THE RELATIONSHIP BETWEEN COLLABORATIVE LEARNING AND SELF-REGULATED LEARNING DURING ADOLESCENCE: A META-ANALYTIC REVIEW

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ABSTRACT

ADRIAN D. BRIDGES: The Relationship Between Collaborative Learning and Self-Regulated Learning During Adolescence: A Meta-Analytic Review
(Under the direction of Jeffrey A. Greene)

There is evidence that, on their own, both self-regulated learning (SRL) and collaborative learning (CL) are effective ways of bolstering students' academic performance. Yet, the relationship between CL and SRL has remained unclear. Using meta-analysis, I explored the relationship between CL and the SRL skills and knowledge that are required for academic success for adolescent students. I identified and investigated a number of factors that might moderate the relationship between CL and SRL, including but not limited to, age, gender, and method of SRL assessment. Scholars also require knowledge about the relative strength of the relationships between various collaborative learning methods and the acquisition of SRL skills and knowledge. The extent to which the relationship between CL and SRL varies across adolescence and subject areas was also unclear. I investigated those and other related research questions.

The results of this study indicated that, overall, there was a positive and statistically significant relationship between CL and SRL. CL methods that included observational learning, among other social cognitive learning processes, demonstrated the strongest effect on the relationship between CL and SRL. Experiment classification, a methodological factor, also demonstrated a positive effect on the relationship between CL and SRL.

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LIST OF ABBREVIATIONS

CI	Confidence interval
CIRC	Cooperative integrated reading
CL	Collaborative learning
CMA	Comprehensive meta-analysis
CoL	Cooperative Learning
CSCL	Computer supported collaborative learning
df	Degrees of freedom
EBSCO	Elton B. Stephens Co
ES	Effect size
FOI	Fidelity of implementation
IL	Inquiry learning
LASSI	Learning and study strategies inventory
Mod	Modeling
MSLQ	Motivated strategies for learning questionnaire
PA	Peer assisted learning
PBL	Problem based learning
RT	Reciprocal teaching
SES	Socio-economic status
SE	Standard error
SMD	Standardized mean difference
SRLIS	Self-regulated learning interview scale

SRL	Self-regulated learning
TAI	Teams-accelerated-instruction
TGT	Teams-games-tournaments
UNC	University of North Carolina

CHAPTER 1

INTRODUCTION

People live in complex social and cultural contexts that constantly require them to make decisions about how to act in ways that satisfy both personal and environmental demands (Brandtstädter, 2006; Demetriou, 2000). This process of adaptation is especially salient for adolescents, who are defined by the American Psychological Association (APA, 2002) as individuals in the age range from 10 to 18. This period is considered particularly significant because adolescents must make behavioral adjustments in the midst of tremendous changes in their neurological, physiological, cognitive, emotional, somatic, and behavioral characteristics (Geldoff & Little, 2011; Lerner et al., 2011).

The pressure to adapt behavior must be managed in the context of major changes in family, peer group, and school (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Buckner, Mezzacappa, & Beardslee, 2009). Such circumstances are evident when adolescent students (hereafter, students) must learn how to adjust to, and manage, differently structured school environments, enlarged peer networks, and work or chore responsibilities (Dotterer & Lowe, 2011; Parker, 2009). Selecting the best means to accomplish multiple and sometimes conflicting goals poses difficult challenges for students (Gurtner, Gulfi, Genoud, de Rocha Trindade, & Schumacher, 2011; Vedder-Weiss & Fortus, 2011; Vekiri & Chronaki, 2008). These challenges include obstacles, problems, and situational demands that adolescents must negotiate in order to control their current and future academic performance (Anderman, Maehr, & Midgley, 1999; Caprara et al., 2008).

To regulate their learning, adolescents must develop skills to monitor and control motivational, affective, cognitive, and social factors that influence their learning (Bandura, 1993; Caprara et al., 2008). Self-regulatory skill development requires bringing self-influence to bear on every aspect of students' learning experiences; however, scholars lack sufficient knowledge about how such skills develop (Rudolph, Lambert, Clark, & Kurlakowsky, 2001; Wang & Eccles, 2013). Understanding this phenomenon is important because developing and exercising self-regulatory skills are central to setting the course of one's academic trajectory (Bandura, 2006; Kitsantas, Steen, & Huie, 2009; Usher & Pajares, 2008a).

Numerous researchers such as Hadwin, Järvelä, and Miller (2011) and Kitsantas, Zimmerman, and Cleary (2000) have suggested that collaborative learning (CL) helps students develop self-regulatory skills. Researchers have described collaborative learning in many ways (i.e., cooperative learning, peer-assisted learning, group work), but virtually all forms of this pedagogy involve instruction during which teachers arrange students into small groups in which students assist each other and share responsibility for learning classroom material (O'Donnell, 2006; O'Donnell & Hmelo-Silver, 2013). Examples of student interactions that help develop self-regulatory skills during CL include but are not limited to defining learning goals, distributing work, and discoursing to achieve consensus among group members (Neber & Heller, 2002; Summers, 2006; van den Boom, Paas, & van Merriënboer, 2007). It is important to note that CL affords students sufficient opportunities to watch and interact with more-skilled learners, practice skills that they observe, and ultimately acquire self-regulatory skills (e.g., the ability to monitor and control their thinking) (Iiskala, Vauras, & Lehtinen, 2004; Vauras, et al., 2003; Volet, Summers, & Thurman, 2009). In other words, social influences within CL environments are mechanisms that help students develop SRL skills and knowledge.

Although the benefits of SRL and CL, are well known (Webb, 2013; Zimmerman, 2001) on their own, researchers and educators require a better understanding of how CL contributes to the acquisition of SRL during adolescence; I used meta-analysis to investigate this relationship between CL and SRL. Meta-analysis is a quantitative method used to summarize and combine the results of numerous studies using a common numerical index (Hedges & Pigott, 2001).

Current literature was also unclear on how various social cognitive factors (Bandura, 1977, 1989, 1993, 2006) moderate the relationship between CL and SRL. Specifically, there was a dearth of information on how personal factors (e.g., age, gender, race, prior achievement, socio-economic status), environmental factors (e.g., instructional method, subject domain), and behavioral factors (e.g., homework practices) influence the relationship between SRL and CL. There was also little information on how methodological factors (e.g., type of SRL measure, type of research study) might moderate the relationship between CL and SRL. I investigated those issues in the present study.

In the remainder of this chapter, I discuss social cognitive theory, the organizing frame for the current study. I also introduce theoretical and empirical findings about the social cognitive factors that may moderate the relationship between CL and SRL, as well as the findings that emphasize how CL contributes to the acquisition of SRL skills and knowledge. I conclude the first chapter by discussing my methods of analysis and research questions.

Theoretical Framework

Self-regulated learning theory. Zimmerman (2001) described self-regulated learners as students who personally initiate and direct their own efforts to acquire knowledge and skill rather than relying on other agents of instruction (e.g., teachers). Self-regulated learning (SRL) connotes the use of task strategies, self-evaluations, and a commitment to goals in order to accomplish a learning task (Zimmerman & Moylan, 2009). Self-regulated learners monitor and control their thoughts as they pertain to learning; negative self-evaluations of performance can undermine those efforts (Zimmerman, 2001). Thus, SRL contains many interconnected processes because feedback, both internal and external, shapes not only current learning efforts but also affective beliefs (e.g., computer anxiety) and strategic planning (e.g., detailed steps to accomplish a learning goal) for future learning (Zimmerman, 2000).

Social cognitive theorists such as Zimmerman have assumed SRL to be a series of reciprocal interactions among personal influences such as gender-related thoughts about learning, environmental influences such as collaborative learning methods, and behavioral influences such as observed peer interactions (Zimmerman, 2001). One prominent reciprocal interaction is the influence that a student's self-efficacy perceptions, which are beliefs that one can accomplish a particular task (Bandura, 2006), exert upon a student's behaviors. As an example, this phenomenon occurs when a person's negative computer self-efficacy related to their prior achievement results in the less-frequent use of computer technology (Vekiri & Chronaki, 2008). This influence also means that prior achievement can influence self-motivational beliefs that foster the use of self-regulatory skill (Kitsantas, Steen, & Huie, 2009; Zimmerman & Schunk, 2008).

Adolescents' self-efficacy perceptions can also influence how students engage with their learning tasks; highly efficacious students use more effective planning and task strategies and are more persistent in their work than students with low self-efficacy (Bandura, 1986). It is significant that some nations and communities use, often inadvertently, teaching strategies and beliefs (e.g., limited student autonomy, lower student expectations based upon race) that reduce the possibility that students will develop a strong sense of self-efficacy. Unfortunately, students within these contexts develop their academic skills while being exposed to environmental factors that do not foster SRL (Birenbaum & Alhija, 2013; Murdock, 2008; Nodoushan, 2012; Tang & Neber, 2008).

Larson and Brown (2007) indicated that many of the factors that moderate student self-regulation success are motivational or emotional in nature. Although the students they observed wanted to work on their assignments, they were not able to focus their attention and behaviors. In addition, these students needed to regulate their emotions such as anger toward collaborating peers or disappointment with a setback, as well as the need to control outward expressions of pride about something they had done well (Larson, 2010). When Larson and Brown (2007) examined their data in detail, they indicated that although they had classified motivational and emotional factors as internal or personal, they realized that almost all of the student observations they analyzed involved an interaction or fit between internal (i.e., personal) and external (i.e., environmental) factors. This insight highlights how reciprocal influences among social cognitive factors moderate the success of students' attempts to regulate their learning.

Motivational factors that moderate SRL success concern specific thoughts or actions, among other things, such as interesting work that increases engagement during a task (Hidi &

Ainley, 2008). Emotional factors often involve events or interpersonal dynamics related to schoolwork, such as negatively perceived teacher interactions or lack of connection with one's school (Wang & Eccles, 2011; Rudolph et al., 2001). The motivational and emotional factors that adolescences encounter do not occur in a vacuum; they intertwine with dynamics in the task environment that require regulation. These factors in the task environment are not centrally related to regulating the self but rather to regulating one's work, including, for example, how to influence a peer through discourse (Määttä, Järvenojä, & Järvelä, 2012; Salonen, Vauras, & Efklides, 2005). In these contexts, environmental factors are cause for students to engage in personal and behavioral regulation that, in turn, suggests the existence of a reciprocal relationship among personal, environmental, and behavioral factors related to SRL (Bandura, 2006; Zimmerman, 2002a). Such factors can moderate students' attempts to regulate their learning (Zimmerman & Cleary, 2009). Other examples that pertain to these relationships include circumstances that indirectly relate to schoolwork, such as cultural norms that discourage the development of higher-level thinking skills (Pino-Pasternak & Whitebread, 2010; Tempelaar et al., 2013) and limited parental income that restricts access to educational resources that can foster SRL skills (Evans & Rosenbaum, 2008; Schultz, 1993).

Finally, biological age can limit student capacity to use self-regulatory skills due to underdeveloped memory capacity or reasoning ability (Veenman, Kok, & Blote, 2005; Wigfield, Klaudia, & Cambria, 2011). Limited domain knowledge also impedes SRL because many self-regulatory processes are domain-specific (Boekaerts & Corno, 2005; Pintrich, 2000; Schunk & Zimmerman, 2007). In sum, there is evidence that personal, environmental, and behavioral factors influence the use of self-regulatory skill.

Collaborative learning and social cognitive theory. Instructional methods that emphasize shared responsibility for learning and student autonomy during learning are some of the environmental factors that influence the development of SRL skills and knowledge (Schünemann, Spörer, & Brunstein, 2013; Zimmerman & Lebeau, 2000). This means that CL can activate positive self-motivational beliefs and trigger behaviors such as the use of self-regulatory skills (Nichols, 1996; Chin & Brown, 2002). Moreover, CL affords students with numerous opportunities to model positive self-motivational beliefs and self-regulatory skills amongst each other (Newman, 1994); all of these conditions contribute to the acquisition of SRL skills and knowledge (Stright & Supplee, 2002; van Grinsven & Tillema, 2006; Wang & Lin, 2007). The general belief is that during CL, members distribute and share thinking responsibilities (Brown et al., 1993) and that this shared responsibility fosters self-regulatory skill (Paris & Paris, 2001; Perry & Winne, 2013).

Social cognitive theorists emphasize that students acquire self-regulatory skills and knowledge by observing behavior and that their learning is most effective when they observe people who are both similar to themselves and display a high level of self-efficacy, in itself an important component of SRL (Britner & Pajares, 2001; Gaskill & Woolfolk Hoy, 2002; Joët, Usher, & Bressoux, 2011). This is a key example of how environmental factors help students acquire self-regulatory skills. Feedback provided by a model during the performance of a behavior amplifies the power of observational learning and helps students internalize the behaviors and skills they observe as well as assume more responsibility for demonstrating the relevant task themselves (Butler & Winne, 1995; O'Donnell, 2006; Zimmerman, 2000). The advantages of such behaviors are often bidirectional, meaning that students who are more capable can benefit from working with less-capable students (King, 1999; Webb, 2009).

Student models can help other students correct their own misconceptions about conceptual definitions (Roschelle, 1992), mathematical operations (Webb & Farivar, 1994) and reading comprehension (Palinscar & Brown, 1984). Watching a peer accomplish a task can give students hope that they can do it too, which aids their motivation to learn materials taught in school (Schunk & Zimmerman, 1996). It is important to note that the social cognitive perspective of CL implies that novice learners will observe, listen to, and seek help from a peer (e.g., a model) who has more advanced SRL knowledge and skills. This perspective allows peers, an environmental factor, to help foster SRL during CL; as a result, students who perceive similarity to a peer who successfully demonstrates an SRL skill will be highly motivated to practice that SRL skill themselves (Wolters, 2011).

Aside from observational learning, students are likely to experience two sources of positive self-efficacy for SRL because of collaborating with peers: mastery experiences and acts of verbal persuasion (Webb & Mastergeorge, 2003). Mastery experiences result from attempts to develop a competency, for example by creating a task strategy (Bandura, 1993). Discourse and other forms of persuasive communication, for instance encouragement to persist during challenging learning tasks, are most effective when expressed by capable and honest parties (Schunk & Zimmerman, 1997, 2007). Both of these conditions foster positive self-efficacy beliefs that help students acquire self-regulatory skills and knowledge (Zimmerman, 2000) and are excellent examples of how environmental factors foster SRL during CL.

Students also acquire SRL skills during CL because several aspects of collaborative tasks activate developmental mechanisms that foster SRL skills and knowledge. One example of these mechanisms concerns how CL tasks reduce the number of teacher-student interactions as compared to other instructional methods, which permits students to practice self-regulatory skills such as self-reflection (Van Grinsven & Tillema, 2006). Other instructional elements of collaborative tasks that help students acquire SRL skills and knowledge include providing students with a choice of learning activities (Mason, 2004; Perry, 1998), having students participate in problem-solving exercises (Webb & Mastergeorge, 2003; Zimmerman & Lebeau, 2000), and assigning students authentic problems that pique their interest (Hidi & Ainley, 2008; Wolters, 2011). Both observational learning and instructional elements inherent to CL provide insight into how CL, an environmental factor, helps students acquire SRL skills and knowledge.

