results deviate from plans.

Building on Winne and Hadwin's (1998; 2008) model of self-regulated learning, socially shared regulation can be conceptualized as unfolding over four loosely sequenced and recursive phases. In the first phase, groups work together to construct shared task perceptions of the collaborative task (Phase 1: Shared task perceptions). Shared interpretations of the task provide a foundation for negotiating shared goals, standards, and plans for strategically approaching the task (Phase 2: Shared goal setting and planning). In Phase 3 (Task enactment), groups coordinate their strategic task engagement, collectively and flexibly drawing upon a range of cognitive, socio-emotional, behavioural and motivational strategies. Throughout this process groups metacognitively monitor and evaluate their processes, progress, and products against shared standards. By doing so, they can strategically adapt their shared task perceptions, goals, and engagement to optimize collaboration in the current and future tasks (Phase 4: Small and large scale adaptation).

Shared task perceptions in regulating collaboration. From this perspective, shared task perceptions facilitate regulation of collaboration from early stages onwards. They provide a common basis on which groups can establish (a) joint goals and strategic plans for collaboration, and (b) shared standards against which to mutually monitor and adapt learning and teamwork. On the other hand, without shared task perceptions, collaboration can become a negative and frustrating experience as group members exert time and energy working at cross-purposes or in ways poorly matched to the task demands (Winne et al., 2013).

Constructing shared task perceptions can be conceptualized along two dimensions. First, constructing shared task perceptions requires groups to negotiate a joint interpretation of the task (Järvelä & Hadwin, 2013; Miller & Hadwin, 2015). This means group members do not simply hold the same or similar task perceptions, but invest in a process to negotiate or co-construct a joint representation of the task at hand.

Second, in order to be effective for regulating collaboration, shared task perceptions must be accurate and complete in terms of specific task demands or specifications (e.g. similar to those of the instructor). Complex tasks that warrant collaboration are layered with explicit and implicit information (Hadwin, 2006; Hadwin

& Winne, 2012). *Explicit task information* refers to specific task requirements and standards, such as task criteria and components. In academic contexts, these task features are often overtly communicated in the instructor's written or verbal task instructions and student-instructor dialogue. *Implicit task information* refers to the contextual meaning or bigger purpose of the task. Implicit task information may be less overt in instructor communications about the task, and embedded in course objectives and descriptions, or in the social, conceptual or physical resources that are accessible within the context of the work. This is not to say there is only one correct way to go about the task. For example, groups may decide to pursue their own goals or negotiate different expectations with the instructor. However, making informed and effective choices to do so necessitates understanding the original task specifications and demands.

Unfortunately, learners often struggle to interpret academic tasks. While task perceptions have been linked to task performance (Butler & Cartier, 2004; Greene, Hutchison, Costa, & Crompton, 2012), research in solo task contexts consistently indicates learners misinterpret tasks across a wide range of academic disciplines (Hadwin, Oshige, Miller, & Wild, 2009; Hadwin & Winne, 2012).

Working collaboratively may amplify these challenges. For example, group members can hold task perceptions misaligned with the instructor's expectations for the task as well as with each other (Hadwin, Malmberg, Järvelä, Järvenoja and Vainionpää, 2010; Miller & Hadwin, 2012; Winne et al., 2013). Furthermore, groups do not always invest in planning as an important facet of collaboration. For example, in an examination of shared regulation in collaborative mathematics tasks, Rogat and Linnenbrink-Garcia (2011) found that some groups simply started the task with little discussion of what the task directions meant.

Supporting shared task perceptions. The potential for technology supported learning contexts to facilitate regulation of collaboration has garnered increasing interest in recent years (Hadwin et al., 2010; Järvelä & Hadwin, 2013; Järvelä et al., 2014). Currently, research about technology for regulation has largely focused on computer-based pedagogical tools for supporting individual self-regulated learning in solo task contexts (Bannert & Reimann, 2012; Azevedo, Johnson, Chauncey, & Burkett, 2010; Dabbagh & Kitsantas, 2005). In comparison, the ways in which technology can promote shared regulatory processes have been largely overlooked.

The rapid evolution of CSCL technology presents exciting opportunities for this purpose. For example, scripts in CSCL have been used to support collaborative processes by specifying, sequencing, and distributing activities learners are expected to engage during collaboration (Dillenbourg, 2002; Kollar, Fischer, & Hesse, 2006). Macro-scripts typically take a pedagogical approach by defining a sequence of activities expected to enhance collaboration (Jermann & Dillenbourg, 2003; O'Donnell & Dansereau, 1992). On the other hand, micro-scripts often take a more fine grained process-oriented approach by providing sentence starters, question prompts, or descriptions that help learners interact productively (Weinberger, Ertl, Fischer, & Mandl, 2005). By structuring how learners interact and work together, scripts can support learners to engage in activities and processes they may not otherwise engage in on their own (Kobbe et al., 2007; Soller, Martínez-Monés, Jermann, & Muehlenbrock, 2005).

While scripts have mainly been used to promote productive collaborative interactions related to domain knowledge construction, they offer much potential for regulation when the target of support is shifted to regulation (Hadwin et al., 2010; Järvelä & Hadwin, 2013; Järvelä et al., 2014). For example, in a recent study Miller &

Hadwin (2015) drew on theoretical perspectives of regulation of collaboration to exemplify how CSCL scripts could be leveraged for regulation. This included a macro-script that specified collaborative tasks as involving (a) multiple regulatory phases beyond simply completing the task, and (b) both individual- and group-level regulatory processes (Hadwin et al., 2011; Järvelä & Hadwin, 2013). As well as micro-scripts that used question prompts and sentence starters to further support learners to go about these regulatory processes in each phase.

Furthermore, CSCL tools also provide exciting opportunities to, not only support groups to construct shared task perceptions, but also investigate this process. Researching shared or social regulatory processes introduces a wide array of methodological challenges (Vauras & Volet, 2013). Specifically, investigating regulation as a social process means developing analytic techniques that move beyond a focus on the individual to capture how this process evolves at individual and group levels across time within the context of meaningful tasks (Iiskala, Vauras, Lehtinen, & Salonen, 2011; Järvelä, Volet & Järvenoja, 2010; Järvelä, Järvenoja, & Näykki, 2013; Perry & Winne, 2013). As learners and groups interact with CSCL supports in online environments, they generate fine-grained traces of their engagement with each other and the task. Thus these tools offer opportunities to collect the critical kinds of data needed to capture groups' shared regulatory processes.

Despite the potential offered by these tools, designing well-balanced scripts requires a great deal of knowledge of the core mechanisms the script aims to promote (Dillenbourg, 2002; Fischer, Kollar, Stegmann, & Wecker, 2013). Research is needed to increase understandings of the processes and factors contributing to negotiation of shared task perceptions. Identifying target areas for supporting students and groups to regulate planning processes is essential for designing technological supports with the power to prompt and guide regulation in collaboration. Thus, the purpose of this cross case comparison was to explore how groups constructed accurate vs. inaccurate shared task perceptions for a collaborative task in a CSCL environment. Specifically we aimed to identify mechanisms contributing to construction of accurate shared task perceptions that may inform future design of CSCL supports for regulating planning.

Methods

Research Context

The broader context within which this case study was situated was a six-week course, *Cognitive, Motivational and Emotional Bases in Learning for Understanding* in a Learning and Educational Technology Master's Program at a university in northern Finland. There were 18 graduate students enrolled in the course (mean age = 44.5, $SD = 7.70$, 10 females and 8 males). The purpose of this course was to develop theoretical and practical understandings about self-regulated learning and to prompt students to reflect on their own regulation processes and strategies.

The course included three learning cycles (see Figure 1). Each cycle included (a) a face-to-face lecture, (b) an online solo studying period (one week) in which students read scientific articles and constructed study notes (ICE notes), and (c) an online collaborative assignment period (one week) which was the focus of this study.

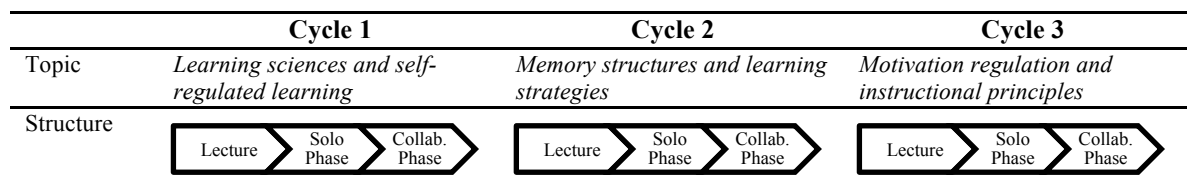


Figure 1. Course structure and topics

Each collaborative assignment was similar in explicit task requirements and underlying implicit task purposes (Table 1). For instance, each required groups to (a) distribute their individual definitions of the course concepts among their group members (ICE notes), (b) co-create a case scenario reflecting the topics covered during the learning period (i.e. self-regulated learning, learning strategies or motivation), (c) analyze their case scenario using course concepts, and (d) generate a solution.

Participants worked in groups of three across all assignments. Groups were assigned at the beginning of the course based on (a) shared educational and work experiences, goals and interests in the graduate program as provided in participants’ letters of application, and (b) instructors’ knowledge of participants’ group work skills.

Table 1. *Explicit and Implicit Task Features of Collaborative Assignments*

Task Features	Assignment 1	Assignment 2	Assignment 3
Explicit (n=4)	1) Share ICE Notes 2) Create a case scenario about a work situation where there is a <i>SRL</i> problem 3) Analyze the case scenario 4) Propose a solution	1) Share ICE Notes 2) Create a case scenario about a work situation where there is a <i>learning strategies</i> problem 3) Analyze the case scenario 4) Propose a solution	1) Share ICE Notes 2) Create a case scenario about a work situation where there is a <i>motivational</i> problem 3) Analyze the case scenario 4) Propose a solution
Implicit (n=5)	1) Share individual expertise and background knowledge 2) Apply course concepts to create the case a scenario 3) Create a scenario that is realistic and personally relevant 4) Improve own learning 5) Deepen understanding of course concepts		

Note: Task features defined by the course instructor

Collaborative Tasks and CSCL Supports

Learners completed each assignment online in the nStudy learning environment (Winne, Hadwin & Beaudoin, 2010). nStudy is a “browser inside the browser” platform that includes solo and collaborative workspaces and a group chat tool. Students received two hours of training on how to use nStudy at the beginning of the course. Training included (a) how to switch between solo and collaborative workspaces, (b) how to share work from solo to collaborative workspaces, and (c) how to use the chat tool to communicate with group members.

To support regulation of collaboration, two types of scripting supports were integrated into each assignment in the nStudy environment (Figure 2). While CSCL scripts typically support knowledge construction, scripts in this study shifted the target of support to regulatory processes (cf., Miller & Hadwin, 2015).

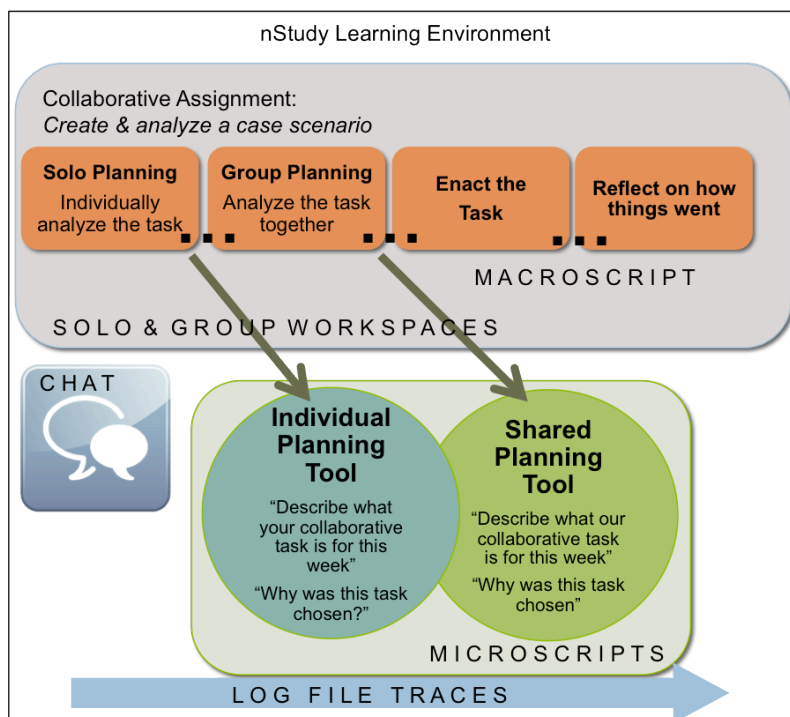


Figure 2. Macro- and micro-scripts supporting regulation of collaborative assignments in nStudy.

Assignment instructions were framed within an over-arching *macro-script* that specified the collaborative task as involving (a) multiple regulatory phases beyond simply completing the task, and (b) both individual- and group-level regulatory processes (Hadwin et al., 2011; Järvelä & Hadwin, 2013). This macro-script encouraged learners to approach the assignment in four phases: (a) an individual planning phase to read about the assignment and construct personal interpretations of the task, (b) a shared planning phase to construct shared task perceptions for the task as a group, (c) a task enactment phase in which to execute the joint assignment together, and (d) a reflection phase in which to reflect on the assignment individually and as a group.