Summary. It is reasonable to differentiate the influences that moderate the acquisition of self-regulatory skill into personal (i.e., related to age or gender), behavioral (i.e., related to student actions such as strategy use), and environmental (i.e., related to instructional methods) factors (Wang & Ling, 2007; Wigfield, Klaudia, & Cambria, 2011; Zimmerman, 2001). Although there is substantial evidence that CL methods can foster self-regulatory skills, there is also a continuing need for researchers to investigate such relationships because numerous factors, for example, age-related characteristics or family income, may moderate the relationship between CL and SRL (Buckner, Mezzacappa, & Beardslee, 2009; Dotterer & Lowe, 2011; Fried & Chapman, 2012). Due to the reciprocal influences of social cognitive factors and the interrelated nature of self-regulatory processes, the current study required a method of analysis that could consider social cognitive influences upon multifaceted constructs in several contexts. Meta-analysis certainly addressed this need.

Benefits of Meta-Analysis and Research Questions

Meta-analysis is a research synthesis tool used to summarize the relationship between two variables across a large number of studies that represent a body of knowledge (Borenstein, Hedges, Higgins, & Rothstein, 2009). Analyzing relationships across a large number of studies has the potential to uncover relationships and research questions that were not addressed in the original work (Cooper, 2010). Meta-analysis has four phases (Borenstein et al., 2009). The first phase for the current study was to locate empirical experiments that had investigated comparisons of CL to control or other comparison groups in terms of their effects upon SRL outcomes. The second phase was the coding of study features (Cooper, 2010). It is important to note that, in addition to social cognitive variables that pertain to SRL and CL, I also coded three methodological variables: publication type, type of SRL measure, and fidelity of implementation. This step was necessary to address the how differences in study methods might affect the relationship between CL and SRL. In this meta-analysis, I coded experiments for publication in a peer-reviewed journal, publication in a non peer-reviewed journal, or lack of publication. Because there was, and continues to be, some debate (e.g., Greene & Azevedo, 2010; Perry & Winne, 2013) about how measurement processes might influence the relationship between SRL and other constructs, I also coded descriptive information for the type of SRL measure (i.e., self-report). Table 1 contains a summary of the information that I coded for each study.

Table 1

Summary of Variables Coded for Meta-Analysis

Predictor Variable	Moderator Variables	Outcome Variables
Collaborative instruction	1. Theoretical a. Prior achievement b. Gender c. Race/ethnic group d. Socio-economic status e. Age of student f. Type of collaborative instruction method g. Year of publication h. Subject domain 2. Methodological a. Type of SRL measure(s) b. Study classification c. Fidelity of implementation	Self-regulated learning or self-regulatory process

Note: Theoretical moderator variables represent social cognitive (Bandura, 1997) factors and methodological moderator variables represent study design features (Wu & Zumbo, 2008); both categories include variables that could influence the relationship between collaborative learning and self-regulated learning.

The third phase of meta-analysis is the calculation of effect sizes, with the goal of estimating the average standardized mean difference between CL and control or comparison conditions in terms of SRL outcomes, along with estimating the heterogeneity (e.g., variance) within the distribution of standardized mean differences (Borenstein et al., 2009). An important step during this phase is converting the results of individual studies into comparable effect sizes (i.e., usually standard deviation units). The fourth phase is the statistical analysis of effect sizes, in order to examine the relations between study features and study effects based upon the level of heterogeneity found within the distributions of effect sizes (Lipsey & Wilson, 2001). Overall, I used pooled data to calculate the average magnitude of the overall relationship between CL and SRL and to examine the extent to which conceptually relevant moderator variables strengthen or weaken this relationship (Borenstein et al., 2009).

Perhaps the most important benefit of meta-analysis is its potential for generating explanatory knowledge of the intervening mechanisms through which CL causes its self-regulatory effects (Cook et al., 1992). This benefit is particularly useful when synthesizing multiple bodies of literature that are comprised of experiments that test dissimilar domain and pedagogical arrangements (Borenstein et al., 2009; Cooper, 2010). Whereas researchers can perform individual experiments to test a specific theory or question (e.g., whether one experimentally manipulated variable induces student learning relative to a control), a meta-analysis can explore a wider range of variations (i.e., subject domains and types of SRL measures) and identify specific conditions (i.e., types of instructional methods) that facilitate an effect. Knowledge of these conditions improves researchers' theories that attempt to explain how academic interventions work; it can also help predict the effects of similar interventions that share similar conditions, as well as produce new recommendations for instructional practice (Cook et al., 1992; Cooper, 2010).

Meta-analysis was well suited to address the data analysis needs of the current study. Specifically, I used meta-analysis to answer three research questions:

1) What is the overall relationship (e.g., main effect) between CL and SRL during adolescence?

2) How do theoretical factors (e.g., prior achievement, gender, race, SES, age, type of collaborative learning method, year of publication, subject domain) moderate the relationship between CL and SRL?
3) How do methodological factors (e.g., type of SRL measure, study classification, fidelity of implementation) moderate the relationship between CL and SRL?

CHAPTER 2

LITERATURE REVIEW

In this chapter, I review literature on how collaborative learning (CL) helps students acquire self-regulatory skills required to overcome academic challenges. I begin this discussion by defining and describing the various models of self-regulated learning (SRL). Next, I define and describe various forms of collaborative learning and discuss how CL helps students acquire self-regulatory skills and knowledge. Then, I discuss factors that moderate the relationship between CL and SRL and conclude the chapter by reviewing my research questions and presenting associated hypotheses for each research question.

Models of Self-Regulated Learning

Several researchers have defined competing models of SRL that emphasize different facets (e.g., metacognition). Reviewing these empirically supported models of SRL is helpful in understanding how CL helps students acquire the SRL skills and knowledge that are required to overcome their academic challenges. The researchers associated with these models are Boekaerts (Boekaerts, 1996; Boekaerts & Niemivirta, 2000), Winne (Winne & Hadwin, 1998), Pintrich (2000), and Zimmerman (2000).

Boekaerts' model of self-regulated learning. Boekaerts (1996; Boekaerts & Niemivirta, 2000) developed a model of SRL to describe how students adapt their thinking based upon three priorities in classroom learning (Boekaerts & Cascallar, 2006; Boekaerts & Corno, 2005). Two priorities in this model are to achieve cognitive and resource growth goals (e.g., increased understanding of class content) and to increase access to peers, technology, and other entities that foster learning. A third priority, the maintenance of emotional well-being within reasonable boundaries, is indicated when students try to protect their egos, avoid emotional harm, and seek additional help in school (Boekaerts, 1996).

It is important to note Boekaerts's hypothesis that, when students attempt to balance the above priorities, they monitor and control their learning activities based upon their perceptions of their learning performances [i.e., they engage in the principal processes of metacognition (Flavell, 1979)]. In other words, favorable conditions for academic tasks and opportunities for learning foster an intrinsic interest in students to learn materials taught in school and to expand their resources and skills that foster SRL (Boekaerts & Corno, 2005). Negative appraisals of academic tasks and opportunities for learning, however, result in a sense of difficulty or distress that causes students to disengage from academic activities to protect their well-being; as they do so, they develop skills that are less likely to foster SRL skills and knowledge (Boekaerts, 1996).

Within this model of SRL, students base their self-appraisals upon metacognitive and domain knowledge [e.g., subject-activated, goal-directed behavior and other self-motivational factors that play a central role in SRL (Boekaerts, 1995)]. From this perspective, metacognitive and domain knowledge pertain to monitoring and evaluating goal achievement along with procedural knowledge (e.g., learning strategy use) (Boekaerts, 1999); goal-directed behavior includes but is not limited to self (e.g., taking action to exceed past achievement levels) and task (e.g., generating study questions for a test) related activities. Additional self-motivational factors concern a student's capacity to use learning strategies, engage in help seeking, and other pertinent self-regulatory processes (e.g., management of negative emotions) related to the relevant domain (Boekaerts, 1997).

Boekaerts and colleagues (e.g., Boekaerts, 1999; Seegers & Boekaerts, 1993) have instantiated their SRL model by demonstrating how two motivational (e.g., positive and negative emotional) mechanisms can influence the development of self-regulatory skills, specifically reading and mathematical skills. Boekaerts and Cascallar (2006) identified instructional strategies that teachers can use to promote positive emotional states that foster SRL. Finally, Boekaerts (1997) demonstrated the importance of prior content and metacognitive knowledge to SRL success thereby supporting the emphasis of these types of knowledge within her model of SRL.

Winne's model of self-regulated learning. Winne (2001) developed his model of SRL to describe student study behaviors such as doing homework or preparing for an oral presentation. He postulated that SRL develops throughout four flexibly ordered and recursive phases. In Phase 1, learners identify external conditions that define the assigned academic task (Winne & Hadwin, 2010). These conditions fall into two main categories. Task conditions are features of the assigned task such as objectives of the teacher (or textbook), time available to complete the task, whether peers are involved, and whether responsibility is individual or shared (Winne & Hadwin, 2010). Cognitive conditions are internal to the learner. They include the range and significance of prior knowledge, motivational factors such as goal orientation (e.g., intrinsic desire to learn material taught in school), and epistemological beliefs such as the value of knowledge, known study tactics, and other qualities that make the student a unique individual (Greene & Azevedo, 2007b; Winne, 2001).

In Phase 2 of this model, learners construct a perception of what the task is and, on that basis, set their own goal(s) such as obtaining a particular grade on a quiz. In Phase 3, learners begin engaging with the task and taking steps to reach goals. In Phase 4, students make decisions to adapt their behaviors regarding actions taken in the preceding phases, including changing or repairing metacognitive knowledge (e.g., the effectiveness of learning strategy use), to enhance success in the present and for future tasks. Because students may reexamine external resources or what they know about the task during any phase of SRL, metacognitive monitoring may reveal significant gaps in their knowledge that cause them to retreat to a prior phase to make adjustments—this is the recursive property of Winne's model (Winne & Hadwin, 2010). Therefore, metacognitive monitoring and feedback are critical components of this model (Winne, 2001).

Each stage of this model shares the same general structure, referred to as COPES (conditions, operations, products, evaluations, and standards; Winne, 2001). Conditions include information about task conditions (e.g., time constraints, available resources, and social context) and cognitive conditions (e.g. interest, goal orientation, and task knowledge) both of which influence how students engage with their learning tasks. Winne defined operations as the cognitive processes, tactics, and strategies students engage in when faced with a task; products refer to information created by operations, such as when students create new knowledge. A different product is thus created at each stage. Products can be internal (e.g., an inference drawn from an attribution) or external (i.e., observable behavior or performance). Evaluations consist of feedback, whether internal or external, about the products. Standards are criteria that students believe are the optimal objectives of whatever phase they are performing; they include both metrics and beliefs, for example obtaining a particular grade on a task (Greene & Azevedo, 2007b).

Winne and colleagues have conducted several studies to examine and provide support for various components and phases of Winne’s model. This research includes Winne and Perry (2000) along with Butler and Winne (1995), who demonstrated that feedback and metacognitive processes form the basis for future actions that support the recursive nature of Winne’s SRL model. Winne also conducted several empirical studies that explored aspects of his model. This research includes Winne (1996) in which he identified how the products of metacognitive monitoring can result in a student updating the goals he or she has assigned to a task because of newly found resources, and Winne (1997) where he investigated the importance of task conditions in SRL.

Pintrich’s model of self-regulated learning. Pintrich’s (2000) model of SRL is composed of four phases: forethought, monitoring, control, and self-reflection. In each phase students attempt to monitor, control, and regulate processes concerning the following areas: cognition, motivation and affect, behavior, and the context of learning. The self-regulatory activities that take place during the forethought phase include, among other things, activation of prior content and metacognitive knowledge concerning current tasks (cognitive area), estimating efficacy and setting goals concerning current tasks (motivation and affect area), planning to monitor performance behavior (behavior area), and analyzing the context of the current learning task (context area). Similarly, the monitoring phase consists of attempts to build awareness of and to monitor changes in cognition, motivation, affect, and context. Control activities refer to the selection and adaptation of strategies for managing cognition, motivation, and affect; for the regulation of effort; and for task negotiation (e.g., requests to change the structure of the learning task). Finally, self-reflection activities include making judgments of task performance and context and having affective reactions to such behaviors that result in decisions that affect similar tasks and the relevant context of learning in the future.

Pintrich (2000) presented his model as a heuristic and indicated that the context of learning and motivational factors would heavily influence the use of self-regulatory processes (e.g., monitoring) within each phase and area (e.g., cognition) of the model. His work indicates that SRL does not always follow a time-ordered sequence and that some students may not engage in all of the phases of his model during a learning episode (Pintrich & Zuscho, 2007). An example of a self-regulatory processes defined within Pintrich's model of SRL is a student setting a goal of reading one chapter in preparation for a test. This behavior pertains to the forethought phase of SRL. Another example concerns the same student using his or her metacognitive awareness to determine if he or she understands the text being read; this behavior concerns the monitoring phase of SRL. When a student realizes that he or she does not understand the text that has been read and decides to repair comprehension by rereading parts of the text, this student is adjusting reading strategy—a behavior that pertains to the control phase of SRL (Pintrich, 2000). If this student does not perform admirably on a test after reading the chapter and attributes this underperformance to the unsuccessful use of learning strategies, he or she has the opportunity to elevate future achievement via this self-reflection process. In general, if students attribute their success to causes they can control, they will expect to succeed in the future (Dweck & Master, 2008); these behaviors pertain to the self-reflection phase of SRL (Pintrich, 2000).

Zimmerman's model of self-regulated learning. Zimmerman (1989) has posited SRL to be a series of reciprocal interactions among personal influences such as positive thoughts about learning, environmental influences such as instruction that motivates students to learn, and behavioral influences such as emulative behavior among peers. A key example of these reciprocal interactions is the influence that a student's self-efficacy perceptions concerning prior learning experiences exert upon his or her future writing behavior, for example the choice of an essay topic (Schunk & Zimmerman, 2007). Adolescents' personal beliefs can also influence how they manage their learning environment, for example when students turn off their TV due to the belief that they can accomplish the relevant task in a quiet location (Zimmerman, 2000). SRL is a proactive process because feedback (both internal and external) shapes not only current learning efforts but also affective beliefs (e.g., anxiety concerning computer instruction) and strategic planning (e.g., detailed steps to accomplish a learning goal) for future learning (Zimmerman, 2000).

The fact that personal, behavioral, and environmental factors change during the course of learning necessitates the use of feedback to monitor and control SRL processes (Zimmerman, 1989). Personal self-regulation involves monitoring and controlling cognitive and affective learning processes such as perceptions of self-efficacy and fears related to learning. Behavioral self-regulation involves monitoring and controlling learning performance processes, for example managing the time spent on discussing a concept with peers. Environmental self-regulation involves monitoring and controlling external conditions such as communicating with and learning from peers (Zimmerman, 1989).

Cyclical self-regulated learning. Because students use feedback to plan future learning performances, Zimmerman (2002a) hypothesized that self-regulation is a cyclical process. Self-regulatory processes, such as planning to use a specific learning strategy, and concomitant beliefs, such as self-efficacy beliefs, help make up three related phases of self-regulation: forethought, performance, and self-reflection.

Forethought phase. This phase (see Figure 1) consists of two parts: task analysis and self-motivational beliefs (Zimmerman, 2000). Task analysis also consists of two parts: goal-setting and strategic planning. Goal setting means deciding upon specific learning outcomes, such as finishing a homework assignment before it is due (Schunk & Zimmerman, 1997) or solving a specific number of math problems during a study session (Anderman & Patrick, 2012; Locke & Latham, 1990). These activities include goals or sub-goals and planning for sequencing, timing, and completing activities related to those goals. Strategic planning refers to choosing or generating a strategy to optimize a learning performance that is necessary because of fluctuations in personal, behavioral, and environmental factors (Zimmerman, 2000). Examples of strategic planning includes meeting with a peer to discuss a quiz prior to studying for it because a student has recognized a gap in his or her knowledge or determining what are the most important parts of a chapter to study and spending significant study time on those parts prior to taking an related examination.

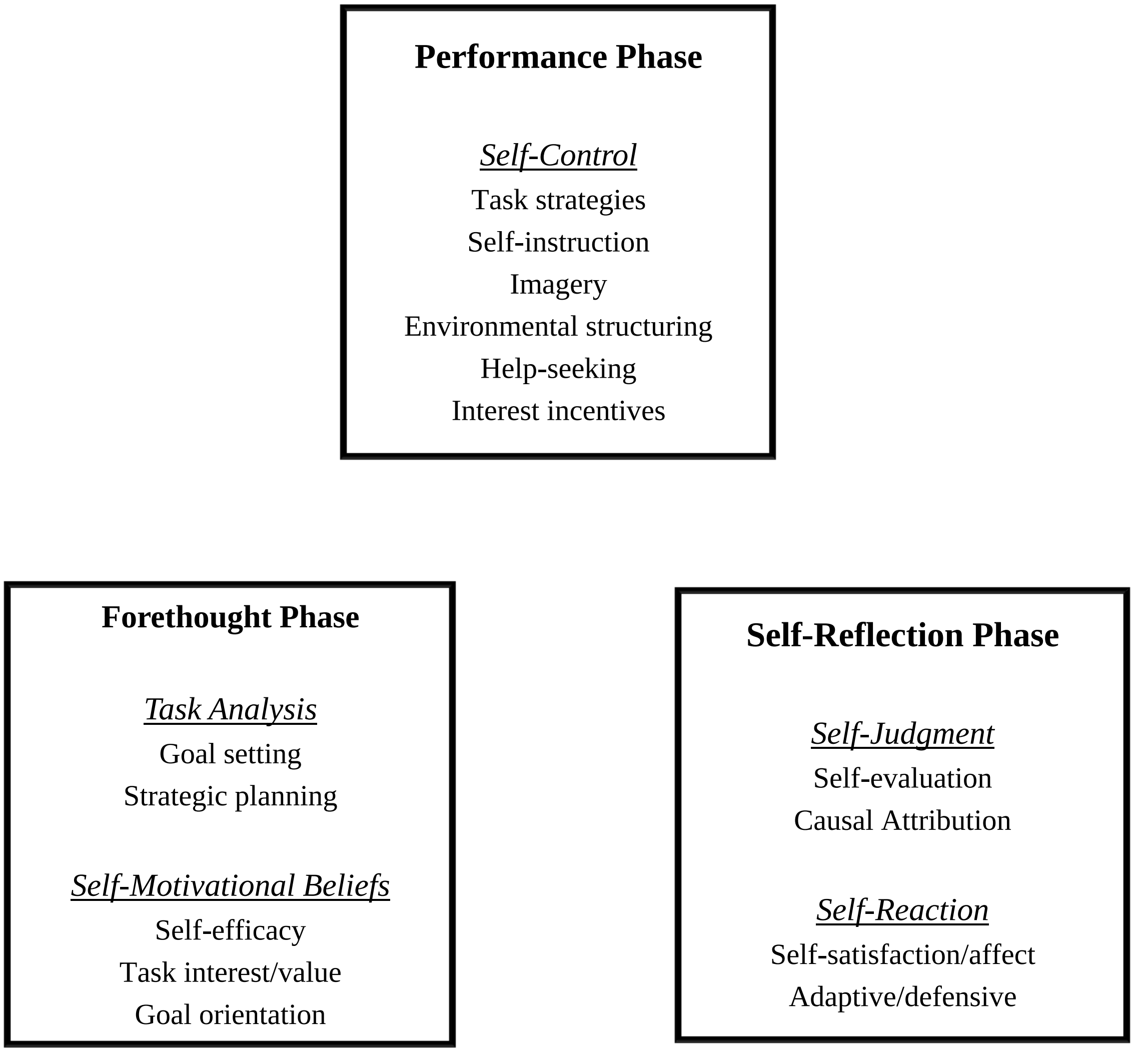


Figure 1. Cyclical phases of SRL. Adapted from B. J. Zimmerman and T. J. Cleary (2009), "Motives to self-regulate learning: A social cognitive perspective," in K. R. Wentzel and A. Wigfield (Eds.), *Handbook of motivation at school* (New York, NY: Routledge), p. 249.

Self-motivational beliefs are important during the forethought phase of SRL because students rely upon these beliefs when they execute their plans and strive to meet the academic goals they have set (Cleary & Zimmerman, 2004). Moreover, the attainment of goals helps students bolster their self-efficacy beliefs—a behavior that helps foster SRL skills and knowledge (Zimmerman, 2001). Two additional self-motivational beliefs that influence the forethought phase of SRL are outcome expectations and interest. Outcome expectations pertain to the consequences of performing a certain task, such as securing a high-paying job after obtaining a college education or receiving a gift from a parent after achieving a perfect test score (Bandura, 1993). It is important to note that perceptions of self-efficacy influence outcome expectations; in other words, students' beliefs about the usefulness of learning outcomes pertain to their efficacy beliefs about such outcomes (Zimmerman & Cleary, 2009). A student's level of interest in the subject matter is also significant during the forethought phase of SRL because high interest levels increase one's motivation and engagement to learn. Hidi and Harackiewicz (2000) have identified these as states that foster SRL skills and knowledge.

Self-control, observation, and experimentation during the performance phase. Self-control processes involve activities that facilitate the successful completion of a task. Examples of self-control techniques that students use are self-rewarding after completing a challenging assignment (Zimmerman, 1989) and attention-focusing that is designed to improve a student's concentration by screening out external events during study episodes (Zimmerman, 2000). Zimmerman (2002a) also emphasized that the goal of student self-control activities is to practice basic skills in order to optimize learning efforts. Self-observation processes involve keeping track of one's cognitive or behavioral activities, for example, maintaining a journal of time per day spent on homework. By becoming aware of patterns (e.g., time, duration, frequency) associated with their learning, students increase their chances of successfully monitoring and controlling their learning behaviors (Zimmerman, 2002a). Self-experimentation refers to the steps students take to test their assumptions about the best ways to learn material taught in school (Zimmerman, 2002a). For example, a student could conduct a self-experiment by comparing his or her homework achievement after using different learning strategies (e.g., studying with peers vs. studying alone) with similar homework assignments.

Judgment and reaction to learning in the self-reflection phase. Bandura (1977) identified two types of processes that social cognitive researchers have continued to associate with the self-reflection phase of SRL: self-judgment and self-reaction. The standards that students choose, such as obtaining a specific GPA, affect their self-judgments (Schunk & Zimmerman, 1997). Using a peer's performance as an achievement goal is an example of how standards can influence self-judgments (Schunk & Zimmerman, 1997) because this act may lower one's self-efficacy (for example, if a student's learning efforts result in grades that are lower than another student's grades). Clearly, these circumstances would not lead to a student's self-satisfaction; therefore, a person's motivation to learn does not stem from the goals themselves, but rather from self-evaluative reactions to behavioral outcomes (Zimmerman, 2000).

Previous performance or self-evaluated criteria provide opportunities to compare one's performance with earlier levels of behavior (Bandura, 1997); these self-judgments can result in efforts to improve SRL skills if inadequate effort is the reason for deficient performance (Zimmerman, 2000). Linking past performance to circumstances that a person can control often leads to positive adaptive behaviors. This result is unlike the results of self-evaluations that contain causal attributions linked to limited personal ability, which can cause students to disengage from learning because they believe their efforts are futile and expect that future learning outcomes will be negative (Schunk & Zimmerman, 1996). Therefore, attributional judgments also affect forethought processes that foster the cyclic nature of SRL (Zimmerman, 2000).

During self-reaction to learning tasks, students develop inferences about how they will approach future learning tasks. Adaptive inferences are important because they help people obtain new and better forms of self-regulatory skill, for example using a more effective learning strategy or setting challenging goals that foster an intrinsic interest in learning (Cleary & Zimmerman, 2004; Zimmerman, Bandura, & Martinez-Pons, 1992). Students may also make defensive inferences about how they need to approach their subsequent efforts to learn or perform. Examples of such behavior include student efforts to protect their egos from future dissatisfaction and adverse affect; this type of self-reaction is often associated with task avoidance, procrastination, and apathy toward materials taught in school (Garcia & Pintrich, 1994). It is significant that self-reactions affect forethought processes cyclically, for example by enhancing self-efficacy beliefs about mastering academic tasks, developing learning goal orientation (Schunk & Zimmerman, 1996), and intrinsic interest in the task (Zimmerman & Kitsantas, 1997). In a similar manner, dissatisfaction with a course grade can undermine a student's sense of self-efficacy to continue enrollment in an advanced learning program (Bandura, 1997). These types of evidence make it apparent that a social cognitive model of SRL can explain the persistence and sense of self-fulfillment of capable students as well as the avoidance and self-doubts of less-capable students (Zimmerman, 1989).

Four levels of self-regulated learning skill. To become a self-regulated learner, students must foster their own educational skills by mastering four successive skill levels: observation, emulation, self-control, and self-regulation (Zimmerman, 2000). SRL skill acquisition results from observing the performance of a model (Schunk, 1987). Models can convey performance standards, for example speed of math calculation and learning strategy use such as persistent behavior (Schunk & Zimmerman, 1996). Students acquire an observational level of self-regulatory skill when they can demonstrate an applicable skill after watching a model (Zimmerman, 2000).

Models can exert an even more positive influence upon an observer's future performance by expressing their beliefs about and interest in their learning performance, because these behaviors help increase observers' self-efficacy for the relevant task (Bandura, 1989; Schunk & Zimmerman, 1997). Models also provide feedback (e.g., explanations) that help students obtain the emulation level of SRL (Cleary & Zimmerman, 2004). Offering explanations is important because this type of discourse helps information providers and receivers become more skilled in enacting the steps (e.g., of a learning strategy—an SRL skill) outlined in the explanation (Chang & Wells, 1987; Schunk, 1982). Nonetheless, when students demonstrate the emulation level of SRL skill, they seldom imitate the exact actions of a model but instead emulate a model's basic pattern of performance (Bandura & Jeffrey, 1973).

To master the first two levels of SRL skill, students depend upon peers who are social sources of regulation. To attain advanced levels of SRL skill, students must deliberately practice tasks designed to enhance performance (Zimmerman & Kitsantas, 1997). When students can routinely produce a required skill, such as performing a learning strategy during a preplanned quiz, they have internalized the learning strategy and acquired the self-control level of SRL skill appropriate to the relevant learning task (Zimmerman, 2000).

Adolescents who have advanced to the highest level of SRL skill can adapt their SRL skills to dynamic environments with little intentional thought because they no longer rely upon memories of model performances (Zimmerman & Moylan, 2009). Instead, such students focus their attention on the outcome they want and use internalized self-regulatory skills (e.g., environmental structuring) to achieve their goals (Zimmerman, 2000). When students demonstrate such behaviors, they have acquired the self-regulation level of SRL skill (Zimmerman, 2000). Table 2 contains a summary and descriptions of the four levels of SRL skill.

Table 2

Levels of Self-regulated Learning Skill

Level	Name	Description
1	Observation	Vicarious induction of a skill from a proficient model
2	Emulation	Emulative performance of the model's basic skill with social assistance
3	Self-control	Independent display of the model's skill under structured conditions
4	Self-regulation	Adaptive use of skill during dynamic conditions

Note: Adapted from "Attaining self-regulation: A social cognitive perspective," by B. J. Zimmerman, 2000, in M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation: Theory, research, and applications* (San Diego, CA: Academic Press), p. 29.

It is evident that researchers have conducted numerous empirical studies to test Zimmerman's model. Self-efficacy has surely been the most-studied aspect of Zimmerman's model (see, for example, Schunk, 1990, 1994; Schunk & Zimmerman, 1996, 1997). Zimmerman and Martinez-Pons (1986, 1988) have developed a structured interview method, the self-regulated learning interview schedule (SRLIS), to test students' use of SRL strategies. It consists of a structured interview assessing 14 classes of self-regulated strategies, such as self-evaluating, organizing, transforming, planning, and monitoring. Zimmerman and Martinez-Pons (1990) used SRLIS to examine the relationship between students' use of SRL strategies and their perceptions of both verbal and mathematical self-efficacy. The results revealed, as hypothesized, that both types of self-efficacy measures were correlated with the use of self-regulated strategies. Grade (5th, 8th and 11th), giftedness (gifted vs. regular), and gender further differentiated the results. Older students' self-efficacy surpassed that of younger students; giftedness had a positive relationship with self-efficacy; and boys' verbal self-efficacy was significantly higher than that of girls. The researchers did not find any gender-related differences concerning mathematical self-efficacy. Zimmerman has also explored and instantiated his model in other domains, such as self-regulated writing (Zimmerman & Bandura, 1994; Zimmerman & Risemberg, 1997), and the acquisition of complex motor skills (Zimmerman & Kitsantas, 1997; Kitsantas & Zimmerman, 1998).

Summary of self-regulated learning models. Even if the self-regulatory terminology varies from one model to another, all of the authors mentioned above have assumed SRL to proceed from a preparatory phase, through the actual performance or task completion phase, to an appraisal or adaptation phase (Winne & Hadwin, 2010). The preparatory phase of SRL includes task analysis as well as planning and goal-setting activities. This phase is based on self-knowledge, motivational beliefs, and metacognitive knowledge about the self, the task, and the situation and it prepares the individual for a forthcoming learning performance.