Students were also provided with *micro-scripts* further structuring regulation of collaboration. Micro-scripts consisted of question prompts and sentence starters that gave individuals and groups more fine-grained support about how to go about regulatory processes emphasized in the macro-script. Since shared task perceptions are the focus of this study, we restrict description of micro-scripts to those supporting planning: (a) the Individual Planning Tool, and (b) the Shared Planning Tool.

The Individual Planning Tool (IPT) scripted each group member to construct personal task perceptions of the assignment with two open-ended questions adapted from Miller, Webster, and Hadwin (2012). The first question prompted consideration of explicit task requirements, "Describe the collaborative task for this week." The second question prompted consideration of the implicit task purpose, "Why was this task chosen for this week?" The Shared Planning Tool (SPT) scripted groups to negotiate and co-construct shared task perceptions (adapted from Hadwin, Miller, & Webster, 2012). The SPT provided groups with identical question prompts to those in the IPT, but group members were tasked with negotiating a single set of responses for the group.

Selection of Cases

We used extreme case sampling to select six cases for analysis where groups appeared to have either accurate or inaccurate shared task perceptions for a collaborative assignment based on submitted SPT responses (Patton, 1990). Accuracy of SPT responses was assessed for all groups (K=6) in all three collaborative tasks. Accuracy was operationalized as the proportion of accurate task features (e.g. key task features defined by the instructor) in the SPT response (Table 1). Accuracy could range from 0% (indicating none of the key task features were included in the SPT) to 100% (indicating all nine of the key task features were included in the SPT). Irrespective of the specific task (1-3), we selected (a) the three cases where groups' SPT responses were most accurate (i.e. Group 1 in Task 1, Group 3 in Task 1, Group 5 in Task 1), and the three cases where groups' SPT responses were least accurate (i.e. Group 4 in Task 1, Group 4 in Task 2, Group 2 in Task 3). Descriptive information for selected cases is provided in Table 2.

Table 2. *Descriptive Information for Selected Cases*

	Case	Group	Task	Group	Gender	Accuracy of SPT Responses
High accuracy cases	A	Group 1	1	Paula, Jarkko, Tomi	2F, 1M	.56 (5)
	B	Group 3	1	Anna, Ari, Veera	2F, 1M	.56 (5)
	C	Group 5	3	Luka, Maria, Sofia	2F, 1M	.44 (4)
Low accuracy cases	D	Group 4	1	Erkki, Heikki, Noora	1F, 2M	.11 (1)
	E	Group 4	2	Erkki, Heikki, Noora	1F, 2M	.0 (0)
	F	Group 2	3	Pirjo, Jani, Anni	2F, 1M	.11 (1)

Note. All names have been replaced with pseudonyms; M = male, F = female; SPT = Shared Planning Tool; Accuracy > .50 in boldface; Frequencies provided in bracket

Using an extreme case sampling strategy allowed us to select cases from which the most could be learned given the purpose of the study (Merriam, 1998). Specifically, selecting cases from the total pool of all groups in all assignments enabled us to target information-rich cases to best compare situations where groups constructed accurate vs. inaccurate shared task perceptions. Importantly, case selection was based solely on the SPT accuracy scores. Since we were interested in how socially shared regulation is (or is not) constructed and negotiated, Phase 1 of the analysis examined whether answers in the SPT were actually constructed by multiple people in the group or just provided by one person.

Data Sources

Three sources of data were used to examine whether and how shared task perceptions were constructed: (a) individual and shared planning tools, (b) chat logs, and (c) logfile records of planning activities in the CSCL environment.

Individual and shared planning tools. During the task, learners and groups reported their task perceptions in the IPT and SPT: (a) “*Describe the collaborative task for this week.*” (explicit task features), and (b) “*Why was this task chosen for this week?*” (implicit task features). We coded statements about task perceptions in learners' IPT responses and groups' SPT responses in two steps. First, two researchers jointly segmented IPT and SPT responses by meaning unit. Meaning unit in this study is defined as a statement about a single task requirement or purpose, such as “*the task requires us to apply course concepts*” (Rourke, Garrison, Anderson, & Archer, 2001).

Second, statements were descriptively coded to capture the meaning of the task perception (Miles & Huberman, 1994). Codes were guided by the instructor's

definitions of key explicit and implicit task features (see Table 1), but were flexibly and inductively constructed based on students' responses rather than adhering to a priori categories. In keeping with qualitative ideas about consistency (Lincoln & Guba, 1985), the researchers constantly compared codes within and across all responses. Any discrepancies were resolved by continuously revising codes until 100% agreement was reached for all responses. A summary of task perception codes and categories is provided in Table 3.

Table 3. *Description and examples of task perception codes and categories*

Task Perception Categories	Task Perception Codes	Examples
Accurate Explicit Task Features	Share ICE Notes	<i>We should send out ICE notes with definitions of concepts to our group members</i>
	Create a case scenario about a problem situation	<i>We are supposed to write a case that shows a student having a problem with motivation.</i>
	Analyze the case scenario	<i>Analyze how the problem happened based on our theoretical understandings</i>
	Propose a solution	<i>Also we provide a solution for the problem for how to improve individuals ways of working</i>
Accurate Implicit Task Features	Share individual expertise and background knowledge	<i>Use each other's many points of view so we can learn from each other</i>
	Apply course concepts to create the case a scenario	<i>We should use different things from our readings on cognition/metacognition in the case</i>
	Create a scenario that is personally relevant	<i>Needs to be part of a teachers job - something we have or could see with students</i>
	Improve own learning	<i>By doing this we can also see solutions on how to make our own learning better</i>
	Master course concepts	<i>Our task is to enrich the knowledge about course concepts in other phases</i>
Misperceptions of Task Features	Create a summary	<i>The main thing is to do a summary of the course concepts.</i>
	Keep ICE notes private	<i>We are not required to share our ICE notes with everyone in the group</i>
	Draw on outside sources other than course readings	<i>Part of the task is doing the analysis using outside sources</i>

Chat discussion logs. Groups' text-based chat discussions during collaboration were recorded in the nStudy environment producing time-based chat logs. Task perceptions in groups' chat logs were coded in two steps. First, specific exchanges where group members discussed task perceptions were identified from the complete set of chat transcripts for each selected case. Second, statements about task perceptions in chat were coded using the same protocol used to code written statements of task perceptions in IPT and SPT (Table 3). During coding of chat discussions, we remained open to revising coding of SPT and IPT responses to better capture task perceptions across all data sources.

Log file data. Logfile records of users' time-stamped actions (e.g. create, edit, view) during collaboration were recorded by the nStudy environment. Logfile records were examined to identify five user actions related to planning including: (a) viewing task instructions (viewed the document providing information about what the task required), (b) viewing the Shared Planning Tool (viewed SPT question prompts), (c) editing the Shared Planning Tool, (contributed task perceptions to the SPT), (d) viewing

edits to Shared Planning Tool (viewed task perceptions explained or reported in the SPT without further contribution), and (e) engaging in chat sessions (engaged in episodes of synchronous planning discussion with other group members). In each selected case, log file data of group members' planning activities were sequenced in temporal order. Second, we identified when planning activities occurred in relation to work on the collaborative task (i.e. before or after the point in time where groups began to work on their collaborative product during the week long assignment phase).

Analysis

In this study, we used a cross-case comparison approach to identify factors that contributed to and constrained development of shared task perceptions in the selected cases (Merriam, 1998; Yin, 2008). Analysis was completed in three phases.

Phase 1 (categorization of cases). In the first phase, we built on our tentative categorization of selected cases ($k=6$) to analyze groups' shared task perceptions in more depth. The purpose of this preliminary analysis phase was to (a) further verify whether task perceptions reported in SPT submitted responses were shared (i.e. agreed upon by the group), and (b) confirm our categorization of cases as demonstrating high vs. low accuracy of shared task perceptions.

Shared task perceptions were identified using (a) statements about explicit and implicit task perceptions in groups' SPT responses, (b) exchanges about explicit and implicit task perceptions in chat records, and (c) log file records of group members' SPT edits and views. Using these data sources together, two authors jointly classified each task perception statement as *shared* or *not shared*.

Statements about task perceptions in SPT and chat were classified as shared when the group evidenced agreement about the idea. Specifically, task perceptions were classified as *shared* when (a) a group member made a statement about a task perception in chat and at least one other group member expressed agreement (e.g. *Ari: We need to do a case analysis for the issue / Heikki: Yes, analyze how it happened*), or (b) a group member stated a task perception in the groups' SPT, and at least one other group member viewed or built on this statement (e.g. *Ari edited the SPT to add the idea that the group needs to do a case analysis for the issue. Heikki opens the SPT to look at Ari's contribution*).

Statements about task perceptions in chat and the SPT not considered to be shared when there was no evidence of awareness or agreement about the idea. Specifically, task perceptions were classified as *not shared* when (a) a group member made a statement about a task perception in chat, but it was not seen or acknowledged by others (e.g. *Ari: We need to create a solution for the case / Heikki: What did everyone think of the readings?*) or (b) a group member stated a task perception in the groups' SPT, but no other group members viewed this change. Consistency in coding was ensured through multiple and repetitive joint coding sessions by two researchers. Any discrepancies between coders were reviewed and used as the basis for refining category definitions until 100% agreement was reached for all task perceptions.

Using only the task perceptions classified as "shared," we then calculated a second accuracy measure (i.e. *shared task perception accuracy*). As with our measure of SPT accuracy, this was calculated using the proportion of relevant explicit and implicit task features identified by groups in their shared task perceptions. Each groups' shared task perception accuracy score was then compared to their SPT accuracy score to verify our categorization of the case as high vs. low accuracy.

Phase 2 (case descriptions). In phase 2, we conducted within group analysis of each group ($k=6$) to explore how shared task perceptions developed during collaboration. To do so, we constructed case descriptions for each group integrating: (a)

group members' personal task perceptions as identified in their Individual Planning Tool (IPT) responses, (b) groups' shared task perceptions as identified in phase 1 of the analysis, (c) group members' planning activities identified in log files (e.g. time stamped instances where group members viewed task instructions and planning tools, contributed ideas to the SPT, viewed contributions in SPT, and participated in chat), (d) chat records of groups' discussion about task perceptions. Case descriptions were constructed by summarizing each case in terms of each data analysis. Visual summaries were created to facilitate integration of multiple data sources and comparison across groups.

Phase 3 (cross-case comparison). Cross-case comparison of accurate vs. inaccurate cases was conducted to reveal similarities and differences in groups' construction of shared task perceptions. Specifically, moderate vs. low accuracy cases were juxtaposed to uncover key mechanisms contributing to these groups' construction of shared task perceptions.

Findings

Phase 1 (Categorization of Cases)

Analysis revealed that groups identified fewer than 70% of the accurate task features in their shared task perceptions (Table 4, *Shared Task Perceptions, Total Accuracy*). Because no groups evidenced 'high' accuracy of shared task perceptions, we categorized two cases as *moderate* accuracy and four cases as *low* accuracy. In moderate accuracy cases, groups' shared task perceptions were more than 50% accurate. In low accuracy cases, groups' shared task perceptions were less than 23% accurate.

What is notable about these findings is that groups' SPT responses provided an incomplete picture of groups' shared task perceptions. Case C was one of three "high accuracy" groups selected for analysis because their SPT included many of the relevant task features (Table 4, *SPT Responses*). However, when group discussion and log files were taken into account, it became clear Case C did not develop shared task perceptions because a single individual completed the SPT without consultation or review by other group members. As such, Case C was moved to our low accuracy analysis grouping.

Table 4. Summary of Shared Task Perceptions, Individual Task Perceptions and Planning Activities across Cases

		Moderate Accuracy		Low Accuracy			
		Case A	Case B	Case C*	Case D	Case E	Case F
Shared Task Perceptions	Shared Task Perception Accuracy						
	Total Accuracy	.56 (5)	.67 (6)	.0 (0)	.11 (1)	.0 (0)	.22 (2)
	Explicit Accuracy	1.0 (4)	.75 (3)	.0 (0)	.0 (0)	.0 (0)	.50 (2)
	Implicit Accuracy	.20 (1)	.60 (3)	.0 (0)	.20 (1)	.0 (0)	.0 (0)
Shared Planning Tool (SPT)	SPT Response Accuracy						
	Total Accuracy	.56 (5)	.56 (5)	.44 (4)	.11 (1)	.0 (0)	.11 (1)
	Explicit Accuracy	1.0 (4)	.75 (3)	.75 (3)	.0 (0)	.0 (0)	.0 (0)
	Implicit Accuracy	.20 (1)	.40 (2)	.20 (1)	.20 (1)	.0 (0)	.20 (1)
Individual Task Perceptions (IPT)	IPT Response Accuracy						
	Group Member 1 (Total)	.44 (4)	.11 (1)	.0 (0)	.11 (1)	.11 (1)	.0 (0)
	Group Member 2 (Total)	.22 (2)	.11 (1)	.33 (3)	.11 (1)	.0 (0)	.11 (1)
	Group Member 3 (Total)	.11 (1)	.11 (1)	.22 (2)	.11 (1)	.11 (1)	.11 (1)
	Combined Accuracy (Total)	.56 (5)	.22 (2)	.44 (4)	.22 (2)	.22 (2)	.22 (2)
	Proportion Shared	.60 (3)	.50 (1)	.0 (0)	.50 (1)	.0 (0)	.0 (0)
Planning Activities in log files	Chat Sessions	2	2	0	0	0	1
	Edit SPT	2	3	1	1	1	1
	View SPT Edits	4	5	2	7	5	0
	View SPT	5	4	2	4	4	1
	View Instructions	9	10	4	9	4	2

Note: Proportions > .50 in boldface; Frequencies provided in bracket.

*Originally selected as a high accuracy case based on SPT product. Re-categorized as low accuracy case after phase 1 analysis

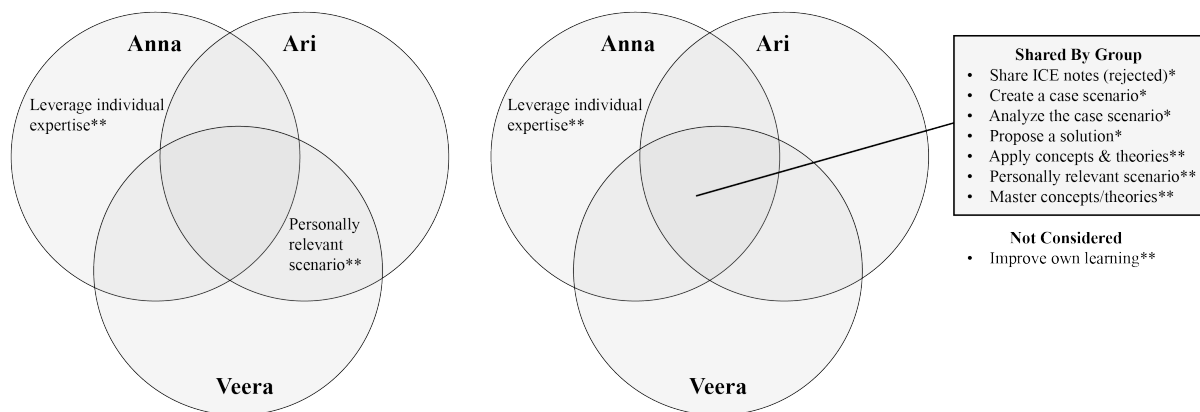
Phase 2 (Case Descriptions)

In a second phase of analysis, we integrated data sources to examine how shared task perceptions developed during collaboration within each of the six cases. Due to space limitations, we provide case descriptions for one moderate accuracy case (Case B) and one low accuracy case (Case E). These cases were typical of each category. We also provide a case description of Case C since it was a non-typical case originally selected as a high accuracy case and re-categorized as a low accuracy case in Phase 1 of our analysis.

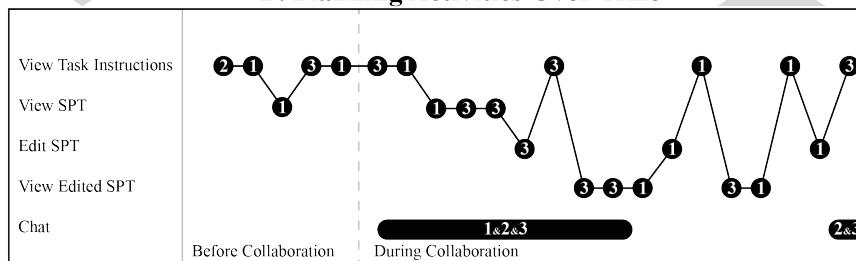
For each case, we provide a graphical representation of the data (Figures 3-5). Section A of each figure is a Venn diagram displaying each group members' personal task perceptions as reported in the IPT (grey circles) as well as the overlap between individuals' reports. Section B displays the planning activities group members engaged in over time as well as when they occurred relative to work on the task (i.e. before or during collaboration). Section C is a Venn diagram displaying groups' shared task perceptions at the end of the task (centre), personal task perceptions that did not become shared by the group (grey circles), and relevant task features not discussed by individuals or groups at any point in the task.

Case B (moderate accuracy). Case B consisted of Anna, Ari, and Veera collaborating in Assignment 1. This groups' shared task perceptions included 66.7% of the relevant task features. Thus, Case B was categorized in our moderate accuracy case grouping.

A. Personal Task Perceptions (IPT) C. Shared Task Perceptions (End of Task)



B. Planning Activities Over Time



1 Anna 2 Ari 3 Veera SPT = Shared Planning Tool; *Explicit Task Features; **Implicit Task Features

Figure 3. Group members' personal task perceptions (a), planning activities (b), and shared task perceptions (c) for the collaborative task in Case B

Our analysis revealed that group members engaged in multiple individual and group planning activities before and during the task (Figure 3b). Specifically, before starting work on

the task, group members planned individually ($f=5$). For example, Anna, Ari, and Veera each viewed the task instructions, and Anna also viewed the SPT prompts.

However, almost immediately upon beginning the task, the group began planning together. For example, as they started the task, Anna, Ari and Veera began a group chat in which they discussed their interpretations of the task. In this chat, the group decided the task required them to create a case description where there is an SRL problem (i.e. *Ari: We have to create a case scenario for the topic with a story / Anna: Yes, there needs to be a story...*), analyze the case description scenario (i.e. *Ari: Do we need to do an analysis? / Veera: Yes, I think so...*), and apply course concepts (i.e. *Veera: We should have a theoretical background applied to our case? Tie the case into the course readings? / Ari: Ok*). Veera and Anna recorded these ideas in the groups' SPT.

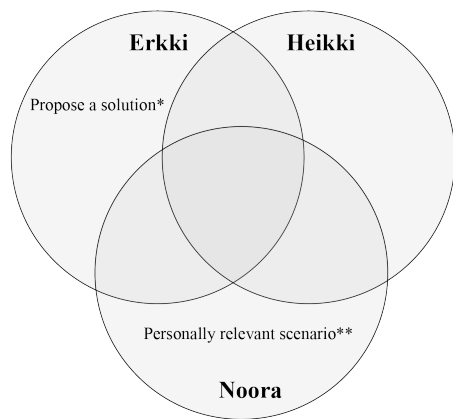
During this chat and afterwards, group members continued to engage in more individual planning activities ($f=9$). For example, Anna and Veera individually returned to view the task instructions at multiple points throughout the task. Finally, near the end of the task, the group chatted again about task perceptions. They decided they needed to come up with a solution to the problem (i.e. *Veera: Also, we need to make a solution / Ari: Yes too bad we can't see how other groups did it*). In addition, Anna contributed her personal interpretation that one purpose of the task was to create a scenario that was "*personally relevant*" to their current work situations which Veera viewed without change.

In doing so, this group constructed shared task perceptions about both explicit and implicit features of the task (Figure 3c). Specifically, their shared task perceptions included 75% of explicit task features (e.g. *the assignment requires us to create a case scenario, analyze a case scenario and propose a solution*) as well as 60% of the implicit task purposes (e.g. *the purpose of the assignment was to master concepts and theories and apply them in the scenario*). Overall, this group could be characterized as actively engaged in planning. There were multiple instances of individual and group level planning activities across the task geared towards developing shared interpretations of both explicit and implicit task features.

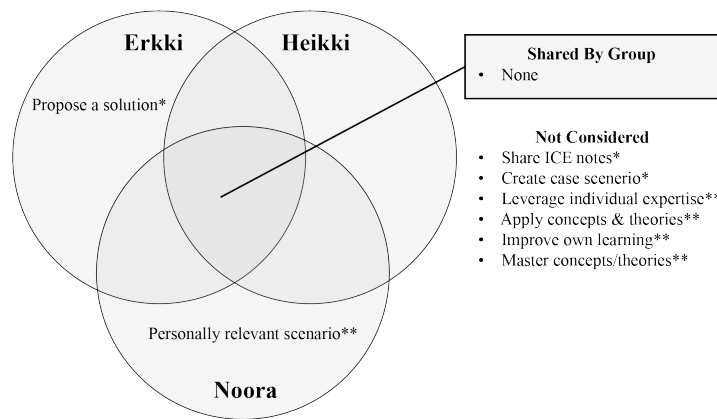
Despite these activities, the group missed a number of opportunities to construct more accurate shared task perceptions. As illustrated in Figure 3a, Anna's IPT responses indicated she correctly believed a key purpose of the task was to leverage group members' expertise (implicit task feature). However, she did not articulate this idea to others and the group did not discuss this relevant aspect of the task at any point (Figure 3c). Furthermore, the groups' discussion was often brief, and during one discussion, the group erroneously decided the task did not require them to share ICE notes (explicit task feature). Finally, group members both individually and together overlooked that one purpose of the task was to improve their own learning (implicit task feature).

Case E (low accuracy). Case E consisted of Erkki, Heikki, and Noora collaborating in Assignment 2. Phase 1 of our analysis revealed this group did not construct any shared task perceptions for the task. Therefore, this group was placed in our low accuracy case category.

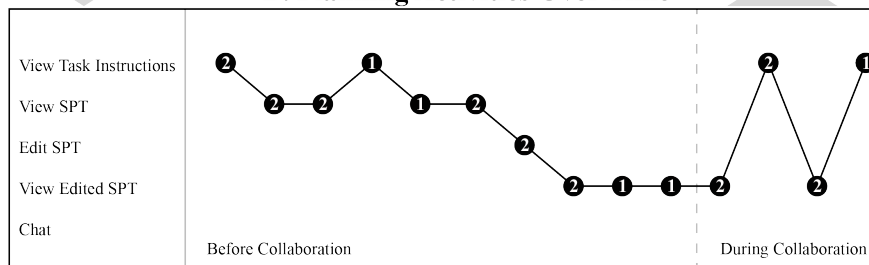
A. Personal Task Perceptions (IPT)



C. Shared Task Perceptions (End of Task)



B. Planning Activities Over Time



1 Erkki 2 Heikki 3 Noora SPT = Shared Planning Tool; *Explicit Task Features; **Implicit Task Features

Figure 4. Group members' personal task perceptions (a), planning activities (b), and shared task perceptions (c) for the collaborative task in Case E

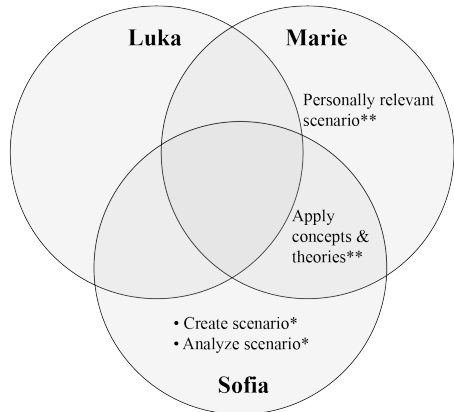
Our analysis revealed some group members engaged in frequent planning activities. However, planning activities were almost exclusively individual and most occurred before collaboration (Figure 4b). Specifically, before the group began working together on the task, Erkki and Heikki individually viewed the task instructions and the planning tool prompts ($f=6$). Heikki then edited the SPT once and Erkki viewed these changes. However, the information added was a partial draft of the assignment product created without input of the rest of the group rather than interpretations about what the task required.

Once the group began working on the task, Heikki viewed this draft again ($f=2$), and Heikki and Erkki individually viewed the task instructions at different points ($f=2$). Although the task was collaborative, the group did not evidence any attempts to plan together by discussing task perceptions in chat ($f=0$) or exchanging task perceptions in the SPT ($f=0$) at any point.

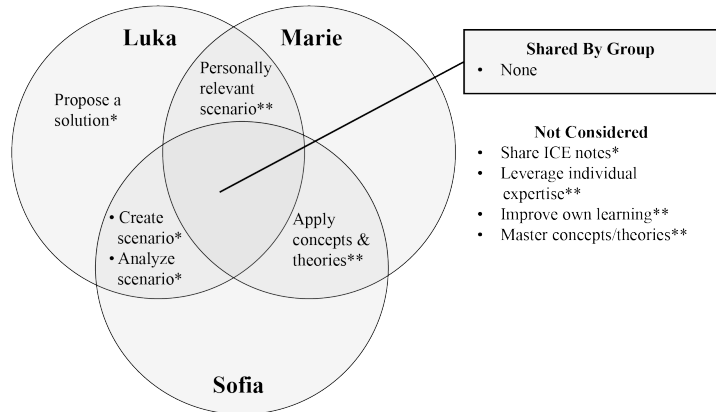
Overall, this group's planning could be best characterized as individual rather than shared. Thus, the group missed a number of opportunities to construct shared task perceptions that were accurate for the task. For example, Erkki believed that the task required them to propose a solution to a problem and Noora believed the task should be personally relevant to their teaching (Figure 4a). However, group members did not become mutually aware of one another's perceptions or improve on them together at any point (Figure 4c). In essence, the group bypassed construction of shared task perceptions in their planning and completion of the collaborative task.

Case C (low accuracy). Case C consisted of Luka, Maria, and Sofia collaborating in Assignment 3 (Figure 5). What is interesting about this group is that we initially categorized it as a high accuracy case since the group's SPT contained many of the relevant task features. However, Phase 1 of our analysis revealed these task perceptions were added by one member (Luka) without knowledge or awareness of the rest of the group.