The second phase concerns performance processes. It consists of learning strategy use and real-time self-regulatory and monitoring activities such as resource allocation and comprehension monitoring. The last phase in SRL, the appraisal phase, includes the evaluation of learning outcomes. Internal and external performance feedback provides students with information about the efficacy of their activity and serves as a basis for attributions, comparisons, and adaptations that influence future learning episodes. Thus, all the authors of the models assume that SRL is cyclical in that self-reflection results in appraisals that influence subsequent preparatory processes.

Examining the commonalities and differences between the models provides further insight into how SRL helps students overcome their academic challenges. Some may argue that Boekaerts' model of SRL places substantial emphasis on the regulation of affect and that this is a distinguishing attribute of her model. However, all of the other models, perhaps with the exception of Winne's model, also thoroughly address this issue (Boekaerts, 1988; Greene & Azevedo, 2007b; Pintrich, 2000; Zimmerman, 2000). SRL affords students the ability to regulate their emotions and this is a strength because emotions can surely influence students' use of self-regulatory skills such as help-seeking (Newman, 1994) and adaptive behaviors (Zimmerman, 2000) that lessen the chance they will engage in self-defeating behaviors (Boekaerts, 1993, 1995). Boekaerts and her associates have also spent significant time investigating the interaction between cognition and affect and have identified how volitional strategies (i.e., actions related to persistence) can help students overcome significant challenges (Boekaerts, 1992, Vermeer, Boekaerts, Seegers, 2001). It is also evident that the other models incorporate how persistence fosters SRL (Greene & Azevedo, 2007b; Pintrich, 2000; Winne & Hadwin, 2010; Zimmerman, 2000).

Pintrich's model has proved to be very flexible concerning its applicability to various learning contexts, student ages, and subject areas (Pintrich & De Groot, 1990; Pintrich & Zuscho, 2007). Pintrich's model of SRL is also flexible because the author describes the model as a heuristic and indicates that students may not engage in all of the phases or all of the processes in each phase during a learning episode (Pintrich 2000). I agree with this perspective, for example, because I surely doubt that students consider planning for self-observation during every learning task. Winne's and Boekaerts' models both emphasize this aspect of SRL because metacognitive and/or motivational processes can redirect a student's learning according to their models. However, Zimmerman's model emphasizes the cyclic aspect of SRL and one can argue that the performance phase of Zimmerman's model is recursive, similar to the other two models, because it includes metacognitive processes that enable learners to redirect their efforts for instance by changing learning strategies. To me it is significant that both Pintrich's and Winne's model have a separate SRL phase for monitoring and controlling self-regulatory processes because Boekaert's and Zimmerman's model specify that that the two types of self-regulatory processes occur in all phases of SRL.

Winne (2000) has described his model as recursive because students use metacognitive processes to reflect on and correct prior actions during current learning episodes. I suggest that this aspect of his SRL model is realistic and is congruent with the research he has performed. His model of SRL is highly structured because each phase of SRL has the same structure [(e.g., COPES that are a basic set of processes: conditions, operations, products, evaluations, and standards   Winne, (2001)]. Winne's (2001, 2010) model is often associated with information processing technology and he has used computer metaphors to describe how students learn within his model; deficiencies in learning are often explained in reference to improper memory processing or learning strategy usage (Greene & Azevedo, 2007b; Pressley, Goodchild, Fleet, Zajchowski, & Evans, 1989; Pressley, Levin, & Ghatala, 1988). Without question, the authors of the other models recognize the importance of memory processing and learning strategy use concerning SRL success, however those authors place a greater emphasis on how motivation related factors and beliefs influence students' self-regulatory successes. This is a key distinction between the models because the creators of the other models all suggest that SRL results from the interaction between metacognitive and motivational processes (Boekaerts, 1996; Pintrich, 2000; Zimmerman & Moylan, 2009). One example of this interaction concerns how changes in students' goals can disrupt their attempts to self-regulate. Indeed, Greene and Azevedo (2007b) have indicated the need for additional research on how Winne's model incorporates motivational processes.

Notwithstanding these differences, I concur with several researchers (e.g., Pintrich, 2000; Puustinen & Pulkkinen, 2000; Winne & Hadwin, 2010) who have suggested that the differences in the definitions used within the models are blurred. This suggestion indicates that the relative weight given to the component parts, more than the components themselves, distinguishes one model from another. Most importantly, I argue that social cognitive constructs that are common to all of the models play a key role in helping students regulate their learning.

Social Cognitive Influences on Self-Regulated Learning

To have the capacity to self-regulate their learning, students must be able to make choices and to act on their choices (Winne & Hadwin, 2010); lacking such freedom in behavior, students cannot engage in SRL. "Agency" is the term that researchers use to describe this capacity to choose and act on choices (Bandura, 1993). Agency involves four processes that are essential to SRL: intentionality, forethought, self-reaction, and self-reflection (Winne & Hadwin, 2010). These features of agency are common to all models of

SRL.

An example of a self-motivational belief that is common to all of the SRL models is self-efficacy; it is important to note that both agency and self-efficacy are significant elements of social cognitive theory (Bandura, 1977, 1986, 1993). Like self-reflection and self-reaction processes, agency related actions and self-efficacy beliefs can precipitate changes in personal thoughts and behaviors. These constructs, along with other social cognitive processes and self-motivational beliefs such as task interest, are critical determinants of whether or not students acquire SRL skills and knowledge (Zimmerman, 2001).

Although the authors of the models already mentioned in this chapter have touched upon how social cognitive factors influence SRL, I feel that researchers who have explicitly used a social cognitive model of SRL have demonstrated the most compelling evidence for how students acquire SRL skills and knowledge. My claim is based on several observations. First, more than 100 empirical studies have been conducted to test and validate the close association between self-efficacy and SRL [see, for example Schunk (1990, 1994); Schunk & Ertmer, 2000; Schunk & Zimmerman (1996, 1997)]. Second, a social cognitive theory of SRL not only provides a broad theoretical framework that includes multiple factors (e.g., instructional practices) that researchers and educators can use to improve student SRL, it also distinguishes the effects of personal self-regulatory influences from overt behavioral ones and can explain the relative advantage of each. Evidence of these circumstances includes how changes in personal goals can influence student self-efficacy and how the use of learning strategies while adopting help-seeking behavior can improve student problem-solving performance (Zimmerman, 1989).

Moreover, a social cognitive perspective of SRL links students' self-regulatory processes to specific social learning or behaviorally enactive experiences and can explain the reciprocal impact of these experiences (Zimmerman, 1989); which are important to the current research. Third, Zimmerman's (2000) social cognitive theory of SRL clearly defines distinct levels of SRL skill and the mechanisms and contexts that students can use to acquire increasing levels of SRL skills and knowledge (e.g., Schunk & Zimmerman, 1996; Zimmerman & Cleary, 2009; Zimmerman & Kitsantas, 1997). For these reasons, I have chosen Zimmerman's social cognitive model of SRL to frame how CL helps students acquire SRL skills and knowledge. In the next section, I make my initial conceptual connections between the social cognitive perspective of SRL to CL by introducing two key ways that CL can scaffold students' acquisition of SRL skills and knowledge. Afterward, I provide more evidence for why I think CL can foster SRL, and why this phenomenon requires further investigation.

Social and Environmental Support of Self-Regulated Learning

A significant feature of a social cognitive model of SRL is the influence of environmental factors, such as peers and instructional methods. Even with the seemingly private and highly individualized craft of writing, there is copious evidence of the value of social and environmental regulation techniques such as emulating the styles of exemplary models (Zimmerman & Risemberg, 1997) and soliciting help from peers (Schunk & Zimmerman, 2007). Specifically, practicing successful learning strategies demonstrated by others and having someone provide assistance with reading-comprehension tasks are both practical examples of how students can improve their self-regulatory skills (Collins, Brown, & Newman, 1989).

Environmental supports such as praise (Webb, 2009) and other forms of feedback from peers during class (Butler & Winne, 1995) can increase student self-regulatory skill. Praise provided by a creditable and sincere peer can certainly increase a student's self-efficacy for SRL (Schunk, 1987; Schunk & Zimmerman, 1997) and thereby affect his or her future use of performance phase strategies. Feedback provided by peers can direct attention to the processes that need attention, correct misconceptions in a student's understanding, and incite his or her interest in a learning task (Winne & Hadwin, 2010). It then follows that the interdependence between environmental and personal influences of regulation promotes goal-directed behavior, the effective use of learning strategies, and the motivation to learn. It is important to note that these behaviors and thoughts foster SRL for students.

Thus, peers are a valuable resource for self-enhancing forethought, performance, and self-reflection phase processes (Zimmerman, 2001). Modeling serves as the primary mechanism through which students acquire self-regulatory skills such as persistence, learning strategy use, and adaptive behaviors related to instruction provided by teachers (Wolters, 2011). Collaborative learning is a form of instruction that relies upon the skills that are required for SRL; therefore, CL can help students acquire the skills they need to overcome academic challenges.

Collaborative Learning

Palinscar and Brown (1984) and other researchers (e.g., Corno, 1987; Webb, 1980) have identified how classroom-based CL enables students to acquire self-regulatory skills and overcome academic challenges. In particular, CL gives students many opportunities to watch more-skilled learners, practice skills that they observe, and ultimately acquire the self-regulatory skills (e.g., learning strategies) that are necessary for academic success (Boekaerts

& Corno, 2005; Wang & Lin, 2007; Wolters, 2011). Researchers have described collaborative learning in many ways (i.e., cooperative learning, peer-assisted learning, group work) but virtually all forms of this pedagogy involve instruction during which teachers arrange students into small groups in which students assist each other and share responsibility for learning classroom material (O'Donnell, 2006; Webb & Palinscar, 1996). O'Donnell and Hmelo-Silver (2013) refined the definition of CL by arguing that CL emphasizes an equal relationship and mutual influence among group members. The ultimate goal of CL is convergence; among other things, this means the construction of shared meanings for conversations, concepts, and processes (Brown et al., 1993; Roschelle, 1992). In acknowledgement of these perspectives, CL methods that embody these characteristics were only considered in the current study.

Many of the original theories of collaborative learning were strongly influenced by social-psychological principles (Deutsch, 2006). The general principle underlying these theories is that of interdependence (Cary, Johnson, & Johnson, 2008). Interdependence is a condition in which group members share common goals that form a basis for the fostering of self-motivational beliefs (Hakkarainen, Jarvela, Lehtinen, & Lipponen, 1998; Johnson & Johnson, 1989a, 1989b). Thus, if a student is to succeed in accomplishing his or her goals, other students must also accomplish their goals and be successful (Cary, Johnson, & Johnson, 2008). This relationship means that instruction that fosters cooperation rather than competition among students is a mechanism educators can use to foster self-motivational processes that are essential to the forethought phase of SRL (Zimmerman, 2000).

Researchers and educators have created the form of interdependence that is necessary for CL by utilizing two different perspectives: social-motivational and social cohesion

(O’Donnell & Hmelo-Silver, 2013). The former approach relies on the use of rewards or recognition for group performance; the use of these incentives influences self-motivational processes in the form of outcome expectations that occur in the forethought phase and self-satisfaction processes that occur in the self-reflection phase of SRL (Zimmerman, 2000).

Theorists who espouse the theory of interdependence assume that students will be motivated to work together and help one another because the group as a whole will receive a reward or recognition. A second assumption is that individual accountability (e.g., by issuance of individual grades to each student) will ensure equal participation. Instructional approaches derived from these perspectives include, among others, teams-games-tournaments (TGT; Slavin, 2011), team-accelerated instruction (TAI; Slavin, 2011), and cooperative integrated reading (CIRC; Slavin, 2011).

The second social psychological approach depends upon creating interdependence through social cohesion. From this perspective, students are motivated to help one another succeed because they care about one another. Examples of instructional approaches derived from this approach include learning together (Johnson & Johnson, 1989), jigsaw (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), and learning together (Cohen, 1994a). The idea is that if students value their fellow collaborators and are dependent on one another, they are likely to encourage and help each other succeed (Slavin, 2011). It is important to note that instructional approaches derived from social cohesion theory often develop interdependence by having students take on roles as “checker,” “recorder,” “observer,” and so on. The use of assigned roles helps students navigate the ambiguity of collaborative tasks that are typically open-ended. More importantly, such behaviors require students to practice and use academic skills in a dynamic fashion [e.g., monitoring the performance of others during a collaborative science experiment (Schraw, Crippen, & Hartley, 2006)] that leads to the acquisition of SRL skills and knowledge (Zimmerman, 2000).

Effective CL requires students to use interpersonal and small-group skills (Cohen, 1994b) that help foster the self-regulatory processes required for SRL. In outlining the Learning Together collaborative method, Cohen (1994b) paid a great deal of attention to the steps educators must take to ensure that students have the necessary environmental supports for the self-regulatory skills that are required for effective collaborative learning. In particular, the teacher must make important decisions about the size of each collaborative group and which students make up a group. Specifically, groups with more than four students may impede CL, and thus self-regulatory skill acquisition; and groups of students with vast differences in skills (e.g., cognitive and social) may not be able to work in a collaborative manner (Webb, 1980) and thereby regulate their learning (Vauras, Iiskala, Kajamies, Kinnunen, & Lehtinen, 2003). The teacher must also ensure that adequate materials are available and assign students to specific roles within a group. In addition, the teacher must establish criteria for evaluating the success of the group and develop a strategy for ensuring that each individual in the group is accountable for his or her performance. As students work together on the assigned task, teachers must monitor and sometimes control their verbal (e.g., asking questions) and behavioral (.e.g., demonstrating a math procedure) interactions. Additionally, teachers should comment on the effective use of particular social skills such as help seeking that is a self-regulatory task strategy (Zimmerman, 2000); students should conclude their CL task by analyzing what they did well and indentifying areas in which they can improve (Cohen, 1994b).

Although teachers provide a social source of regulation for many of the learning processes in CL methods, it is evident that these types of instructional approaches require students to use and thereby internalize the self-regulatory processes that are required for SRL. In particular, CL requires students to regulate their efforts in pursuit of a single goal, to monitor their individual progress toward that goal, and to redirect their efforts if necessary (O'Donnell & Hmelo-Silver, 2013). Importantly these behaviors are representative of the three cycles of Zimmerman's (2000) social cognitive model of SRL.