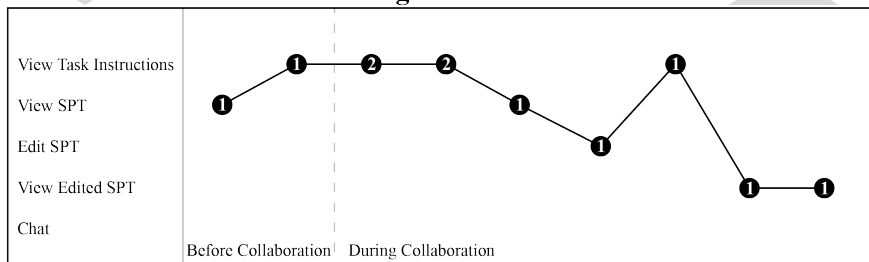
A. Personal Task Perceptions (IPT)



C. Shared Task Perceptions (End of Task)



B. Planning Activities Over Time



1 Luka 2 Maria 3 Sofia SPT = Shared Planning Tool; *Explicit Task Features; **Implicit Task Features

Figure 5. Group members' personal task perceptions (a), planning activities (b), and shared task perceptions (c) for the collaborative task in Case C

In this case, group members engaged in relatively infrequent planning activities. However, most planning activities were individual and most occurred after collaborative work had already begun on the assignment (Figure 5b). Specifically, before working on the task together, only Luka viewed the planning tool prompts and task instructions ($f=2$). Once collaboration began, group members continued to engage in mostly individual planning activities. For example, Maria and Luka viewed the task instructions ($f=3$), and Luka viewed the planning tools prompts again ($f=1$). At one point, Luka contributed some task perceptions to the SPT ($f=1$). These included perceptions about the explicit task features (i.e. *the task requires us to create and analyze a scenario as well as propose a solution*) as well as implicit task features (i.e. *the purpose of the task was to create a personally relevant scenario*). Unfortunately, Maria and Sofia were unaware of this and did not see or discuss his ideas at any point.

By the end of the task, this group failed to construct shared task perceptions (Figure 5c). Overall, this group's shared planning can be characterized as disjointed. Although Luka appeared

to attempt to initiate shared planning by editing the SPT, group members were unaware of one another's interpretations of the task. Furthermore, group members failed to identify four other task features described as important by the instructor (e.g. *improve own learning*). While some group members held complementary personal interpretations by the end of the task (Figure 5c), they missed opportunities to bring their different interpretations together and extend them to develop more complete shared task perceptions on which to base their strategic enactment of the task.

Phase 3 (Cross Case Comparison)

In phase 3, we compared moderate accuracy cases ($k=2$) and low accuracy cases ($k=4$) in the interest of discovering similarities and differences in how shared task perceptions developed during collaboration. Comparison of cases revealed four major differences that contributed to groups' construction of shared task perceptions.

Scope of task features. Constructing shared task perceptions that are effective for collaboration means systematically deconstructing the multiple explicit and implicit layers of the task (Hadwin, 2006; Winne et al., 2013). A striking difference between cases in this study was that low accuracy groups negotiated incomplete shared task perceptions that were narrow in scope comprised of either explicit task features (0-50%) or implicit task features (0-20%) rather than both (Table 4, *Shared Task Perceptions*). On the other hand, moderate accuracy groups considered both explicit task features (75-100%) and implicit task features (20-60%). As such, diving deeper into multiple layers of task information appeared to facilitate groups' construction of accurate shared task perceptions.

Planning individually and together. A second difference between cases was the extent to which groups approached planning and construction of task perceptions as both an individual and group process. While we expected that groups would engage in a certain level of shared planning for collaborative tasks, a somewhat surprising finding was that low accuracy group members mainly planned as individuals (e.g. by checking task instructions and viewing planning prompts). For example, across all low-accuracy groups, there were only one or two instances where group members discussed task perceptions as a group, such as by editing the SPT or engaging in chat sessions (see Table 4, *Planning Activities*).

Comparatively, moderate accuracy groups engaged in both individual planning activities and group level planning activities. For example, moderate accuracy groups engaged in at least four activities each in which they discussed or exchanged task perceptions with others (e.g. editing the SPT and chatting with other group members about the task features). It was during these exchanges that group members were able to construct more comprehensive perceptions of the task.

What is interesting about this finding is that although all groups in this study were provided with tools for shared planning (e.g. SPT and chat tool), low-accuracy groups more often ignored these tools and approached planning in a collaborative task as a more individual process. Self-regulatory processes, such as individual planning, play an important role in collaboration; However, optimizing collaboration means groups must move beyond simply self-regulating their personal engagement to also regulate together, such as by constructing shared task perceptions of what is required (Hadwin et al., 2011; Järvelä & Hadwin, 2013; Volet et al., 2009). By focusing on personal task interpretations without engaging in shared planning activities, low accuracy groups had little opportunity to hear what others in the group thought about the task or construct shared task perceptions to guide their work together.

monitor task perceptions throughout the task, recognize when perceptions are misaligned or need repair, and make changes if needed to optimize collaborative work.

Difficulties across all groups. Despite these differences, it is important to note that none of the groups constructed highly accurate shared task perceptions. Groups' shared task perceptions included fewer than 70% of the relevant task features, and all groups evidenced difficulties in the factors described above. First, all groups failed to recognize the full breadth of explicit and implicit task features and tended to overlook implicit task information in particular (Table 4, *Shared Task Perceptions*). With the exception of Case B, groups discussed 20% or fewer of these underlying aspects of the task. As such, consistent with previous research evidencing minimal amounts of shared planning (Miller & Hadwin, 2012; Hurme, Palonen, & Järvelä, 2006), groups tended to approach collaborative tasks with only partial consideration of task features intended to guide their collaboration.

Second, planning activities in which group members communicated or discussed task perceptions as a group were relatively infrequent across all cases and the majority of planning activities in all groups were individual. For example, groups often engaged in fewer than three instances of editing the SPTs and there was a total of only five chat sessions spread across only three of the groups (Table 4, *Planning Activities*). Thus, although groups were provided with tools emphasizing shared planning as an integral aspect of the assignment, individual planning activities tended to dominate across all cases.

Third, when groups did plan together, they rarely did so before starting work on the collaborative task. Across all groups, there were only three instances where groups discussed or exchanged ideas about what the task required and why before collaboration (Figure 6). These included one chat discussion and two instances of communicating task perceptions in the SPT evidenced by Case A, D, and E respectively. Thus, although groups were prompted to construct shared plans for collaboration prior to starting the task, groups rarely did so. This finding is similar to previous research indicating that groups do not always engage in purposeful discussion about the task before delving into collaboration (Rogat & Linnenbrink-Garcia 2011).

Finally, all groups evidenced instances where group members' personal task perceptions were overlooked even when they were relevant to the task at hand. Across all cases, groups integrated or built on 60% or fewer of individual's task perceptions (Table 4, Shared task perceptions). Thus, groups' shared task perceptions were often less accurate than they had the potential to be. These findings are in line with previous research indicating that metacognitive knowledge does not always become shared within the group (Hurme, Merenluoto, & Järvelä, 2009; Hurme, et al., 2006) and group members may be hesitant to externalize metacognitive knowledge regarding task planning (Azevedo, Moos, Johnson, & Chauncey, 2010; Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003).

Conclusions and Future Directions

This study compared groups with moderate or low accuracy of shared task perceptions in terms of how shared task perceptions unfolded in collaboration. Findings indicated a number of factors contributed to development of accurate shared task perceptions including (a) scope of task perceptions considered, (b) planning individually as well as collectively, (c) capitalizing on group members' distributed task perceptions, and (d) dynamically constructing task perceptions throughout the task.

Overall, these findings illuminate shared task perceptions to be a complex social phenomena and lend support to theoretical accounts positing regulation as an active dynamic

process that unfolds across the individual and group level over time (Hadwin et al., 2011; Hadwin & Oshige, 2010; Järvelä & Hadwin, 2013).

However, despite being provided with CSCL planning tools, groups evidenced difficulties with each of the above processes and no groups constructed highly accurate shared task perceptions. The difficulties learners faced suggest a number of ways in which CSCL supports may facilitate groups' shared planning. First, given that all groups' shared task perceptions were incomplete compared to task specifications, learners may benefit from CSCL supports that prompt systematic analysis of the multiple levels of task information comprising collaborative tasks and projects. Second, despite having constructed and articulated individual task perceptions in their IPTs, students often neglected to share those ideas with their groups during planning discussions and the construction of the SPT. One target for CSCL tools may be to make collective summaries or visualizations of individual's task perception ideas available to the group during shared planning. Providing a window into what others in the group believe, and supporting groups to consider the diversity of task perceptions offered by each group member may create opportunities for building on one another's interpretations and resolving discrepancies. Finally, many groups evidenced a surprisingly individual approach to planning. The use of CSCL tools to prompt shared planning episodes throughout the task, as well as guide groups to actively negotiate and discuss task interpretations warrants further investigation.

It is important to note this study had a number of limitations. Since this study examined shared task perceptions in a small number of groups, findings cannot be generalized to collaboration in general. Furthermore, since groups constructed only low to moderately accurate shared task perceptions, further investigation of how accurate shared task perceptions develop would also be fruitful to confirm and expand on these findings. Another limitation concerns our sampling strategy. While purposefully selecting cases across all assignments enabled us to best compare situations where groups developed accurate vs. inaccurate shared task perceptions, groups' experiences in previous assignments and with each other likely impacted how they constructed shared task perceptions in ways not captured in this study. Finally, since task perceptions are covert at the individual level, measures of individual task perceptions in this study are limited by information learners choose not to provide. For example, individuals may have not fully reported their personal task perceptions IPT or may have agreed with others simply to move the work along or to avoid conflict. Thus, future research would benefit from corroborating findings with other measures, such as interviews at the conclusion of the task.

Despite these limitations, the present study contributes to the emerging discussion of social aspects of regulation. As research of shared regulatory processes is scarce (Panadero & Järvelä, 2015), prior studies have often focused on identifying episodes of shared regulation and distinguishing self- and social aspects of regulation. This study contributes to the emergent literature by shedding light on the micro-processes underlying shared planning for regulating collaboration. In particular, an important contribution of this paper is that we have been able to provide a framework for examining task perception accuracy and the processes that do or do not lead to it.

Findings also revealed the potential of blending pedagogical tools to support regulation with research tools for examining and understanding regulation. CSCL supports included in this study (IPT, SPT, chat discussion) created ways to prompt and promote the development of shared task perceptions, as well as important ways to capture critical data for understanding this process. Specifically, data generated by learners as they interacted with these tools and the CSCL environment enabled us to capture shared task perceptions as they unfolded in the context of

meaningful collaborative tasks across the individual and group level. Our analysis revealed that drawing on multiple sources of data was key to understanding shared task perceptions. For example, SPT responses alone were inadequate for identifying shared task perceptions since members could complete this tool without knowledge of others. Coupling such statements with log files of planning activities (e.g. edits and views of shared planning tool), and exchanges about task perceptions in group chat was critical for teasing out whether task perceptions were shared by the group. In addition, groups' SPT responses and chat discussions about task perceptions were limited in their ability to capture what group members personally believed about the task. Comparing groups' shared task perceptions with group members' statements about personal task perceptions in the IPT provided valuable information about how task perceptions evolved across the individual and group level.

Moving forward, we suggest two key directions for future research. First, shared task perceptions are posited to play a key role in launching regulation and collaboration (Hadwin et al., 2011; Järvelä & Hadwin, 2013; Winne & Hadwin, 1998, 2008). Thus, it would be fruitful to investigate how shared task perceptions influence and evolve with other shared regulatory processes (e.g. shared goal setting, strategic enactment of the task, and mutual monitoring and adapting during collaboration), as well as how they influence task performance. Although shared regulation has been linked to learning, performance, and productive collaboration in previous research (e.g. Janssen, Erkens, Kirschner, & Kanselaar, 2012; Järvelä et al., 2013; Volet, Summers, & Thurman, 2009), more systematic investigation of this relationship is needed.

Second, although findings offer potential targets for scripted support of shared task perceptions in shared regulation, future efforts are needed to investigate *how* to provide this support. For example, while CSCL scripts inadequately supported shared task perceptions in this study, it is unclear whether groups would benefit from support at the individual level, the group level, or both. Simply providing more structure may not be beneficial. Too tightly constraining collaboration can impinge on interaction, lead to difficulties accommodating structure dictated by scripts, or cause failure to use scripts at all (Soller, 2001; Lazonder, Wilhelm, & Ootes, 2003). Thus, future research is needed to compare different types of supports if we wish to advance understanding about how learners can be facilitated to develop the critical skills needed to regulate collaborative learning.

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Manuscript 3: Miller M., & Hadwin, A. F. (2015b). Comparing the effectiveness of CSCL supports for shared task perceptions in socially shared regulation of collaborative learning. Manuscript in submission.

Abstract

This study examined the effect of CSCL tools supporting individual and group planning on construction of shared task perceptions for socially shared regulation of collaboration. Individual and group planning tools were integrated directly within a complex collaborative task. Groups were assigned to one of four conditions differing in terms of level of individual-level support (high vs. low) and group-level support (high vs. low). Findings indicated that, regardless of level of individual support, a high level of group support facilitated groups to construct more accurate shared task perceptions, capitalize on individuals' task perceptions, and engage in more transactive planning discussion. However, no effect of planning support was found for group performance. Directions for future investigation of CSCL supports for shared regulation are discussed.