Problem-solving methods. In this form of pedagogy, student learning centers on a complex problem that has multiple paths to an acceptable answer (Hmelo-Silver, 2004). Problem solving methods (e.g., problem-based learning or PBL, which is a form of CL) include an iterative cycle of steps for identifying the problem, defining the problem, constructing a strategy to solve the problem, organizing information required to solve the problem, allocating resources, and monitoring and evaluating problem solutions (Bruning, Schraw, Norby, & Ronning, 2004; Byrnes, 2009a). Students work in collaborative groups in order to solve a problem, and teachers often assign math or science collaborative tasks so that students can enhance their critical thinking skills (e.g., creating a hypothesis) (Webb & Mastergeorge, 2003).

In her review of PBL, Hmelo-Silver (2004) indicated that problem-solving methods and SRL emphasize similar cognitive processes; in a related manner, many of the experiments cited in the current study involve problem solving (e.g., Barnes & Todd, 1977a, 1977b; Hogan et al., 2000, Roschelle, 1992, Webb & Mastergeorge, 2003). Therefore it is not surprising that Sinatra and Taasoobshirzai (2011) asserted successful problem solving involves using learning strategies and monitoring the effectiveness of those learning strategies, processes that both pertain to the performance phase of SRL (Zimmerman, 2000).

Hmelo-Silver's (2004) work is also noteworthy because it indicated that this method of learning benefits from the use of learning strategies, goal setting, and intrinsic motivation. She also emphasized the goal of helping students apply their knowledge in flexible ways; all of which help foster SRL skills and knowledge (Zimmerman, 2000). In problem-solving methods, students work on practical problems and have the ability to choose their learning materials and set their own learning goals, (Mayer & Alexander, 2011). The authenticity, intrinsic motivation, and self-direction associated with these types of academic tasks motivate students to learn and use their metacognition, both of which foster SRL skills and of knowledge (Zimmerman & Moylan, 2009). Based upon the literature review of the current study, no other researcher has investigated the relationship between PBL and SRL across the period of adolescence. Including this instructional method as part of my analysis expanded scholarly knowledge concerning the relationship between CL and SRL.

Inquiry learning. During this method of instruction, students carry out their own scientific investigations and therefore engage in authentic, explorative learning that many consider the hallmark of science education (Anderson & Hogan, 2000). Anderson (2002) stated that inquiry learning (IL) fundamentally involves proposing hypotheses about the world and testing them in a methodical manner (e.g., posing research questions, constructing solutions, and checking results) within a CL environment. Schraw, Crippen, and Hartley (2006) argued that IL promotes self-regulatory skill acquisition in two important ways. One way is to stimulate students' active engagement in the learning process by activating a learning strategy (e.g., self-checking one's work) and metacognitive (e.g., monitoring a peer's understanding) skills that are required for successful task performance. Modeling, the second way that IL fosters SRL, increases an observer's motivation to succeed in science especially when such observational learning concerns learning strategies for hypothesis testing (Windschitl, 2002) or asking questions to generate new knowledge (Chinn & Brown, 2002). It is important to note that both ways help foster the acquisition of all levels of self-regulatory skill (Zimmerman, 2000).

IL also fosters SRL because throughout IL students expand and elaborate upon their prior knowledge during collaborative discussions of meaningful tasks (Mayer & Alexander, 2011). This constructivist and thus motivational process is a combination of cognitive (e.g., learning strategy use), metacognitive (e.g., monitoring) and social conditions (e.g., peer interactions) that allow students to collaborate and individually self-regulate their learning (Schraw et al., 2006). Specifically, during IL students choose the procedures they use to solve research question(s) that initiate the IL task. After this step, students produce an inventory of their existing knowledge/resources about their research question(s) and collect new information necessary for subsequent learning steps. Next, students develop arguments to support their findings using testable hypotheses. In IL, teachers scaffold student learning to ensure adequate learning progress but reduce their interactions as students become more capable (Mayer & Alexander, 2011).

In IL, cognitively engaged students work with open-ended tasks, projects, and problems that teachers have based upon authentic questions (Rapp, 2005; Wheeler & Bell, 2012). Researchers have found these contexts to foster SRL (Boekaerts & Corno, 2005; Schraw et al., 2006). It is evident that IL provides students with mechanisms that foster SRL. These mechanisms include but are not limited to the use of learning and metacognitive strategies, task attributes that motivate students to learn, and the requirement to engage in self-reflection concerning the accuracy of their hypotheses. In the end, a wealth of evidence [see for example (Baird & Penna, 1996; Neber & Schommer-Aikins, 2002; Nichols, Tippins, & Wieseman, 1997)] support the efficacy of IL in fostering SRL skills and knowledge. Exploring the relationship between IL and SRL within my current study increased scholarly knowledge concerning the relationship between CL and SRL.

Cooperative learning. This form of collaborative learning enhances achievement through an emphasis of group goals and individual accountability. That is, students receive grades based upon the individual learning of all group members (Slavin, 1991). Evidence favoring cooperative learning (CoL) as a way to foster SRL is substantial (Slavin, 1991, 1999) in a wide variety of academic subjects and age groups (Eilam & Aharon, 2003; Lou, Abrami, & & d'Apollonia, 2001). As with other forms of CL, during CoL teachers arrange students into small groups which then work together to assist one another in learning material taught in school (Slavin, 2011); to do so they use a variety of learning strategies (e.g., providing explanations to peers) that foster SRL skills and knowledge (Nichols, 1996).

It is clear that during CoL students have the opportunity to discuss information and practice learning strategy skills (Slavin, Lake, & Groff, 2009), both of which help foster SRL (Zimmerman, 1989, 2000). However, theorists have typically used social cohesion, developmental, and motivational perspectives, rather than social cognitive theory, to explain student success during CoL (O'Donnell, 2006; Webb & Palinscar, 1996). Social cohesion theories stress the idea that because students identify with their work group and want each other to succeed, they will work efficiently to help their group members learn (Webb & Palinscar, 1996). A hallmark of CoL is an emphasis on social activities to create "team spirit" within student work groups (Cohen, 1994b).

Developmental theorists of CoL who subscribe to the theories of Piaget or Vygotsky maintain that social interaction among peers enhances their mastery of critical concepts as well as their self-esteem (Lau & Chen, 2013; Slavin, 2011). Advocates of a related theoretical perspective called cognitive elaboration posit that cooperative learning enhances achievement by giving children opportunities to master information by summarizing and restating (i.e., by using a learning strategy) their current understandings while working with peers (Slavin, 2011). In this context, CoL often involves pairs of students taking turns teaching each other discrete skills or content. Instructional methods based on these methods have shown strong evidence of academic effectiveness and fostering SRL (Boekaerts & Corno, 2005; Collins et al., 1989; Paris & Paris, 2001).

There is also evidence that cooperative learning elevates a student's motivation to learn (Slavin, 2011), a circumstance that also fosters SRL (Zimmerman, 2000). One way that cooperative learning increases student motivation to learn is by allowing students to gain confidence by watching someone else performing a reading comprehension strategy. Ideally, the model for strategy performance will come from someone with whom the learner has a positive relationship (Schunk, 1987; Webb, 1980). Another way that cooperative learning stimulates motivation to learn is by increasing engagement during learning tasks (Fox and Alexander, 2011).

Without question, educators have used CoL (Slavin, 2011) extensively to improve student learning. Research supports this method of instruction as an effective way to foster SRL (Cohen, 1994a; Nichols, 1996; Palinscar & Brown, 1984). However, because researchers have not frequently used social cognitive theory to investigate the achievement and self-regulatory benefits of CoL, including this instructional approach within the current study helped fill a gap that currently exists in scholarly literature.

Reciprocal teaching. Palincsar and Brown (1984) developed reciprocal teaching (RT), a CL method for reading comprehension instruction that incorporates many of the self-regulatory processes that help students acquire skills described in Zimmerman's (2000) model of SRL. These self-regulatory processes include observational learning, articulation of learning strategies, evaluating and monitoring the work of others. In addition, RT requires self-evaluation by comparing one's performance to a peer's performance and to self-set standards of performance (Collins et al., 1989; Palinscar & Brown, 1984).

Specifically, during RT educators teach students four learning strategies (clarification, question generation, summarization, and prediction) that include both cognitive and metacognitive processes through modeling combined with the Socratic teaching method (Palincsar & Brown, 1984). That is, during dialogue between a teacher and students, the teacher first demonstrates and clarifies learning strategies, and then uses procedural prompts to help students use the learning strategies themselves. It is clear that during this method of instruction students initially depend upon teachers, a social source of regulation, to acquire observation and emulation levels of self-regulatory skill (Zimmerman, 2000).

Next, teachers gradually fade their scaffolding as students demonstrate proactive attempts to regulate their learning using the four learning strategies; this process results in a gradual shift from the teacher doing much of the modeling and explaining to dyads or small groups of students taking over the control and direction of the collaborative dialogues (Palincsar & Brown, 1984). When this occurs, and after sufficient student practice supported by peer modeling, students develop the self-control level of SRL skill (Zimmerman, 2000). An important property of RT is that students are required to analyze and comment on the behavior of students who demonstrate the four comprehension learning strategies (Palinscar

& Brown, 1984); as Bandura (1989) and Schunk (1982) indicated, such behavior fosters self-regulatory skills and positive self-efficacy beliefs that are necessary for the highest level of SRL skill. At the self-regulated level of SRL, skill students require limited teacher scaffolding because students serve as role models as not only owners of some aspects of reading comprehension knowledge but also as acquirers, users, and extenders of such knowledge (Cohen & Scardamalia, 1998; Järvelä & Järvenoja, 2010). A wealth of evidence (e.g., Boekaerts & Corno, 2005; Paris & Paris, 2001) supports the efficacy of RT in fostering SRL skills and knowledge. Based upon my knowledge there is a paucity of information concerning the relative strength of the relationship between RT and SRL; investigating this issue addressed a gap in extant CL and SRL literature.

Self-regulatory skills and processes within collaborative learning. Social cognitive theorists emphasize that students learn by observing behavior and that their learning is most effective when they observe people who are both similar to themselves and display high levels of self-efficacy (Bandura, 1997; Schunk, 1987). This means that observing a similar peer who exhibits high-level SRL skills can help students with low self-efficacy beliefs for SRL increase their self-efficacy for SRL and thus their SRL skill levels (Schunk & Zimmerman, 1996). Because of this relationship, I hypothesize that modeling, a common occurrence during CL, is a mechanism that helps students acquire SRL skills during CL.

Besides observational learning, students are likely to experience two other sources of positive self-efficacy for SRL during CL: mastery experiences and acts of verbal persuasion (Bandura, 1997; Pajares, 2008a). Mastery experiences result from the desire to develop a competency, for example with a learning strategy; these experiences are usually associated with elevated student motivation (Anderman & Maehr, 1994). Acts of verbal persuasion, for example encouragement to persist during challenging learning tasks, are most effective when expressed by parties who are both capable and honest (Bandura, 1986). Because of the potential for students to have mastery experiences and to engage in acts of social persuasion concerning SRL during CL, I hypothesize that mastery experiences and acts of social persuasion are mechanisms that influence self-efficacy in CL and subsequent likelihood acquisition of SRL skills and knowledge.

Feedback, a form of verbal evaluation provided by a model during the performance of a behavior, amplifies the power of observational learning and helps students internalize the SRL skills that they observe (Schunk & Zimmerman, 1996). The advantages of such feedback are often bidirectional, meaning that students who are more capable can increase their skill levels by working with less-capable students (Webb & Palinscar, 1996). During CL, student models can help other students correct their own misconceptions (Roschelle, 1992), improve mathematical operations (Webb & Farivar, 1994), and improve reading comprehension (Palinscar & Brown, 1984); all of these behaviors contribute to increases in SRL skill (Boekaerts & Corno, 2005). Zimmerman (1989) stated that students must help each other practice and thereby internalize task strategies, a point that Webb et al. (2008) also emphasized in their discussions of how a student’s help seeking and help-giving behaviors foster the acquisition of his or her academic skills. The point about practice is significant because practicing academic skills helps students achieve the self-control level of SRL (Zimmerman, 2000). Because of these relationships, I hypothesize that students can use modeling and the practice of skills as mechanisms to acquire successive levels of SRL skill and knowledge during CL.

Summary of collaborative learning. CL involves instruction during which teachers arrange students into small groups whose members assist each other in learning classroom material (O'Donnell, 2006; Webb & Palinscar, 1996). During CL, students engage in cyclical verbal interactions (Roschelle, 1992; Webb & Palinscar, 1996) that stimulate the practice and use self-regulatory behaviors in all phases of SRL (Zimmerman, 2000). One example of these relationships occurs when peer negotiations within a CL group result in a student changing his or her writing strategies (Wolters, 2011). Verbal interactions function as learning strategies during CL (Webb & Mastergeorge, 2003) and provide a frequent mechanism for students to acquire SRL skills.

Students also acquire SRL skills during CL because several aspects of collaborative tasks provide mechanisms for them to acquire SRL skills. For example, CL tasks reduce the number of teacher-student interactions compared to other instructional methods; asking for help from the teacher less often permits students to practice self-regulatory skills such as self-reflection (Van Grinsven & Tillema, 2006). Other instructional elements of collaborative tasks that help students acquire SRL skills include providing students with a choice of learning activities (Perry, 1998), having students participate in specialized roles (Webb & Mastergeorge, 2003), and assigning students authentic problems that pique their interest (Wolters, 2011).

Many instances of CL require students to solve math- or science-based problems (Webb & Mastergeorge, 2003). Effective problem-solving involves setting goals, enacting task strategies, and practicing metacognition (Byrnes, 2009a). Because all of these activities pertain to the use of SRL skills, having students take part in collaborative problem-solving provides a mechanism that fosters their SRL knowledge and skills. A key example of the relationship between collaborative problem-solving and SRL involves the positive effect peer models can have on fostering new SRL skills. Watching a model demonstrate a previously unknown problem-solving strategy increase an observers' self-efficacy about that specific strategy, this in turn should promote use of the new skill (Zimmerman, 2002a).

Peer models are an integral part of the social cognitive perspective of SRL (Zimmerman, 2002a) because this perspective assumes that novice learners will actively recruit, receive, and shape the support they receive from peers (Wolters, 2011). Bandura (1997) emphasized the significance of these relationships when he described how models could support skill acquisition by displaying the mastery performances that are a key source of positive self-efficacy beliefs that in turn pertain to several self-regulatory processes (Zimmerman & Cleary, 2009). Using a model to enhance an observer's self-efficacy for an SRL skill is a key mechanism for acquiring SRL skills. Boekaerts and Corno (2005) argued in favor of this premise when they indicated that CL supports SRL skill acquisition because during CL, peers demonstrate and discuss their task and motivation strategies.

The articulations of models are also very important because analyzing what a peer is saying allows students to use metacognition and engage in self-appraisal to gain deliberate and eventually dynamic control over their own mental resources (Chang & Wells, 1987; Collins et al., 1989); when this occurs, students have acquired the highest levels of SRL skill (Zimmerman, 2000). The general belief is that during CL, students distribute and share thinking responsibilities (Brown et al., 1993). Shared responsibility for thinking is not a passive activity and requires students to regulate their learning by using learning strategies such as seeking help from other students (Zimmerman, 1989) and attempting to understand the thoughts of others during task performance, which is a metacognitive process

(Zimmerman, 2000).