Introduction

Collaboration is increasingly recognized as an important skill in both academic and work contexts. However, the research is clear that simply placing learners in groups does not reliably result in effective collaboration or learning (Dillenbourg, Järvelä, & Fischer, 2009). While over two decades of research indicate successful students self-regulate their learning by taking control of their thinking, behaviour, motivations, and emotions in a task (SRL, Zimmerman, 1989), recent perspectives emphasize collaboration also demands that groups engage in socially shared regulation (SSRL) by collectively interpreting task features, setting shared goals and plans to strategically approach the task, sharing in the monitoring and evaluating of progress and products, and adapting when needed and persisting in the face of challenge (Hadwin, Järvelä, & Miller, 2011; Järvelä & Järvenoja, 2011; Volet, Vauras, Salonen, 2009).

However, shared regulatory processes rarely occur adequately without support (Winne, Hadwin, Perry, 2013). In particular, groups encounter difficulties constructing shared perceptions of the task (Miller & Hadwin, 2012) and report strategic planning challenges to be one of the biggest difficulties hindering their collaborative efforts (McCardle, Helm, Hadwin, Shaw, & Wild, 2011). This aspect of shared planning is critical for collaboration as it lays the groundwork for launching, evaluating, and adapting engagement in the task (Hadwin, et al., 2011; Winne & Hadwin, 1998, 2008).

Although the last two decades has witnessed an explosion of Computer Supported Collaborative Learning (CSCL) technologies supporting knowledge construction, adequately preparing 21st century undergraduates for their future careers also means developing tools that support regulation (Hadwin, Oshige, Gress, & Winne, 2010; Järvelä & Hadwin, 2013). In essence, a key priority for research is designing tools that not only help students collaborate to learn, but also learn to collaborate. Despite this need, research investigating CSCL supports for shared regulatory processes is scarce. This study aimed to contribute to this emerging research by examining the effect of CSCL planning supports on groups' construction of accurate shared task perceptions and collaborative task performance.

Regulation of Collaboration

Collaboration is a complex social process that requires groups to co-construct shared knowledge through productive collaborative interactions (Resnick, Levine, & Teasley, 1991;

Roschelle & Teasley, 1995). Groups can encounter cognitive, motivational, and socio-emotional challenges that impede them from reaching their full potential even when activities are carefully designed (Kirschner, Sweller, & Clark, 2006; Van den Bossche, 2006).

Recent perspectives emphasize that achieving the purported benefits of collaboration requires learners to regulate their cognition, behaviour, motivation, and emotion at both the individual and group level (see Hadwin et al., 2011; Järvelä & Hadwin, 2013). Specifically, collaborative tasks demand individuals self-regulate their engagement in the joint task by (a) intentionally analyzing task and setting goals and standards, (b) strategically using tools and strategies, (c) monitoring progress and intervening if needed, and (d) persisting in the face of challenges.

Furthermore, groups must regulate together through socially shared regulation of learning (SSRL). When groups engage in SSRL, they share in the strategic planning of the joint task, coordinate enactment through strategically adopting and thoughtfully adapting tools and strategies, and monitor and evaluate their progress together, intervening if results deviate from plans. (Hadwin & Oshige, 2011; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013). In this way, collaborative groups can be conceptualized as comprised of individual self-regulating agents who must also regulate together as a social entity. These forms of regulation arise alongside one another and work together as a basis for successful collaboration (Hadwin et al., 2011; Volet, et al., 2009).

In our work, we have extended Winne and Hadwin's (1998, 2008) model of self-regulated learning to conceptualize SSRL as unfolding over four loosely sequenced and recursive phases. In phase 1 groups construct shared task perceptions about the collaborative task by surveying and interpreting the raw materials of the external task or situation (Phase 1: Shared task perceptions). This negotiated awareness of the task features and requirements provides the basis on which groups set shared goals and plans for strategically approaching the task as well as standards against which to monitor engagement (Phase 2: Shared goal setting and planning). In Phase 3 (Task enactment), groups coordinate their strategic task engagement by collectively and flexibly identifying, constructing, and adapting a range of cognitive, behavioural, socio-emotional, and motivational strategies. Throughout the task, groups collectively monitor and evaluate their collaborative processes, progress, and products in order to strategically adapt shared task perceptions, goals, plans, and engagement when needed in order to optimize collaboration in the current task as well as in future tasks (Phase 4: Small and large scale adaptation).

Although Winne and Hadwin's (1998, 2008) model has often been characterized as an information-processing model of individual regulation (Puustinen & Pulkkinen, 2001; Zimmerman & Schunk, 2001), we suggest it is well positioned to explain regulation as social. First, by suggesting learners' regulatory choices and processes in each phase are framed by conditions, both internal (e.g. beliefs and prior knowledge) and external (e.g. environmental affordances and constraints), this model allows for a nuanced and detailed understanding of how regulation unfolds within and across tasks (Greene & Azevedo, 2007). Second, we suggest the products of individual regulation (e.g. personal task perceptions) become the conditions of shared regulation (e.g. shared task perceptions) and vice versa. In this way, this model provides an account of how self and shared regulation reciprocally intertwine and evolve together in the context of a collaborative task.

Shared task perceptions for regulating collaboration. Constructing shared task perceptions is vital for regulation of collaboration. Shared task perceptions refer to metacognitive

knowledge about task requirements and specifications. As the first phase of regulation, this aspect of planning creates a common foundation from which groups are positioned to (a) set goals and make plans for strategically approaching the task, and (b) create standards against which to monitor and evaluate their processes, progress, and products (Winne & Hadwin, 1998, 2008). Without this common basis, teamwork may become a negative and frustrating experience as group members exert time and energy working at cross-purposes or in ways ill-suited to the task.

The centrality of having a common basis on which to collaborate has been well established in the field and is often referred to as negotiating common ground (Beers, Boshuizen, Kirschner, & Gijsselaers, 2006) or shared mental models (Salas, Sims, & Burke, 2005; Stout, Cannon-Bowers, Salas, & Milanovich, 1995). Research on team effectiveness originating in organizational sciences indicates shared mental models are conditional for effectively setting team goals, deciding on team strategies, allocating subtasks to team members, adequately monitoring team processes, and engaging in effective communication (Klimoski & Mohammed, 1994; Van den Bossche, Gijsselaers, Segers, Woltjer, & Kirschner, 2010).

However, an important difference between shared mental models in this research and shared task perceptions concerns the types of information they include and the role they play in collaboration. Specifically, shared task perceptions include metacognitive knowledge about specific task requirements and specifications framed by self, task, and group conditions. They are considered to be the first phase of regulation on which subsequent regulatory processes are based (Winne & Hadwin, 1998, 2008; Winne et al., 2013). As regulation of collaboration unfolds, shared task perceptions about the situation evolve and change.

On the other hand, shared mental models include a wide array of information that is often distinguished into different types (Akkerman et al., 2007; Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000; Fransen, Kirschner, & Erkens, 2011). These include (a) team mental models regarding team functioning, roles and responsibilities, and expectations for group member behaviours, and (b) task mental models regarding strategies, procedures, likely scenarios and contingencies, components, and environmental constraints. In this way, shared mental models are more akin to a holistic ‘vision’ of how the task can be successfully completed and often centre on domain specific knowledge of the task.

Constructing shared task perceptions requires much more than simply reading task instructions. In our work, we have conceptualized this process as involving at least two dimensions. First, in order for task perceptions to provide a solid basis for regulation, they must permeate the group. The term ‘shared’ can hold multiple meanings including (a) *commonality*, such as team members holding overlapping or similar beliefs, and (b) *division*, such as distributed knowledge of task features among team members. In the context of regulation, shared means *co-constructed or negotiated* by the group. Therefore, groups must invest in a process to (a) become mutually aware of potential differences in their individual task perceptions, and (b) negotiate consensus or a joint representation of the task at hand. Akin to notions of transactivity in knowledge convergence (Roschelle, 1996, Teasley, 1997), shared task perceptions are created when learners understand and build on each other’s perspectives, and acknowledge and resolve differences among their ideas (Fischer & Mandl, 2005; Van Boxtel, Van der Linden, & Kanselaar, 2000, Weinberger, Stegmann, & Fischer, 2007).

Second, task perceptions must be *accurate and complete* (e.g. aligned with the expectations of the instructor) in order to be optimally effective for informing subsequent regulation. Complex tasks, such as those warranting collaboration, are comprised of multiple

layers of information learners must decipher and interpret (Butler & Cartier, 2004; Winne & Perry, 2000). Deconstructing the details and nuances of tasks means considering at least two types of information: (a) explicit task information about concrete task requirements and criteria, and (b) implicit task information, such as the bigger purpose or meaning of the task (Hadwin, 2006). While explicit task information is often presented overtly by an instructor or client, implicit task information must often be inferred by groups from course objectives and descriptions, or the larger context in which the task is embedded. This does not mean there is only one correct way to go about the task. For example, groups use task perceptions to inform their personalized goals and approaches to the task. These goals may or may not be similar to the original task demands. Alternatively, groups may decide to further negotiate the task requirement with the instructor. However, constructing accurate and complete task perceptions enables groups to do so in a purposeful, strategic, and informed way.

While learners' task perceptions influence their subsequent regulation and achievement (Greene, Hutchinson, Costa, & Crompton, 2012; Schellings and Broekkamp, 2011), the emergent research consistently indicates learners and groups struggle with this process. For example, undergraduate students frequently misinterpret task features across a wide array of disciplines and often fail to recognize these misperceptions, thus limiting opportunities to regulate learning (Butler & Cartier, 2004; Hadwin, Oshige, Miller, & Wild, 2009; Hadwin & Winne, 2012; Luyten, Lowyck, & Tuerlinckx, 2001; Oshige, 2009). Research about shared task perceptions in collaborative tasks similarly indicates group members often construct task perceptions misaligned with the task requirements as well as each other (Hadwin, Malmberg, Järvelä, Järvenoja, & Vainionpää, 2010; Miller & Hadwin, 2012). For example, in a recent case study, Miller, Malmberg, Hadwin and Järvelä (2015) found that groups constructed incomplete perceptions of the task and failed to discuss one another's personal interpretations of the task. In addition, groups often failed to engage in shared planning until well after the task was underway. Similarly, in an examination of shared regulatory processes in a face to face mathematics task, Rogat & Linnenbrink-Garcia (2011) found that groups sometimes overlooked planning and jumped into task completion with little discussion or attention to task requirements.

Designing supports for shared task perceptions. One possibility for remediating these difficulties is technology itself. Specifically, online environments can move from simply being platforms for collaboration to being tools for supporting and scaffolding this process (Hadwin et al., 2010; Järvelä & Hadwin, 2013). While the ability of technology to support self-regulated learning has been well established (Azevedo & Hadwin, 2005; Dabbagh & Kitsantas, 2005; Perry & Winne, 2006), few studies have explored how technology can support shared regulatory processes.

Research in the area of Computer Supported Collaborative Learning (CSCL) presents exciting opportunities for this purpose. Research in CSCL has evidenced the effect of technological supports on groups' interaction and functional coordination for domain knowledge construction (Soller, Martínez-Monés, Jermann, & Muehlenbrock, 2005). Two types of tools have garnered much attention: (a) scripting tools that structure and guide collaboration by specifying, sequencing, and distributing activities learners are expected to engage in during collaboration (Dillenbourg, 2002; Kollar, Fischer, & Hesse, 2006); and (b) group awareness tools that facilitate collaboration by helping learners become aware of actions, thinking, knowledge, or social functioning of the group (Bodemer & Dehler, 2011; Janssen & Bodemer, 2013).

Recently, researchers have argued these tools can be leveraged to promote shared regulatory processes by shifting the target of support to shared regulation and its underlying

processes (Hadwin et al, 2010; Järvelä & Hadwin, 2013; Järvelä et al, 2014). In particular, Miller and Hadwin (2015) drew on theoretical frameworks of regulation in collaboration to propose ways in which macro-scripts, micro-scripts, and group awareness tools could directly support regulation of collaboration. For example, while macro-scripts are typically used to orchestrate activities and processes expected to enhance collaborative learning (Dillenbourg & Hong, 2008; Dillenbourg & Tchounikine, 2007), they may also be used to support regulation, such as by orchestrating engagement in phases of regulation within and across assignments (e.g. planning, enacting, and monitoring and adapting).

Second, while micro-scripts typically provide learners with fine-grained guidance for engaging in specific activities (Kobbe, et al., 2007), they can support regulation by targeting specific regulatory processes instead (e.g. question prompts and sentence starters facilitating negotiation of task features). Finally, group awareness tools typically support collaboration by assisting group members to become aware of information about group members' actions, thinking, knowledge, or social functioning (Bodemer & Dehler, 2011; Janssen & Bodemer, 2013). However, these tools can be leveraged to promote regulation by displaying information about regulation itself. For example, groups can be provided with a visualization of what each member personally believed about the task.

However, while the emergent research indicates that tools can be tailored to promote shared regulatory processes (Järvelä et al., 2014), learners often encounter challenges despite being provided with tools. For example, in a recent case study, Miller, et al., (2015) compared groups with accurate and inaccurate shared task perceptions in terms of how this processes unfolded during a collaborative task in a CSCL environment. Findings indicated that, despite being provided with planning tools scripting individual and shared task perceptions, no groups constructed highly accurate shared task perceptions. Furthermore, groups often jumped into the task without making any plans and when planning occurred it was often done individually rather than as a group. Finally, group members often neglected to capitalize on group members' personal interpretations of the task.