Overall, a social cognitive perspective of CL provides several arguments for how students can acquire SRL skills during CL (Zimmerman, 1989, 2000; Zimmerman & Moylan, 2009). Numerous scholars (e.g., Jöet, Usher, & Bressoux, 2011; Sungur & Tekkaya, 2006; Zimmerman & Kitsantas, 1999) have indicated that a student’s self-regulatory skill level will greatly influence his or her academic success. Yet, diverse groups of researchers (e.g., Boekaerts & Corno, 2005; Hadwin et al., 2011; Salonen, Vauras, & Efklides, 2005) have also argued that theoretical and methodological factors influence the relationship between collaborative learning and self-regulatory skill. This indicates the need for meta-analysis, a quantitative method of summarizing the results of numerous experiments that also takes into consideration the effects of moderators within each study (Hedges & Pigott, 2001). Accordingly, in the next sections I discuss constructs and methodological considerations that moderate the relationships between participation in CL and acquisition of SRL skills, along with hypotheses that pertain to the current study.

Theoretical Moderators

Socio-economic status. Theorists posit that measures of family income, parental education, and parental occupation make up the construct of socio-economic status (SES) (Blau, 1999). Most researchers agree that economically disadvantaged students face a host of challenges to academic success (APA, 2002; Caprara et al., 2008; Schultz, 1993). Many scholars also posit that SES affects educational outcomes according to two theories. High SES theorists propose that families with higher income or more capital can invest more in their children’s development (Bradley & Corwyn, 2002; Orr, 2003). Low SES theorists suggest that families with low SES are subject to more environmental stressors (e.g., crime and inadequate health care, among others) and that these factors are strongly associated with less effective parenting that has direct, negative biological and psychological effects on students' development, which limit academic performance. Although there is not a surfeit of research concerning SES and SRL, these findings seem accurate in light of extant literature.

Because parental income makes up the majority of family income, it is evident that parents heavily influence a child's SES (Conley, 2001; Sirin, 2005). Pino-Pasternak and Whitebread (2010), in their review of the role of parenting in children's self-regulated learning, stressed that high-SES parenting behaviors influence students' acquisition of self-regulatory skills and knowledge. They emphasized that high-SES parents help foster self-regulatory skills in their children because such parents have opportunities to model and discuss self-regulatory behaviors with their children. It is important to note that modeling and verbal persuasion help develop metacognition and task strategy use, critical components of SRL (Zimmerman, 2000). These parents also demonstrate how to share responsibility for learning with their children, a behavior that helps foster emotional regulation skills that students require during collaborative tasks (Boekaerts, 1993, 1995). These researchers also indicated that when parents engage in such activities, they foster self-competence, intrinsic motivation, positive self-efficacy for learning, and mastery-oriented behaviors within their children; all of which help students acquire SRL skills and knowledge.

Like high-SES parents, low-SES parents tend to place high value on education and have academic aspirations for their children. However they do not always have the educational experiences or the resources that would help them enact parenting practices (e.g., hiring a private tutor) to foster their children's self-regulatory skills (Becker, 2000; Evans & Rosenbaum, 2008; Spera, 2005). SES influences may also be domain specific; for example students from low-SES families are less likely to have access to a home computer (Bovée, Voogt, & Meelissen, 2007), to be exposed to a wide range of computer applications, and to have parents who are knowledgeable about computers (Becker, 2000). Certainly, these factors could explain why students from low-SES families tend to have less positive computer beliefs than their peers from middle- and high-SES families (Shashaani, 1994; Todman & Dick, 1993). Negative self-beliefs can lead to maladaptive behavioral responses (Boekaerts, 1996; Dweck & Master, 2008; Fried & Chapman, 2012) and it is evident that low-SES students have more difficulty regulating their emotions and behaviors than their wealthier counterparts (Evans & Rosenbaum, 2008).

Notwithstanding this evidence, some research suggests that parents and teachers can help students acquire self-regulatory skills in spite of their economically disadvantaged backgrounds. In their study of young adolescent students, Evans and Rosenbaum (2008) implied that parents who provided nurturing and supportive relationships could mitigate some of the effects associated with low SES. Schultz (1993) provided evidence that indicated that low SES students who are reportedly high in achievement motivation have a better chance of becoming self-regulated learners than comparable students who are reportedly low in achievement motivation. He reached these conclusions because motivation as operationalized in his study was strongly related with mastery performances and positive self-beliefs that are associated with SRL (Zimmerman, 2000). In terms of the current study, I expected SES to have a strong positive influence on the relationship between CL and SRL.

Gender. Gender is the range of physical, mental, and behavioral characteristics pertaining to biological sex (e.g., the state of being male or female; Byrnes, 2009c). A large body of knowledge documents significant gender differences in performance concerning

SRL (e.g., Meece & Painter, 2008; Pajares, 2002). Zimmerman's (2000) model of SRL includes 15 self-regulatory processes; researchers have documented disparities between genders in many of the self-regulatory processes defined in this model.

Anderman and Young (1994) investigated motivation and strategy use for science among sixth- and seventh-grade students and found that girls were more mastery-focused than boys and less ability-focused than boys; however, boys were more self-efficacious than girls concerning science performance. Rozendaal, Minnaert, and Boekaerts (2003) investigated gender differences concerning study activities for late-adolescent students and found that girls and boys differed significantly with respect to several motivational and cognitive variables including test anxiety, performance anxiety, interest, and cognitive strategy use.

Other experiments that have indicated gender differences concerning SRL include Bezzina's (2010) investigation of eleventh-grade students and Tang and Neber's (2008) study with tenth- and twelfth-grade students. The results of Bezzina's study indicated that girls reported greater use of SRL strategies, whereas boys claimed to be more self-efficacious and intrinsically motivated to learn. Tang and Neber's investigation also reported gender disparities because girls and boys reported different levels of learning effort, types of goal orientation and strategy use during science tasks. In a similar fashion, Britner and Pajares (2001) found that boys reported stronger performance approach goals for science and girls reported stronger self-efficacy for self-regulation and science.

In their research with elementary-school boys and girls, Vekiri and Chronaki (2008) found that parental support and, to a lesser extent, peer support were factors strongly associated with boys' and girls' computer self-efficacy and value beliefs. These factors resulted in gender differences in frequency and type of computer use; in addition, boys reported more perceived support from their parents and peers to use computers and more positive computer self-efficacy and value beliefs than girls. These findings suggest that in computing, environmental factors contribute to a gender gap in self-motivational beliefs, an important part of self-regulatory success.

Pajares (2002) has stressed that gender differences in self-regulatory skills arise from a number of environmental factors including parental and educational influences. Parents often underestimate their daughters' academic competence and hold lower expectations for them. Meece and Painter (2008) have indicated that parents often portray mathematics and science as male domains; Schunk and Meece (2006) implied that adolescent girls might uphold the perception of mathematics as a masculine domain, which may weaken their interest in the subject. It is important to note that this implication is congruent with social cognitive theory because environmental factors (parents) are the cause of personal changes in self-motivational beliefs, in this case task interest.

Educators can influence gender differences in a number of ways (Meece & Painter, 2002). In the area of mathematics, for example, Junge and Dretzke (1995) indicated that differences could arise because of the context in which students engage in mathematical tasks; boys and girls often change their self-efficacy perceptions depending upon the type of task (e.g., whether the task is stereotypically feminine or masculine). Moreover, counselors may also hold dissimilar expectations for boys and girls. In other cases, teachers may convey to girls that mathematics may be difficult for them that can undermine their self-efficacy that is critical for self-regulatory success (Betz & Fitzgerald, 1987; Bussey & Bandura, 1999). This evidence highlights how environmental factors (e.g., social practices) foster differential gendered expectations that in turn influence the relationship between CL and SRL for boys and girls.

Race. Race is a classification system used to categorize humans into large and distinct populations or groups by anatomical, cultural, ethnic, genetic, geographical, historical, linguistic, religious, and/or social affiliation (Byrnes, 2009c). Addressing each of these dimensions of race is beyond the scope of the current study; in this study, race will refer to the different categories of people (i.e., of African origin, Asian origin, European origin, Hispanic origin) defined by researchers within their respective experiments. When it was feasible I further divided students within my sample into subgroups based upon nationality (e.g., Chinese or African American). In particular, I investigated how culture and contextual factors related to students' nation of residence influences the relationship between CL and SRL. This is a reasonable aim because these influences are included within a social cognitive perspective of SRL (Birenbaum & Alhija, 2013; Salili, Fu, Tong, & Tabatabai, 2001).

Culture is the evolved human capacity to classify and represent experiences with symbols in distinct ways, meaning that people, who live (e.g., learn) differently, also classify and represent their experiences differently (Evans, Kelly, Silora, & Treiman, 2010). Volet (1999) emphasized that the context of learning is shaped by the cultural values that are shared by the participants of a particular culture. One example of how culture shapes the context of learning concerns the difference in class sizes in China and the United States (Liu, 2003). Specifically, organizational elements (i.e., class size, curriculum structure) of U.S. elementary and middle schools are very different from the schools that similarly aged students attend in China. This is important because school organization is a factor that is theorized to affect student motivation and use of self-regulatory skills (Wang & Eccles, 2013; Zimmerman, 2002b).

Another example of how culture pertains to the context of learning concerns self-efficacy beliefs and learning strategy use that are key components of SRL. Specifically, Birenbaum and Alhiza (2013) found that, concerning mathematics performance, Arab students' self-efficacy appraisals, metacognitive monitoring, and learning strategy use were much less effective than their Jewish counterparts. These researchers indicated that differences in self-efficacy calibration (e.g., adjusting beliefs based upon performance feedback) and test-taking behavior produced the differences in performance. A third example involves Salili et al. (2001) who investigated the effect of culture and context on student motivation and self-regulation with late adolescent Chinese, Chinese Canadian, and Canadian students. The results of their study indicated that Chinese students spent more time studying than Canadian students, were more anxious about their upcoming work, and perceived themselves to be less competent and not as effective with self-regulatory behaviors as their Canadian counterparts. These researchers also found significant differences in the goal orientations that the three groups of students displayed and stressed that the performance differences between these groups of students reflected differences in learning and teaching methods used in China and Canada.

These types of findings are not uncommon. Other researchers (e.g., Jackson, Mackenzie, & Hobfoll, 2000; Liu, 2003; Tang & Heber, 2008) have also found significant differences when comparing the use of self-regulatory skills on an interracial or intercultural basis. Indeed, there is a burgeoning body of evidence that people of different races will develop and use self-regulatory skills and knowledge at different rates due to the influences of their cultures (Hattie, Biggs, & Purdie, 1996; Britner & Pajares, 2001). Nodoushan (2012) has indicated that environmental factors such as family aspirations, school budgets, teacher ideologies, and societal aims and priorities, among others, also play significant roles in the differences that races display regarding self-regulatory skills and knowledge. Therefore, I expected the results of the current study to demonstrate significant student variability concerning race.

Prior achievement. Zimmerman and Schunk (2008) have indicated that self-regulation is highly influenced by prior math achievement experiences. A student who has done well in reading (Schunk & Zimmerman, 2007) will likely have more adaptive goal oriented cognitions and self-regulatory behaviors in the future than a student who has not done well in reading. Bandura (1977, 1993) also indicted this phenomenon when he emphasized that mastery learning experiences foster self-efficacy beliefs that have a positive relationship with self-regulatory skills (Caprara et al., 2008; Joët et al., 2011; Usher & Pajares, 2008b).

When Zimmerman, Bandura and Martinez-Pons (1992) investigated the relationship between ninth-grade students' self-efficacy beliefs, academic goals, and prior academic achievement, they found that students' (n = 116) prior grades were predictive of their parents' grade goals for them, which in turn were linked to the goals students set for themselves. DiPerna, Volpe, and Elliott (2005) conducted a study with elementary students (grades 36, $n = 202$) to show how prior achievement influenced elementary students' reading and language-arts achievement. Findings showed that prior achievement influenced motivation and study skills, which are personal and behavioral factors necessary for SRL (Zimmerman, 2000, 2001)

Research evidence suggests that students' prior academic achievement is indeed related to self-regulatory processes that foster SRL skills and knowledge, such as mastery-goal orientation (Anderman, Anderman, & Griesinger, 1999; Broussard & Garrison, 2004; Patrick et al., 2007; Phan, 2012) and self-regulated learning strategies (Fuchs et al., 2003; Glaser & Brunstein, 2007; Patrick et al., 2007; Pintrich, 2000). However, the majority of this evidence pertains to non-adolescent American students. It is also important to note that Rotans and Schmidt (2012) found that prior achievement was not a predictor of motivation for 17-year-old students in Singapore, which suggests that the relationship between prior achievement and self-regulatory processes might vary depending upon race. The current study addressed both of these issues.

Age. Wigfield, Klaudia, and Cambria (2011) have contended that it is important to consider developmental differences in the acquisition of SRL skills and knowledge. Using Zimmerman's (2000) model of SRL and related theories (e.g., Zimmerman & Kitsantas, 1997) as an organizing frame, they argued that three mechanisms influence a student's acquisition of SRL skills and knowledge. Those things are students' capacity to regulate from a biological standpoint, students' knowledge of strategies and expertise, and changes in SRL-related factors such as the types of goals students choose that influence their self-regulatory processes.

Specifically, students younger than 10 years may not have the cognitive ability to monitor and control their actions; even at older ages, there may be biological limits on how much students can self-regulate (Flavell, 1979; Flavell, Green, & Flavell, 1995). Numerous researchers have examined the relationships between cognitive developmental stages and self-regulatory processes. For example, Alexander, Carr, and Schwaneflugel (1995) found developmental differences among gifted students related to metacognition (i.e., thinking about one's thinking) concerning cognitive monitoring and regulation of learning strategy use. Because metacognition is a ubiquitous component of SRL, this finding is important; it suggests that metacognitive differences in student abilities help explain why some students are effective self-regulated learners during CL.

With respect to cognitive monitoring as a part of metacognition, children begin to develop these skills by age 4 or 5 (Cultice, Sommerville, & Wellman, 1983) but do not begin to actively utilize them until age 11 or 12 (Spaans & Veenman, 2005). Such monitoring includes keeping track of progress toward academic goals; therefore, students may find this behavior challenging because it requires complicated cognitive processing (Dowson & McInerney, 2003) that some may be unable to perform. In addition, younger students may have overly optimistic perceptions of their competence in various academic tasks (Usher & Pajares, 2009). If students are excessively optimistic about their capabilities, they set over-ambitious goals; in turn, failure to achieve such goals can dampen perceptions of self-efficacy and competence that are vital for successful forethought phase processes as described by Zimmerman (2000).

A significant body of research indicates that students' interest in their schoolwork decreases as they progress from elementary to high school [e.g., (Anderman & Maehr, 1994; Meece, Wigfield & Eccles, 1990)]. When students find their academic subjects less interesting they demonstrate lower levels of SRL compared to students who place intrinsic value upon their studies (Ames, 1992). This lower level of interest also affects the types of goals that students set for themselves (Zimmerman, 2002a). Students' goal orientation influences their motivation to regulate their learning (Zimmerman, 2000). Students who have a mastery orientation engage in tasks with the hope of improving their performance through effective strategy use, whereas students who have a performance orientation engage in tasks with the hope of not appearing incompetent. The latter type, therefore, set lower achievement goals and use less-effective learning strategies than the former (Wigfield & Cambria, 2010). Many students develop a proclivity for performance orientation as they age, a disposition that weakens self-regulatory success and self-efficacy perceptions (Wolters, 1999).

Performance phase self-regulatory skills and knowledge such as a student's learning strategy skill and knowledge of metacognitive strategies develop with age (Wigfield, Klaudia, & Cambria, 2011). Over time, biological maturation and experience allow students to regulate their behavior more efficiently (Zuscho, Pintrich & Coppola, 2003). Such changes influence an individual's ability to optimize his or her learning and achieve higher self-regulatory skill levels (Zimmerman, 2002a), Because these changes can vary substantially among same-aged students, teachers observe individual differences in the self-regulatory skills of students (Paris & Paris, 2001) that are required in performance phases' processes (Zimmerman, 2000).

There is evidence that as students get older they may use progressively more complex learning strategies. Hilden and Pressley (2007) identified differences in the complexity of strategy usage from later elementary grades through middle school. Pressley, Goodchild, Fleet, Zajchowski, and Evans (1989) also found evidence supporting this premise when they concluded that students demonstrate relatively simple math strategies during the early primary grades but acquire sophisticated text comprehension strategies in the latter elementary school years. Students' learning strategy development (i.e., of persistence or help-seeking) depends on their experiences as well as their schooling (Pressley, Levin, &

Ghatala, 1988), which means that increased practice and exposure to models who use learning strategies during CL accelerate their development in the relevant areas.

Significantly, younger students may not understand the relationship between causal dimensions (e.g., effort and ability) and skills that they can change over time (e.g., learning strategy use that improves one's ability). This means that some students do not always have a firm grasp on circumstances that they can control; moreover, by implication, such students will not be able to make attributions that foster SRL because they are unsure of which thinking processes to monitor. Significantly, Wigfield, Klauda, and Cambria (2011) have argued that such conditions prevent younger students from becoming efficient self-regulated learners.

The latter circumstances reduce the motivation to learn, which in turn dampens self-efficacy perceptions and impedes students' attempts to self-regulate their learning (Zimmerman & Moylan, 2009). Frequent occurrences of such behaviors result in student choices (e.g., deciding to engage in a learning task with a performance orientation) that negatively influence SRL (Zimmerman, 202b). Unfortunately, this negative disposition toward academics intensifies as students grow older (Durik, Vida, & Eccles, 2006).

Because researchers have emphasized the intertwined nature of SRL constructs, it is not surprising that research suggest that the development of many SRL factors is related (Schunk & Zimmerman, 1997; Usher & Pajares, 2008b). Meece and Miller (2001) investigated how the goals of elementary school students changed over the course of two years (3rd to 5th grade). Specifically, they attempted to identify how student goals changed or remained stable over time in the domains of reading and writing and how such changes influenced their use of self-regulated learning strategies. The researchers found that student adoption of mastery goals decreased over time and that changes in mastery-goal orientation explained a significant portion of the changes in SRL strategy use. It is important to note that student adoption of mastery goals was positively related to more effective self-regulatory strategies and negatively related to less effective surface-level (i.e., rote) strategies.

Forethought phase goals depend upon self-reaction phase attributions that result from the learning strategy behaviors of students during the performance phase of SRL (Zimmerman, 2000). Students' persistence in using learning strategies during performance phase processing is often related to the belief that they can increase their own intelligence (Dweck, 1993; Dweck & Master, 2008). Many of the factors mentioned in this section not only develop at different rates but also support my intention to examine how age moderates the relationship between CL and SRL.

Academic subject. The self-motivational beliefs and strategies (cognitive and metacognitive) described in the previous section are important components of SRL regardless of the academic subject (Zimmerman, 2000), yet students' perceptions of their self-motivational beliefs and uses of related learning strategies are likely to vary based upon the relevant subject area (Schunk & Zimmerman, 2007; Wolters & Pintrich, 1998). In other words, the level and quality of SRL that students display depend upon their subject area self-efficacy beliefs along with their ability to monitor and control the learning strategies they practice and use in the particular subject area (Trautwein & Lüdtke, 2007; Vanderstoep, Pintrich, & Fagerlin, 1996). This relationship seems reasonable because self-efficacy beliefs and learning strategy use are critical to SRL success (Zimmerman, 2000) and are likewise highly contextualized social cognitive processes (Bandura, 1993; 1997). This means that high performance in a subject area requires high self-efficacy beliefs and adept task-strategy use in the relevant subject area (Schunk & Zimmerman, 2007; Zimmerman & Kitsantas, 1999). In other words, efficient task-strategy use and high self-efficacy beliefs in the related learning strategy are two sides of the same coin.

In spite of these facts, scholars require additional knowledge concerning when and if a student's self-efficacy perception related to the use of a particular learning strategy differs across academic domains (Jöet, Usher, & Bressoux, 2011; Schunk & Zimmerman, 1996). Boekaerts (1996, 1997) implied that a consistent relationship between a student's belief and behavior across subjects would be infrequent when she argued that SRL happens after students develop and access self-motivational beliefs and self-regulatory skills that are domain-specific. Although Paris and Paris (2001) have provided support for this view, other SRL researchers (e.g., Zimmerman & Martinez-Pons, 1986) have shown that students use certain learning strategies (e.g., organizing and transforming information, help-seeking, and rehearsing or using memory aids) and hence associated self motivational beliefs, regardless of domain. As a result, integrating SRL evidence by meta-analytic review can test whether the use of certain learning strategies (and concomitant self-motivational beliefs) in the context of CL are more strongly associated with performance in some subjects than others.

Additionally, research (Hadwin & Oshige, 2011; Määttä, Järvenojä, & Järvelä, 2012; Roschelle, 1992) has shown that contexts such as challenging problem-solving tasks that are frequently associated with math and science can facilitate SRL. Although empirical evidence (e.g., Gaskill & Woolfolk Hoy, 2002; Woolfolk Hoy, Hoy, & Davis, 2009) supports the argument that certain types of tasks facilitate SRL skill acquisition because such tasks require self-regulation for successful completion, the extent to which the academic subject itself shapes the acquisition process of SRL skills and knowledge is not clear (Rotgans & Schmidt, 2012; Wolters & Pintrich, 1998). Stated another way, scholars require additional knowledge about how the subject area in which collaborative learning occurs might moderate the relationship between CL and SRL skills and the current meta-analytic review can help answer this question.

Collaborative instructional methods. Current scholarly literature certainly suggests a positive relationship between CL and adolescence SRL skills and knowledge (Dopkins Stright, & Supplee, 2002). However, I suggest, and current literature does not adequately address the relative strength of such relationships. This is an important issue because the various CL methods emphasize different mechanisms for learning that affect the relationship between SRL and CL. This issue is also significant because different researchers may operationalize instructional methods in different manners (Slavin, 2011).

Therefore, it is reasonable to assume that reciprocal teaching methods do not afford students with the most efficient way to acquire the observation and emulation levels of SRL skill because teachers are a significant source of student observation and emulation learning during RT; peer models are better sources for fostering these types of self-regulatory skill levels (Bandura, 1993; Schunk, 1987). Researchers have implemented CoL in diverse manners (Slavin, 1991) and it can be argued that CoL does not emphasize all phases of SRL because many of Slavin's writings (e.g., Stevens & Slavin, 1995) do not put emphasis on learning processes normally associated with the self-reflection phase of SRL (Zimmerman, 2000) such as self-evaluation, causal attributions, and metacognitive reasoning that leads to adaptive behaviors. Such conditions would certainly weaken the association between SRL skills and CoL. For these reasons, a meta-analysis can help scholars understand how the type of instructional method influences the relationship between CL and SRL.

Year of publication. Since the mid-1980s, researchers have modified and expanded the ways that scholars have conceptualized and measured SRL (Zimmerman, 2008). Initially, researchers defined SRL as an individual aptitude and used self-report questionnaires such as the motivated strategies for learning questionnaire (MSLQ; Pintrich & DeGroot, 1990) to measure what was perceived as a relatively stable trait of a student that foretold future behavior (Winne & Perry, 2000). More recently Greene and Azevedo (2010), among others, have conceptualized SRL as a series of events such as making a note or highlighting a passage of text, both of which have a distinct beginning and end. From this event perspective, Schunk (2013) and Perry and Winne (2013), among others, have advocated the use of multimodal methods (i.e., cognitive traces, think-aloud protocols) for measuring SRL in specific learning contexts such as science education. For these and other reasons, SRL theory and measurement has evolved over time.

It is clear that the methods of collaborative instruction have evolved as well. In the latter half of the twentieth century, researchers initially surmised that CL was effective because of social interdependence that fosters common goals among students (Deutsh, 2000). Since then, researchers have identified several other elements of CL that contributed to effective CL. These include but are not limited to, observational learning (Schunk, 1993), the use and practice of learning strategies (Brady, 1990), setting goals and tacking action to achieve such goals (Sungur & Tekkaya, 2006), using self-reflection processes to improve learning (Wang, 2011), and the use of role playing as a way to develop adaptive skills (Nichols, 1996).

Contemporary researchers have combined many of these elements into their CL experiments in order to foster SRL skills and knowledge. The experiments that I collected for this dissertation varied in terms of when and how they were conducted. Given that SRL and CL research have both evolved over time, it made sense to investigate whether year of publication might moderate the relationship between CL and SRL. Therefore, I have added year of publication as a moderator.

Methodological Moderators

In this section I discuss methodological moderators, which are essentially study-design features that influence experimental results. Specifically, I discuss how the SRL assessment instrument used by researchers might moderate the relationship between CL and SRL. I also discuss how the publication source along with variation in intervention implementation might moderate the relationship between CL and SRL.

Type of publication. I assigned a publication code (e.g., peer-reviewed, non-peer-reviewed, unpublished) to each study in my sample to determine if experiment characteristics help explain the relationship between CL and SRL (Borenstein et al., 2009). Performing this step helped me determine if my findings are biased because of a reliance on published experiments that tend to have larger effect sizes and samples (Lipsey & Wilson, 2001). Using both published and unpublished research helped mitigate the effects of publication bias (Cooper, 2010).

Type of self-regulated learning measure. Researchers have conceptualized SRL as a multidimensional process that is comprised of several phases and components that are influenced by developmental, instructional, and contextual factors (Boekaerts & Corno, 2005; Winne & Perry, 2000) and as a result researchers continue to debate how to measure SRL (Greene & Azevedo, 2010; Winne, 2010). Generally, SRL data collection methods belong to two categories: offline methodologies that researchers use to capture the deployment of SRL processes before and/or after such processes have occurred and online methodologies that researchers use to capture the deployment of SRL processes during learning (Greene & Azevedo, 2010).

Offline measures of self-regulated learning. Many researchers initially viewed SRL as an enduring aptitude or skill in which students demonstrated relatively little variation across contexts, they initially developed SRL offline measures that students self-reported before and/or after completing a task (Winne & Perry, 2000). Pintrich and DeGroot (1990) developed and used this type of measure, specifically the MSLQ, when they surveyed junior high students about their typical use of SRL strategies concerning science and English tasks. The results of their study indicated that self-efficacy and intrinsic value had positive relationships with engagement in learning. The researchers also found that intrinsic value had a strong positive association with self-regulation and cognitive strategy use, regardless of prior achievement level.

In general, researchers can use the MSLQ to assess motivational beliefs (e.g. self-efficacy, intrinsic value, and test anxiety) as well as use of learning strategies (i.e. cognitive, metacognitive, and regulatory or resource-management strategies). This self-report questionnaire contains nine subscales that address the nature of motivation and use of cognitive and metacognitive learning strategies in different types of content areas such as middle school physical education, middle and high school math, and high school chemistry, among others (Duncan & Mc Keachie, 2005). Researchers have used the MSLQ in an abundant number of empirical studies (e.g., Pintrich, Conley, & Kempler, 2003; VanderStoep, Pintrich, & Fagerlin, 2007; Wolters & Pintrich, 1998) and have found a consistent positive association among several motivation constructs, self-regulatory processes, and achievement.

The use of Pintrich's MSLQ questionnaire helped advance the idea that motivation plays a key part in SRL; however, self-report instruments have some measurement limitations. In this case, the correlations between students' self-reports and their actual use of self-regulatory processes are low, which suggests that self-reports do not give a very accurate picture of the strategies and tactics students actually use (Greene & Azevedo, 2010; Winne, 2010). This is especially true when students answer questionnaire items that are not task- and context-specific (Veenman, Kok, & Blote, 2005; Winne, Zhou, & Egan, 2011). As a result, self-reported SRL variables might not accurately display their relationships with related CL task-achievement variables and thereby become a source of measurement error.

Structured interviews (Hadwin & Oshige, 2011; Winne & Perry, 2000; Zimmerman & Martinez-Pons, 1986) are offline measures of SRL that typically present a hypothetical learning scenario and ask students to describe how they would use SRL strategies during it. This measure is context-specific; students draw upon memories of specific events to arrive at their proposed use of self-regulatory processes during structured interviews (Veenman, 2011). Under these conditions, self-reported strategy use should be a more valid indicator than more generalized questionnaires of past SRL behaviors (Greene & Azevedo, 2010). Structured interviews and offline questionnaires are the most common ways for measuring a self-regulatory process or skill. Examples of these types of measurements include assessment of knowledge pertaining to: cognitive operations that comprise cognitive tactics, procedural knowledge that enacts cognitive tactics, the evaluation of achievement and goals.