It is clear more research is needed to investigate how tools can be best designed to support this process. A critical question centres on how supports are configured and provided to learners and group. Designing effective supports means taking care to provide learners and groups with levels of support that both adequately facilitate learners' engagement in the targeted process without disrupting the rich interaction that is the hallmark of collaboration itself (Dillenbourg, 2002; Beers, Boshuizen, Kirschner, & Gijsselaers, 2005). When tools do not provide learners with sufficient guidance, they are unlikely to provide the support needed to help learners engage in processes they may not engage in on their own. On the other hand, excessive structure may impede genuine collaboration by interfering with teams' natural interactions (Bromme, Hesse, & Spada, 2005; Dillenbourg 2002). Since few studies have systematically examined supports for shared regulatory processes, we have little knowledge about how much support learners require or whether support should be provided at the individual level, the group level or both.

Purpose

The purpose of this paper was to investigate the extent to which individual and shared CSCL planning tools supported construction of shared task perceptions for regulating collaborative learning. Two CSCL planning tools supporting individuals and groups to construct task perceptions were integrated directly within a complex collaborative task. Groups were assigned to one of four conditions that varied in terms of level of individual support (high vs.

low) and group support (high vs. low). Effect of level of individual and group planning support was examined for (a) accuracy of groups' shared task perceptions, (b) degree to which groups capitalized on individual task perceptions, (c) the extent to which groups transactively negotiated shared task perceptions in planning discussion, and (d) group performance on the task. Based on our theoretical framework, we hypothesized that a high level of individual and group planning support would facilitate learners to construct more accurate shared task perceptions by capitalizing one another's distributed task perceptions as a group, and transactively building on each other's ideas to negotiate shared task perceptions. Furthermore, we expected that, by facilitating shared task perceptions, a high level of support would also contribute to greater task performance.

Method

Participants and Context

Participants were 192 undergraduate students (86 male, 106 female) enrolled in a first year elective course at the University of Victoria, British Columbia, Canada (M=18.69 years, SD=1.56). The purpose of this course was to develop theoretical and practical understandings about self-regulated learning. Coursework included a grade bearing collaborative assignment in which students worked in groups of three to four (K = 48). The assignment was an applied test for the course that required groups to work together to (a) analyze a case depicting a student encountering difficulties in an academic task, and (b) identify the root the student's problems. Assignment task features are summarized in Table 1. Students were assigned to groups on the principle of heterogeneity with respect to gender and prior knowledge as indicated by performance on two subject matter quizzes that tested domain knowledge needed for the collaborative task.

Table 1. *Explicit and Implicit Task Features for the Collaborative Assignment*

Explicit Task Features	Implicit Task Features (Task Purpose)
Analyze a problem case scenario	Build on each other's knowledge
Identify all SRL strengths & weaknesses	Learn to collaborate
Classify strengths and weaknesses according to phases of SRL	Master course concepts
Identify the problem that came first	Apply course concepts to solve a problem
Back up our answer with examples from the scenario	Learn to collaborate with online tools

Learning Environment and Procedure

The collaborative assignment was delivered and completed in the University of Victoria's instance of Moodle 2.4 (Modular Object-Oriented Dynamic Learning Environment, Dougiamas, 2001). Moodle was selected because it enabled flexible design of collaborative learning tasks and opportunities for collaborative interaction among learners. Furthermore, students were familiar with the Moodle environment and its functionalities since this platform is used extensively at the University of Victoria. Zoho Chat was used as a group chat tool. Students were provided with opportunities to use the chat tool in lab prior to the assignment.

Prior to the assignments, students were provided with the assignment description in the online environment. The description provided an overview of the explicit task features and components (see Table 1). Learners and groups completed the assignment online with three types

of CSCL supports: (a) a macro-script orchestrating engagement in the phases of socially shared regulation in the assignment, (b) micro-scripts providing more fine-grained support regarding how to engage in these phases, and (c) a group awareness tool supporting groups to become aware of group members' individual regulation. While CSCL supports traditionally target shared knowledge construction, tools in this study targeted processes for regulating collaboration with a particular focus on individual and shared planning (Miller & Hadwin, 2015).

Regulation macro-script. The collaborative assignment was framed in a five-step macro-script that specified the task as involving (a) multiple regulatory phases beyond simply completing the task, and (b) both individual- and group-level regulatory processes (Miller & Hadwin, 2015). Specifically, the macro-script broke the task down into five key steps (Figure 1): (a) planning (Steps 1–3), (b) enacting the task, and monitoring, and evaluating progress and products (Step 4), and (c) reflecting for adapting (Step 5). Steps were loosely sequenced meaning that students moved through the steps in order, but could return and revise work from previous steps at any point before submitting their collaborative work.

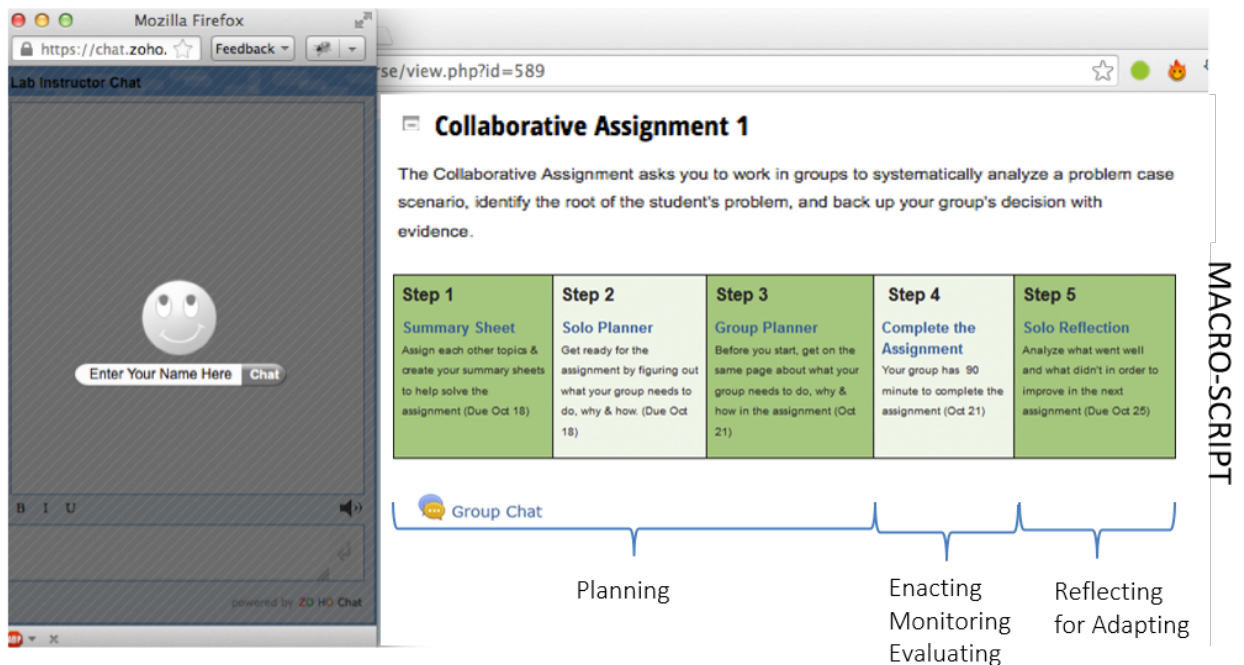


Figure 1. Online collaborative assignment module in Moodle 2 environment

Step 1 (*Preparatory Expertise*) was completed during the two weeks prior to the collaborative assignment. Group members were asked to (a) each select one of four target course topics covered earlier in the semester, and (b) review critical information from lectures, readings and activities to construct a “summary sheet” or reference guide to be used during the collaborative assignment task. This step set the stage for collaboration by ensuring group members activated and augmented prior knowledge about course concepts and, at the very least, developed distributed expertise about those concepts.

Step 2 (*Individual Planning*) was also completed during the two weeks prior to the assignment. In this step, individuals were encouraged to actively plan for the task by (a) reading the assignment description, (b) exploring and generating personal task perceptions about the collaborative assignment instructions, details, and purpose, (c) setting goals for the collaborative

assignment, and (d) articulating planning ideas for embarking on the collaborative assignment together.

Step 3 (*Shared Planning*) was completed in a 10-15 minute dedicated online planning session that occurred immediately prior to the collaborative problem solving task. Building on step 2, groups were prompted to collectively plan for this task by discussing and negotiating shared task perceptions about the task details/instructions, and goals and plans for approaching the task.

Step 4 (*Task Enactment*) was the collaborative problem solving task itself. Groups completed the collaborative assignment online in one 70-minute time block during class time. Groups were provided with a complex case based scenario and worked together to compile ideas and answers in a shared wiki space and text-based chat discussion.

Step 5 (*Solo Reflection*) was completed within a week following the collaborative task. Group members were encouraged to individually reflect on their collaboration including individual and team-based strengths, weaknesses, challenges, and potential improvements for future collaborative tasks.

Planning micro-scripts. Learners and groups were also provided with micro-scripts that provided more fine-grained support for carrying out each step of the macro-script (e.g. solo planning, group planning, and reflection). Since task perceptions are the focus of this study, description is limited to micro-scripts supporting task perceptions provided in two planning tools: (a) the Individual Planning Tool, and (b) the Shared Planning Tool.

The Individual Planning Tool (IPT, Miller, Webster, & Hadwin, 2012, 2013) was provided to learners during Step 2 of the assignment (Solo Planning). This tool included two question prompts that scripted learners to actively construct personal task perceptions by considering the explicit task features (i.e. *What is my group being asked to do in the Timed Collaborative Challenge*) and the implicit task features (i.e. *Why are we doing the Collaborative Challenge*).

The Shared Planning Tool (SPT, Hadwin, Miller, & Webster, 2012, 2013) was provided to groups during Step 3 of the assignment. This tool included identical question prompts to those in the ITP. However, in the SPT, questions scripted groups to construct shared task perceptions by negotiating and co-constructing a single response for the group.

Group awareness tool. The Shared Planning Tool (SPT) also included a group awareness tool. This tool complemented the micro-script by helping groups become aware of similarities in differences in group members' personal task perceptions (i.e. IPT responses) in order to better draw on these distributed ideas during negotiation. The group awareness tool displayed each group members' responses to IPT question prompts to the group (e.g. *What is my group being asked to do during the Timed Collaborative Challenge* and *Why are we doing the Collaborative Challenge?*). As part of the SPT, groups were instructed to use the group awareness tool to 'view a summary of what we each said' and "use this summary to help complete the questions."

Treatment: Individual and Group Planning Support

This study compared two levels of individual (IPT) and group (SPT) support for developing shared task perceptions (low vs. high support).

Low support planning tools. In the low support planning tools (IPT-L and SPT-L), task perceptions were merely prompted with broad open ended questions (i.e. "*What is my group being asked to do during the Timed Collaborative Challenge*" and "*Why are we doing the collaborative challenge?*"). Open-ended questions prompted learners to consider both explicit

and implicit task features, but required learners to generate a list of task features without further support or guidance on what to consider. Learners' responses to the open format question prompts in the IPT-L were anonymously displayed by the group awareness tool in the SPT as a full text compilation to be used as a reference in discussing and constructing shared task perceptions (Figure 2).

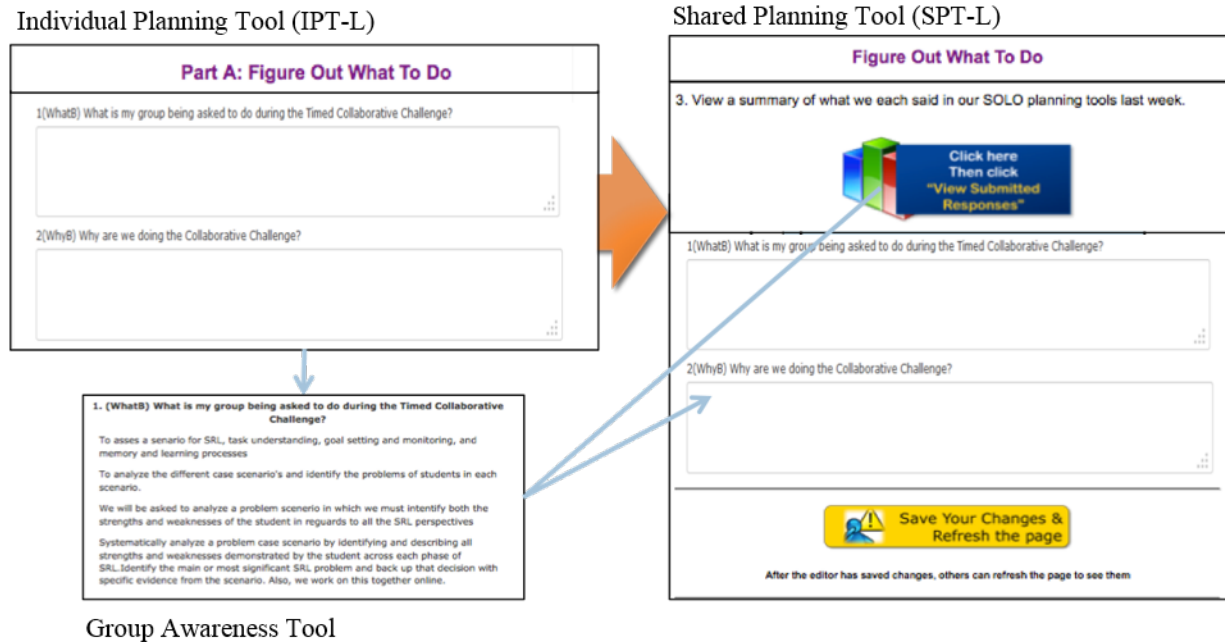


Figure 2. Example item on the IPT-L (top left) and SPT-L (right), and group awareness tool (bottom left)

High support planning tools. The high support version of the planning tools (IPT-H and SPT-H) contained identical questions to low support tools. However, each question prompt was pre-stocked with a list of ten potential answers. Five of the potential responses were accurate task features defined by the instructor (see Table 1). The other five were common misperceptions about the task identified in learners' responses to open ended planning tool questions in our past work (cf., Miller & Hadwin, 2012). Students were asked to identify the correct task requirements and purposes among the possible choices. Thus, high support planning tools not only prompted learners to consider both explicit and implicit task features, but further supported planning by helping learners and groups evaluate the relevance of task features they may not have otherwise considered or generated on their own. The group awareness tool in the SPT graphically displayed group members' IPT-H responses as a bar graph displaying total frequency of items identified across group members (see Figure 3).

Individual Planning Tool (IPT-H)

Part A: Figure Out What To Do

Choose only the 5 BEST answers:

1 (1TUExplicit) What is my group being asked to do during the Timed Collaborative Challenge?

- Analyze a problem case scenario
- Analyze an SRL strength and weakness
- Identify all SRL strengths and weaknesses
- Classify strengths and weaknesses according to four phases of SRL
- Describe what the student did
- Identify the problem that came first
- Summarize all the student's problems
- Come up with a solution
- Back up our answer with examples from the scenario
- Create a group cheat sheet

What is my group being asked to do during the Timed Collaborative Challenge next week?

- Analyze a problem case scenario: 4 (100.00 %)
- Analyze one SRL strength in adapting: 0
- Identify all SRL weaknesses in planning and enacting: 2 (50.00 %) 3 (75.00 %)
- Define the four phases of SRL: 1 (25.00 %)
- Describe what the student did: 3 (75.00 %)
- Identify the problem that came first: 0
- Explain a notetaking/reading strategy that works for you: 1 (25.00 %)
- Describe two strategies for the student: 4 (100.00 %)
- Back up our answer with examples from the scenario: 2 (50.00 %)
- Explain why the strategy(ies) will work: 2 (50.00 %)

Shared Planning Tool (SPT-H)

Figure Out What To Do

3. View a summary of what we each said in our SOLO planning tools last week.

Click here
Then click
"View Submitted
Responses"

5. Choose only the 5 BEST answers: What is my group being asked to do during the timed Collaborative Challenge today?

- A analyze a problem case scenario
- F Analyze an SRL strength and weakness
- C Identify all SRL strengths and weaknesses
- D Classify strengths and weaknesses according to four phases of SRL
- E Describe what the student did
- F Identify the problem that came first
- G Summarize all the student's problems
- H Come up with a solution
- I Back up our answer with examples from the scenario
- J Create a group cheat sheet

Save Your Changes &
Refresh the page

After the editor has saved changes, others can refresh the page to see them

Group Awareness Tool

Figure 3. Example item on the IPT-H (top left) and SPT-H (right), and group awareness tool (bottom left)

Planning tool conditions. Each group was randomly assigned to one of the four conditions in a 2 X 2-factorial design (Table 2). Conditions differed with respect to the level of support provided in: (a) the Individual Planning Tool (low vs. high), and (b) the Shared Planning Tool (low vs. high). A univariate analysis of variance (ANOVA) indicated there were no statistically detectable differences between conditions in terms of learners' prior knowledge of course concepts (mean score on two tests of assignment topic material), $F(3,169) = .762, p = .52$.

Table 2. Level of Individual and Group Planning Support in Each CSCL Condition

		Shared Planning Tool (SPT)	
		High	Low
Individual Planning Tool (IPT)	High	Condition A (n=12) <i>ITP-H SPT-H with graphic awareness tool</i>	Condition C (n=12) <i>ITP-H SPT-L with graphic awareness tool</i>
	Low	Condition B (n=12) <i>ITP-L SPT-H with text awareness tool</i>	Condition D (n=12) <i>ITP-L SPT-L with text awareness tool</i>

Groups in the high support condition (Condition A), received a high level of support for constructing personal task perceptions in the Individual Planning Tool (IPT-H), and high level of support for constructing shared task perceptions in the Shared Planning Tool (SPT-H). Groups in the low support condition (Condition D) received a low level of support for constructing personal task perceptions in the Individual Planning Tool (IPT-L), and a low level of support for constructing shared task perceptions in the Shared Planning Tool (SPT-L). The remaining two conditions received a combination of high and low level of support. Groups in Condition C

received a low level of support for constructing personal task perceptions in the Individual Planning Tool (IPT-L) followed by a high level of support for constructing shared task perceptions in Shared Planning Tool (SPT-H). Groups in Condition D received a high level of support for constructing personal task perception in the Individual Planning Tool (IPT-H) followed by a low level of support for constructing shared task perception in the Shared Planning Tool (SPT-L).

Measures

Data for this study were collected at both the individual and group level. They included (a) Individual Planning Tool (IPT) responses, (b) Shared Planning Tool (SPT) responses, (c) chat records of group planning sessions, (d) log file records of planning tool use during planning sessions, and (e) group grade on collaborative assignment.

Shared task perception accuracy. Accuracy of shared task perceptions was operationalized as number of relevant task features in groups' shared task perceptions. Relevant task features were defined by the instructor (see Table 1). Accuracy could range from 0 indicating identification of no relevant task features to 10 indicating identification of all relevant task features (five explicit task features and five implicit task features).

Accuracy of groups' shared task perceptions was scored in three steps. First, accurate task features were identified in groups' responses to the SPT questions. In the SPT-H, this meant identifying correct task perceptions selected from the pre-stocked options in accordance with the instructor's definition of the task (Table 1). In the SPT-L, responses to open format questions were first segmented by meaning unit (e.g. statements including a single idea about a task requirement or purpose, such as "*the task requires us to apply course concepts*" (Rourke, Garrison, Anderson, & Archer, 2001). Segments were then coded according to the list of pre-stocked task perceptions in the SPT-H (Appendix A). Additional task perceptions were coded as 'other.' Interrater agreement was determined by having a second rater independently code all SPT-L responses and then calculating Krippendorff's alpha (Hayes & Krippendorff, 1997). Interrater reliability was acceptable ($\alpha = .97$). All disagreements were resolved through discussion until 100% agreement was reached. As with the SPT-H, accurate responses were identified in accordance with the instructor's definition of the task.

There was nothing preventing one individual from completing the SPT without input from other group members. Therefore, a second step was taken to confirm each accurate task perception in the SPT was shared (i.e. the group evidenced agreement to include the task perception in their SPT response). Using chat records and log files as complementary data sources, responses were classified as *shared* when the statement was discussed in chat and the group evidenced agreement to include the idea (e.g. *Anna: An important thing we need to do is analyze SRL strengths and weaknesses / Sara: Yes, say what was good and what wasn't*). In cases where discussions about task perceptions were vague (e.g. *What do you think of the idea I just added. Tell me if you think it fits*), time stamped log files of SPT edits and views were consulted to identify the specific idea discussed.

Statements in the SPT were classified as *not shared* if there was no evidence the group agreed to the idea during planning chat (e.g. the statement was ignored or overlooked in chat or the statement was simply added by one group member without consultation or knowledge of the rest of the group). A second rater independently classified SPT responses as *shared* or *not shared*, and interrater reliability was high ($\alpha = .88$). All disagreements were resolved through discussion. A final measure of accuracy was then calculated for all groups using only task perceptions classified as shared.

Use of distributed task perceptions. The extent to which groups capitalized on members' accurate task perceptions was operationalized as the proportion of accurate IPT responses groups included in their shared task perceptions. Analysis was completed in two steps. First, we identified members' accurate personal task perceptions recorded in their IPT responses. For responses in the IPT-H, accuracy was assessed using number of accurate task perceptions selected from the pre-stocked options (Appendix A). Accurate responses in the IPT-L were identified using the same coding procedure as was used for SPT-L responses (see above). To ensure consistency, a second rater independently coded a random sample of IPT-L responses (48%). Interrater reliability was acceptable ($\alpha = .92$). All disagreements were resolved through discussion. Second, we calculated the proportion of group members' accurate IPT responses that groups included in their shared task perceptions as identified above.

Transactive planning discussion. Building on notions of transactivity in knowledge construction (Teasley, 1997), transactive planning discussion was operationalized as the degree to which group members built on and evaluated one another's ideas as they negotiated SPT responses during the group planning session. The planning portion of the chat session was used holistically as the unit of analysis. Degree of transactivity was scored on a scale from 1 to 5 (see Table 3) with 1 denoting low transactive discussion (i.e. Task perceptions came from a single group member and were simply accepted by the group without further discussion.) and 5 denoting highly transactive discussion (i.e. Task perceptions suggested by multiple group members and were discussed, compared, and evaluated against the task criteria).

This coding scheme was loosely informed by Weinberger and Fischer's (2006) framework for analyzing argumentative knowledge construction in CSCL. This framework is based on the notion that knowledge construction can occur in different ways (e.g. social modes) that exist along a continuum representing the extent to which learners transactively operate on the knowledge of their peers. Social modes includes quick consensus building (e.g. simply accepting others' ideas) and integration-oriented or conflict-oriented consensus building (e.g. integrating perspective, synthesizing and building on ideas). However, categories in this study were primarily informed by the data. Interrater agreement was determined by having a second rater independently a random sample of groups' planning discussions (20%). Interrater reliability was acceptable ($\alpha = .93$). All disagreements were resolved through discussion.

Group performance. Collaborative assignment product score served as a measure of group performance. Assignment products were scored out of 50 marks using an adapted rubric created by the course instructor. Product score was calculated using the proportion of correct and relevant concepts included in the group product. To ensure consistency, a second rater independently scored a random sample of assignment products (20%) and interrater reliability was acceptable ($\alpha = .96$). All disagreements were then resolved through discussion.

Table 3. Coding Scheme for Level of Transactivity in Planning Discussion

Score	Description	Example
Low (1)	Task perceptions come from a single group member and are simply accepted by the group without further discussion.	Ben: So why are we doing this? April: I think main reasons are to apply course concepts & to build on each other's knowledge Jon: Okay Maddy: Sounds good Ben: Thanks April April: You're welcome
Somewhat Low (2)	Task perceptions come from multiple group members and are simply accepted by the group without further discussion.	Lara: So what do we need to do? Hardeep: Analyze case Jay: and describe what student did Bayley: and create a group summary sheet Lara: ok. I'm putting in what everyone says.
Moderate (3)	Task perceptions suggested by multiple group members and are discussed/compared. Unclear why one idea was accepted over another.	Yuko: I personally think we need to classify the strengths and weaknesses by phases of SRL Taylor: I think analyze the case and identify the problem that came first. Isa: I think we need to identify the problem that came first and back up our answers Yuko: Seems like we all think similar things Taylor: So we can all agree with me and Isa? Isa: ok
Somewhat High (4)	Task perceptions suggested by multiple group members and are discussed/compared. Group uses a shallow criteria for selection unrelated to the task (e.g. most popular answer)	Li: The idea for this task it to compile our summary sheets so we have something to study from later Brandon: I think it's about knowing how to the concepts in our own studying in the end Sarah: Yes learning more about them. Also knowing how to improve our studying Li: We don't all think the same thing Brandon: So let's choose the ones we most have in common Sarah: okay that sounds fair.
High (5)	Task perceptions suggested by multiple group members and are discussed/compared. Group uses a task related criteria for selection.	Tara: I agree with all of your suggestions Amy except I don't think we need to "summarize the students problems" because if when we're analyzing the scenario it it's means we have to do a lot more than just describe it Amy: ok so would "analyze SRL strengths and weaknesses" be better? Zach: Yes I think so.

Results

The effect of level of planning support at the individual and group level was tested with 2X2 analyses of variance (ANOVA) for each dependent variable (shared task perception accuracy, use of distributed personal task interpretations, transactivity of planning discussion, and group performance). The grouping variables were level of support in the Individual Planning Tool (high vs low) and level of support in the Shared Planning Tool (high and low). Separate ANOVAs were used rather than MANOVA because the primary purpose of the study was to investigate the effect of conditions on each separate variable irrespective of others rather than on the linear combination of variables. To prevent inflation of Type I error, a Bonferroni correction was used to adjust the alpha level to $p=.013$. Assumptions of normality were met for all variables. Differences in variances across cells were within acceptable ranges when sample sizes are equal ($F_{max} < 10$) (Milligan, Wong, Thompson, 1987). One exception was the measure of distributed task perception use ($F_{max} = 13$). Therefore, based on recommendation by Tabachnick and Fidell (2013), a more stringent rejection criterion was set for this variable ($p < .01$). Means and standard deviations for outcome variables are displayed in Table 4.

Table 4. Means and standard deviations of outcome variables as a function of level of individual and group CSCL planning support

	Low Individual		High Individual		Total	
	M	SD	M	SD	M	SD
Shared Accuracy						
Low Group	4.75	1.49	5.08	2.35	4.92	1.93
High Group	7.75	0.754	7.75	0.866	7.75	0.794
Total	6.25	1.92	6.42	2.21	6.33	2.05
Distributed Accuracy Use						
Low Group	0.58	0.161	0.551	0.253	0.565	0.208
High Group	0.838	0.106	0.787	0.072	0.813	0.092
Total	0.709	0.189	0.669	0.219	0.689	0.202
Transactive Planning						
Low Group	2.08	0.793	2.67	1.23	2.38	1.06
High Group	4.00	1.21	3.00	1.21	3.50	1.29
Total	3.04	1.4	2.83	1.2	2.94	1.3
Group Performance						
Low Group	16.92	3.61	16.75	3.08	16.83	3.28
High Group	17.33	3.89	15.33	5.61	16.33	4.83
Total	17.13	3.68	16.04	4.49	16.58	4.09

Shared task perception accuracy. For accuracy of groups' shared task perceptions, the 2 X 2 (individual support x group support) ANOVA yielded a statistically detectable main effect for level of group support, $F(1,44) = 42.53$, $p = .00$, and effect size was large (partial $\eta^2 = .491$) (Cohen, 1988). There was no main effect of individual support, $F(1,44) = .147$, $p = .70$, and no individual support by group support interaction, $F(1,44) = .147$, $p = .70$. Hence, regardless of level of individual support, groups who received the high support version of the Shared Planning

Tool (SPT-H) constructed more accurate shared task perceptions than groups who received the low support version of the Shared Planning Tool (SPT-L).

Distributed task perception use. Similar results were obtained for comparisons of groups' use of distributed task perceptions. Here, the 2 X 2 (individual support x group support) ANOVA yielded a statistically detectable main effect for level of group support, $F(1,44) = 27.68$, $p = .00$ and effect size was large (partial $\eta^2 = .386$) (Cohen, 1988). There was no main effect for level of individual support, $F(1,44) = .743$, $p = .39$, and no individual support by group support interaction, $F(1,44) = .057$, $p = .81$. These results indicate that, regardless of level of individual support, groups who received the support version of the Shared Planning Tool (SPT-H) built upon a larger proportion of members' accurate individual task perceptions than groups who received the low support Shared Planning Tool (SPT-L).

Transactive planning discussion. For degree of transactivity in planning discussion, the 2 X 2 (individual support x group support) ANOVA yielded a statistically detectable main effect for level of group support, $F(1,44) = 15.19$, $p = .001$ and effect size was large (partial $\eta^2 = .215$, Cohen, 1988). There was no main effect for level of individual support, $F(1,44) = .521$, $p = .52$, and the individual support by group support interaction did not reach detectable levels, $F(1,44) = 7.52$, $p = .02$. These results indicate that, regardless of level of individual support, groups who received the support version of the Shared Planning Tool (SPT-H) engaged in more transactive negotiation of shared task perceptions than groups who received the low support Shared Planning Tool (SPT-L).

Group performance. In contrast, for group performance, the 2 X 2 (individual support x group support) ANOVA yielded no statistically detectable main effects for group scripting, $F(1,44) = .174$, $p = .679$, individual scripting, $F(1,44) = .815$, $p = .372$, or individual scripting by group scripting interaction, $F(1,44) = .583$, $p = .449$. Thus CSCL planning tools did not appear to influence group performance in this study.

Discussion

This study investigated the extent to which individual and group CSCL planning tools facilitated shared task perceptions for regulating collaborative learning. While few studies have examined how CSCL tools can promote shared regulatory processes, learners in this study received (a) an individual planning tool (high vs. low support) facilitating construction of personal task perceptions, and (b) a shared planning tool (high vs. low support) prompting co-construction of shared task perceptions. Based on a theoretical framework of regulation of collaboration, we expected a high level of individual and group supports would facilitate groups to construct more accurate shared task perceptions, make better use of group member' personal interpretations of the task, engage in more transactive planning discussion, and perform better on the collaborative task.

Findings revealed that, regardless of level of individual support, groups receiving the high support shared planning tool (SPT-H) constructed more accurate shared task perceptions compared to groups who received the low support version (SPT-L). Furthermore, these groups capitalized on a greater proportion of group members' accurate personal task perceptions during shared planning and engaged in more transactive planning discussion (e.g. by eliciting multiple viewpoints and evaluating and weighing them in consideration with which were a best fit for the task). On the other hand, groups who received low levels of group support had a propensity to overlook key aspects of the task, fail to draw on the distributed task perceptions held by group members, and engaged in less transactive negotiations shared task perceptions. These findings are line with previous research indicating that while shared task perceptions are vital to

regulating collaboration, groups often struggle with this process (Hadwin & Winne, 2012; Miller et al., 2015). Furthermore, these findings partially supported our hypothesis that a high level of support in CSCL tools can facilitate this challenging aspect of shared regulation. Specifically, pre-stocked responses in the SPT-H appeared to help groups systematically consider a wide range of task features and draw on one another's ideas to discuss and negotiate accurate and complete perceptions of the task.

Contrary to expectations, a high level of individual support did not enhance these processes. Specifically, we expected the high support individual planning tool (IPT-H) would facilitate negotiation of shared task perceptions by helping groups members create accurate personal task perceptions they could then bring to the group. In addition, since the group awareness tool displayed IPT-H responses in a bar graph (compared to text responses in the IPT-L), we expected the IPT-H would facilitate groups to draw on one another's responses more effectively to construct more accurate shared task perceptions. However, this was not this case in this study. While a high level of support at both levels did not seem to hinder this process as suggested by notions of over scripting in collaboration research (e.g. Dillenbourg, 2002), it did not appear to positively contribute to this process.

There are at least two possible explanations for this finding. First, support at the group level may have rendered group members' preconceived ideas less important or impactful in terms of constructing accurate shared task perceptions. For example, the structure provided by the SPT, particularly the pre-stocked responses in the SPT-H, may have enabled groups to overcome situations where individuals had inaccurate or incomplete perceptions, or may have made it less important to draw on individuals' ITP responses to construct shared task perceptions.

A second possibility is that the SPT prompts did not sufficiently facilitate groups to draw on IPT responses or discuss group members' personal perceptions in a productive way. For example, groups may have had difficulty dissecting and discussing group members' IPT responses in the short time they had. Also, analysis of transactivity revealed groups' used relatively shallow criteria, such as 'how common' ideas were, as a basis for agreement. Further research is needed to disentangle these possibilities.

Finally, shared task perceptions are posited to play a foundational role in regulating collaboration by setting the stage for effective planning and informing standards against which products and progress can be monitored and evaluated. We expected that a high level of CSCL planning support would positively influence task performance. However, findings did not reveal any statistically detectable effect of CSCL planning support at the individual or group level on group task performance. One potential explanation for this result is that planning tools promoted construction of shared task perceptions, but provided little guidance about how groups could make use of these to regulate their engagement in the collaborative task. Although CSCL tools in this study facilitated groups to more effectively negotiated shared task perceptions that were well aligned with the requirements of the task, they may not have sufficiently stimulated groups to engage in reflective thinking about how these task perceptions could be translated into action. However, since research in this study was limited to shared planning sessions, further research is needed to examine this possibility.

Taken together, these findings indicate CSCL tools and supports at the group level can positively impact groups' construction of accurate shared task perceptions. However, it is important to note this study had a number of limitations. First, this study focused on undergraduate students completing a complex task in one educational context. Future research is

needed to examine how these processes emerge and can be supported in different types of teams and different types of tasks including those that extend over longer periods of time. Second, while planning tools and chat records provide insight into negotiation of shared task perceptions, learners may sometimes agree to ideas simply to move the task along or avoid conflict. Thus, it would be beneficial to corroborate findings using complementary data sources such as learners' reports about their shared planning after collaboration.

Conclusions and Future Directions

Overall, as empirical investigations of shared regulation are scarce (Panadero & Järvelä, 2015), findings contribute to the emerging research about shared regulatory processes underpinning successful collaboration. Although the importance of shared regulation has become increasingly recognized (Volet & Vauras, 2013), prior studies have mainly focused on identifying and validating differences between self- and social aspects of regulation (e.g. Iiskala, Vauras, Lehtinen, & Salonen, 2011; Volet, Summers, & Thurman, 2009). This study extends prior research by empirically investigating groups' shared planning, as well as developing practical tools to foster and promote these processes. Furthermore, while research of shared regulatory processes is challenging (Volet & Vauras, 2013), this study used CSCL tools as a methodological solution to examine groups' shared task perceptions. Data produced by learners as they engaged with the CSCL supports enabled examination of task perceptions as they were constructed across the individual and group level in the context of the task.

Moving forward, we suggest two key directions for future research. First, this study investigated shared task perception constructed during a dedicated planning session. However, shared task perceptions may evolve and change throughout the task, and make up only one aspect of socially shared regulation (Hadwin et al., 2011; Winne & Hadwin, 1998, 2008). Thus, future research should examine how groups construct and maintain shared task perceptions within and across tasks in concert with other aspects of regulation, such as construction of shared goals and plans and regulation of thinking, behaviour, motivation and emotion.

Second, findings of this study bring forth a number of questions regarding how tools can be configured to best support shared regulatory processes. In light of research indicating that groups often fail to consider task features, tools in this study aimed to support learners by providing checklists of possible task features to consider. However, shared task perceptions are accomplished through social interactions in which groups generate ideas about the task and negotiate between multiple perspectives. As such, a fruitful avenue of future research would be investigating tools, such as scripts and group awareness tools, that move away from structuring the content of *what* groups discuss to more directly facilitating *how* groups discuss and make use of task perceptions in collaboration. In addition, while tools in this study focused on shared task perceptions, future research is needed to extend the target of CSCL supports to other facets of regulation.

Finally, from the view that regulating collaboration is a critical skill learners must be supported to develop, the ultimate goal of providing learners with CSCL support is to facilitate continued engagement in regulatory processes after supports are longer available as well as to transfer these skills to other appropriate collaborative situations (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989; Winne, et al, 2013). We suggest research is needed to examine how this can be accomplished. For example, research could explore development of adaptive tools or agents that (a) diagnose and provide as needed, calibrated support to groups, or (b) allow groups to adjust or select the level or type of support required. While research has begun to explore these types of tools for individual regulation (cf. Manlove, Lazonder & de Jong, 2007;

Winters & Azevedo, 2005), the question of how this might occur for shared regulation or shared metacognition has only recently emerged (e.g. Molenaar, Roda, van Boxtel, Sleegers, 2012; Järvelä, et al. 2014). Developing CSCL tools that support regulation as a multi-faceted process that dynamically unfolds over time across multiple social levels is a challenging undertaking for researchers. However, it offers great potential to facilitate learners to develop the quintessential skills for regulating teamwork in today's knowledge economy.

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Appendix A

Description of task perception codes and categories for the IPT-L and SPT-L

Question Prompt	Task Perception Code	Example
What is my group being asked to do in the Collaborative Challenge (<i>Explicit task features</i>)	Analyze a problem case scenario*	<i>We have to break down the scenario into its component parts</i>
	Analyze an SRL strength and weakness	<i>We need to analyze one thing the student did in terms whether it was good or bad</i>
	Identify all SRL strengths and weaknesses*	<i>We need to analyze all the things the student did well and didn't do well</i>
	Classify strengths and weaknesses according to four phases of SRL*	<i>We need to say which phase of SRL the strengths and weaknesses belong to</i>
	Describe what the student did	<i>We need to give an account of the studying like say the things they did to study</i>
	Identify the problem that came first*	<i>We have to figure out the root problem that started everything</i>
	Summarize all the student's problems	<i>We have to make a list of the problems the student encountered</i>
	Come up with a solution	<i>We need to say what the student could have done to fix or avoid the problem</i>
	Back up our answer with examples from the scenario*	<i>We need to justify answers using parts from the scenario</i>
	Create a group summary sheet	<i>We need to bring together our cheat summary sheets to make one for the group</i>
	Other	<i>We need to come up with a scenario where a student has a problem</i>
Why are we doing the Collaborative Challenge (<i>Implicit task purpose</i>)	To learn to use CourseSpaces (Moodle)	<i>A major reason for this assignment is to learn to use the LMS</i>
	To build on each other's' knowledge*	<i>The reason we are doing this is to share and build on what people in our group know</i>
	To memorize ED-D 101 course concepts	<i>We're doing this task to help us remember the course terms better</i>
	To learn to collaborate*	<i>The purpose of the assignment is to develop and improve teamwork skills</i>
	To prepare for ED-D 101 quizzes	<i>We're doing the assignment because it will help us get ready for the next course quiz</i>
	To equally divide up the work	<i>The purpose of the assignment to divide up work so that everyone has an equal part</i>
	To master course concepts*	<i>We are doing this assignment to improve understanding of SRL</i>
	To learn to solve an academic problem within a time limit	<i>The purpose of the assignment is finding out what it's like to work with a time limit.</i>
	To apply course concepts to solve a problem*	<i>We doing this so we that we use what we've learned in ED-D 101 to solve a real life scenario</i>
	To learn to collaborate with online tools*	<i>The assignment is to help us learn to use technology well for collaborating and group work</i>
	Other	<i>The reason for the assignment is to learn what different exam strategies there are.</i>

*denotes accurate task feature as defined by the instructor