Online measures of SRL. Although offline measures of SRL are still commonly used and theoretically supported (e.g., Cleary & Platten, 2013; Winne et al., 2011; Zimmerman &

Moylan, 2009), many researchers (e.g., Greene & Azevedo, 2010; Hadwin, Winne, Stockley, Nesbit, & Woszczyna, 2001) recommend using SRL data-capture methods that occur in real time. This trend arguably reflects a shift in how researchers conceptualize SRL (Boekaerts & Corno, 2005; Hadwin, Järvelä, & Miller, 2011; Hadwin and Oshige (2011) with event qualities that occur during dynamic episodes of learning such as problem solving with a group of peers (Perry & Winne, 2013). Researchers taking this position have recommended, among other strategies, trace data and think-aloud protocols as ways to capture real-time and context-sensitive SRL information. Trace data (Winne, 1982) are observable products of cognition that students create as they engage in an academic task such as labeling a diagram or writing in the margins of a textbook (Winne & Perry, 2000). It is important to note that trace data generated by a learner should occur simultaneously with a cognitive operation that is part of a self-regulatory process (Winne, 2010). Accordingly, researchers must ensure that they provide a precise explanation of how the pertinent traces reflect the underlying cognitive processes (Winne & Perry, 2000) which will allow them to gain insight into contexts that trigger self-regulatory processes (Winne et al., 2001). Researchers consider trace data, such as taking notes while learning on the Internet, to be a more objective indication than self-reporting of SRL because trace data do not rely on students' perceptions of their own strategy use (Greene & Azevedo, 2010).

Think-aloud protocols are also a way to produce context-sensitive SRL measures. Unlike trace data that are based upon student-produced physical data, think-aloud data results from in-the-moment, self-provided ,verbal descriptions of what a learner is performing, for instance a learning strategy during an academic task (Winne, Zhou, & Egan, 2011). By verbalizing their feelings and thought processes, students make their affective, cognitive, and metacognitive processes publicly available for researchers to codify and analyze. Moreover, Greene and Azevedo (2010) have stressed that concurrent think-aloud protocol data over multiple tasks allows researchers to draw inferences about relative levels of motivation and aspects of the students' learning contexts (Azevedo, Cromley, and Seibert, 2004; Greene, Costa, Robertson, Pan, & Deekens, 2010). However, some students (e.g., those with low self-regulatory skill) may find the requirement to multitask mentally overwhelming, which can cause SRL measurement error (Howard-Rose & Winne, 1993). Winne (2010) also argued that researchers who use think-aloud protocols do not accurately sample student cognitions, because such researchers have no or little understanding of how a learner samples their cognitions and afterwards determines which of them to produce as a think aloud utterances. This implies that SRL measurements based upon this protocol do not capture a significant number of self-regulatory processes and therefore contain some percentage of measurement error.

Summary of self-regulated learning measures. The key differences between the types of measures pertain to when students produce their measurements and the assumptions associated with each type of measurement (Greene & Azevedo, 2010). Students produce their SRL data before and/or after learning tasks for offline measures of SRL performance. Researchers who only use off-line measures of SRL assume SRL is static and can be measured outside of the actual learning context. During online measurement of SRL performance, students produce their SRL data concurrently with their learning performance, and researchers assume that this type of SRL data is more context and domain specific than offline measures of SRL. While it is clear that both online and offline measures of SRL have their supporters, many researchers have suggested using a combination of both approaches to capture SRL data (Greene & Azevedo, 2010; Hadwin & Oshige, 2011; Winne, 2010). Indeed, I argue that a combination of both online and offline measures is the best way to capture SRL data because researchers have conceptualized SRL with aptitude (captured by offline measures) as well as event (captured by online measures) qualities (Schunk, 2005; Winne & Perry, 2000; Zimmerman & Moylan, 2009). This measurement approach is consistent with Zimmerman's (2000) theory that self-regulated learners have the skill to apply their knowledge in a variety of contexts because of their elevated self-efficacy beliefs. I also presumed that experiments that used both online and offline measures of SRL would provide the most insight into how CL might foster SRL skills and knowledge for students. To capture and analyze these phenomena I coded each experiment to calculate effect sizes for online, offline, and summary effects for both online and offline measures of SRL; that is, if my sample would permit such analysis with the appropriate statistical power (Borenstein et al., 2009).

Fidelity of Implementation. There is evidence that indicates educators may have difficulty teaching collaborative interventions due to a lack of *fidelity of implementation* (FOI) (Rodriguez, Loman, and Horner (2009). Crawford, Carpenter, Wilson, Schmeister, and McDonald (2012) have stated that within the field of education there is not one universally accepted definition for FOI but emphasized that it essentially means the extent to which an intervention was implemented as originally planned. Many researchers have operationalized FOI into two categories: fidelity to process and fidelity to structure; however, there is considerable debate about the elements of each category (Crawford et al., 2012; Hill, King, Lemons and Partanen, 2012; O'Donnell, 2008). Nevertheless, fidelity to structure generally pertains to (a) the total time a student is in an intervention, (b) the percentage of time a student spends in various lessons within the intervention, and (c) teacher adherence to and level of student engagement with the intervention (Crawford et al., 2012). Fidelity to process also has two subcategories: quality of implementation and intervention differentiation. Quality of implementation is the manner in which the implementer delivers the intervention using the prescribed learning strategies such as self-questions and processes such as individual practice of SRL skills. Intervention differentiation is the extent critical features, such as heterogeneous grouping of students, of the intervention are present or absent during implementation (O'Donnell, 2006).

Newfield (1990) in his critique of methods that measure FOI identified two categories of data that one should assess: self-report such as rating scales and checklists based upon direct observation of teachers and/or students. O'Donnell (2009) in her review of K-12 studies that examined the relationship between implementation fidelity and learner outcomes corroborated Newfield's recommendations but indicated that checklists based upon direct observation of teachers and/or students were not used in the primary studies in her review. Specifically, O'Donnell indicated that researchers only used data on student artifacts (e.g., assignment completion rates, level of student engagement during learning tasks) to assess fidelity of structure. Notwithstanding these differences across studies, I assigned a FOI indicator (e.g., yes, no) to each study in my sample to determine if FOI characteristics could help explain the relationship between CL and SRL (Borenstein et al., 2009).

Why Meta-Analysis, and Why It Was Needed

The relationship between collaborative learning, arguably the one of the most effective methods of instruction (O'Donnell & Hmelo-Silver, 2013; Webb & Palinscar, 1996) and self-regulated learning (SRL), a key contributor to academic success (Bandura, 1993;

Zimmerman, 2000) was uncertain and required additional investigation. The extent to which CL fostered self-regulatory skills and knowledge across adolescence and subject areas was unclear. The importance of a single study lies in the scholarly contribution such research provides (Cooper, 2010). By comprehensively examining existing research about CL and SRL, I had the opportunity to advance relevant theory and provide valuable insight to practitioners (Cooper, 2010). By performing this meta-analysis, I accomplished both of these goals by assessing what an entire body of literature can tell scholars about the relationship between CL and SRL. Exploring research questions through meta-analysis has enhanced and potentially transformed scholarly understanding of a body of work by uncovering relationships that individual experiments could not detect due to their relatively limited statistical power (Cohn & Becker, 2003; Hedges & Pigott, 2001).

The scope and interdisciplinary nature of both CL and SRL has produced a diverse body of research that explored many contexts such as subject areas, processes such as learning strategy use, and outcomes such as motivational beliefs (Schunk & Zimmerman, 2007; Slavin, 2011). Theorists have disagreed over how to conceptualize CL and SRL, but evidence has certainly suggested that collaborative learning methods can help foster self-regulatory skills (Pintrich, 2000; Webb, 2013). However, the fact that extant research had not fully addressed the relationship between CL and SRL produced gaps in the literature that meta-analysis was uniquely able to address. Using meta-analysis to answer questions about what type of CL methods has have the strongest relationship with student acquisition of SRL skills has integrated previous findings and provided a foundation for future research.

Researchers needed to address gaps in the SRL literature in order to overcome current challenges to the expansion of scholarly knowledge of how students acquire SRL skills and knowledge during CL (Hadwin & Oshige, 2011). Research was also needed to provide insight into the domain-specific attributes of collaborative tasks that foster the acquisition of SRL skills and knowledge (Boekaerts, 2011). Until now, scholarly knowledge did not sufficiently explain from a social cognitive perspective how CL helps foster SRL for students from late elementary school through high school. It is also important that this research helps scholars explain how factors such as self-efficacy beliefs influence the relationship between SRL and CL as well as how these relationships have varied across academic domains (e.g., science), varied among groups of students (e.g., high school students), and varied across collaborative instructional methods. Examining these relationships has helped identify mechanisms that educators can use to help students acquire self-regulatory skills and expanded scholarly knowledge of personal, behavioral, and environmental factors that contribute to self-regulatory success.

Social cognitive researchers have produced a diverse body of research that explores SRL's many antecedents, processes, outcomes, and measures (Bandura, 1997; Wolters, 2011; Winne et al., 2011; Zimmerman, 2000). However, based upon my extant knowledge, the current study is the only research that has examined the strength of the relationship between various forms of CL (e.g., inquiry learning) and SRL while taking into consideration moderating variables such as race, type of instruction, age of student, SRL measure, and academic domain. This systematic review and meta-analysis addressed research questions related to these issues that were gaps in SRL literature.

CHAPTER 3

METHODS

In this chapter I explain the methods and procedures for the current study. First I describe the literature search and data analysis of theoretical and empirical research concerning how collaborative learning methods help students acquire SRL skills and knowledge. Second I describe the collection of empirical research used to produce a sample that was used to perform a meta-analysis concerning the relationship between collaborative learning methods and SRL skills. The chapter concludes with a discussion of the statistical processes that were required for meta-analysis, and how I addressed each research question along with my expected findings from this meta-analysis.

Data Collection and Preparation

Using the University of North Carolina library system, I gathered peer-reviewed articles from EBSCO databases including Academic Search Premier, Teacher Reference Center, and Education Full Text among others, using various combinations of the following search strings: “SRL,” “self-regulated learning,” “peers,” “dyads,” “peer-assisted,” “collaborative learning,” “effect,” “relationship,” “association,” “metacognition,” “problem based learning,” and “cooperative learning.” I completed this search in January 2014. The literature I compiled covers several types of learning tasks and multiple subject areas. I created a database of records for each article in my initial sample. Each record contained information pertaining to (a) the article’s research questions, (b) the ages of participants, (c) how the researchers selected the participants, (d) how closely the theory and/or experiment aligned with SRL and collaborative learning theory, (e) availability of empirical data, and (f) the experiment's conclusions. Next, I scanned the database to identify common themes across the experiments and during this step I also sorted the articles into groups that corresponded to the self-regulatory processes that make up the cyclic phases of SRL (Zimmerman, 2000). Then I sorted the groups into categories that represented the reasons why CL fosters SRL, for example modeling is a mechanism that helps students acquire SRL skills during CL, or CL affords students opportunities to practice SRL skills and encode SRL knowledge. I presumed that these groups would emerge as themes that I would discuss in my results section. As I executed the aforementioned steps I removed articles from the database that did not pertain to students from the ages of 10 to 18 and identified articles that I could potentially use in my meta-analysis due their inclusion of relevant empirical data.

Using the University of North Carolina library system, I gathered peer-reviewed experiments from articles, conference proceedings, dissertations, and other scholarly material using the *Articles+* search tool with the name of common measures of SRL and learning strategies along with the search terms "adolescent" and "student." The names of the measures that I used to search the databases were: Motivated Strategies for Learning Questionnaire (Pintrich & DeGroot, 1990), Learning and Study Strategies Inventory (Mealey, 1988; Weinstein, 1996), Patterns of Adaptive Learning Survey (Midgley et al., 2000), Approaches to Studying Inventory (Entwistle et al., 2000), Inventory of Learning Processes (Schmeck, 1991), Approaches and Study Skills Inventory (Entwistle & Tait, 1996), and Self-Regulated Learning Interview Schedule (Zimmerman & Martinez-Pons, 1986, 1988). I also conducted a reference search for the Motivated Strategies for Learning Questionnaire in *Articles+* to retrieve all documents citing its original or revised publications.

To prevent bias in my meta-analysis toward self-report questionnaires, I explicitly searched *Articles+* for experiments that utilized online measures of SRL; for example, I also used “think-aloud protocols” and “cognitive traces” as search terms Winne (1982, 2010). To increase my chances of gathering relevant unpublished research, I employed direct-contact strategies (Cooper, 2010). I sent individual emails to 20 researchers who have authored at least two publications on SRL and/or CL from 1998 to 2014 and to authors of major review or theoretical papers on these topics. Dr. Timothy Cleary was the only researcher that contacted me and we discussed how observational learning and other mechanisms helped students acquire SRL skills and knowledge. I also examined the reference lists of significant articles to increase the likelihood of finding other pertinent experiments (Cooper, 2010).

Study inclusion criteria. Experiments included in the meta-analysis had to meet several requirements. During the literature searches, I initially narrowed down the number of research reports based on three initial screening criteria applied to information found in their abstract. I retained a document if it (a) compared the results of a CL intervention group with a control or comparison group, (b) appeared to include empirical findings, and (c) examined the relationship between any SRL construct and method of collaborative instruction such as PBL. Next, I read the methods and results sections of the potentially relevant documents to determine whether they qualified for inclusion in the meta-analysis. With regard to the latter criterion, an experiment had to explore one or more self-regulatory processes as defined in Zimmerman’s (2000) model of SRL.

I included experiments in the meta-analyses if participants were in the age range of 10 to 18 years. This age range represents a time of critical changes in both SRL and academic performance (Eccles et al., 1993; Paris & Winograd, 1990). The experiments included in the current study concern academic tasks found in regular education courses or learning activities performed in a laboratory setting.

Experiment exclusion criteria. I further narrowed the list of relevant literature by using several exclusion criteria. First, because I used a weighting procedure that considers sample size; experiments with more than 10,000 students were not included in the meta-analysis (Borenstein et al., 2009). Although my literature search did not produce a study with 10,000 or more students, this exclusion would have been necessary because mean effect size calculations based on such a large sample size would confound my results by minimizing the impact of experiments with relatively small samples. In particular, large sample sizes decrease standard error values that increase relative weights assigned to associated effect sizes.

Other excluded experiments did not conform to specific experiment design requirements (Cooper, 2010). I excluded an experiment if, among other things, there was evidence of student exposure to events that could have confounded the relationship between CL and SRL. This could occur, for example, if I could not detect a clear distinction between control and experimental procedures within an article. I also excluded experiments that displayed evidence of control groups having vastly different characteristics (e.g., cognitive ability) compared to experimental groups. Finally, research that did not include accurate calculations for effect sizes, standard errors, or related statistical tests were excluded.

Given that there can be considerable variation in the terminology that authors use to define CL and SRL constructs (Puustinen & Pulkkinen, 2000; Webb & Palinscar, 1996), I verified that relevant constructs had been labeled and used in a manner that was consistent with the measured outcomes and the proposed effects of instruction (Cooper, 2010). I used both the label and operational definition of constructs to determine whether I would exclude an experiment from this meta-analysis. An exclusion of this type would occur, for example, if a researcher labeled a construct as self-efficacy but used the construct in a manner that was not task specific; however, in my review it was not necessary to exclude an experiment for these or other related reasons.

Information coded from the experiments. I coded and categorized the variables into the following categories: report characteristics, settings characteristics, characteristics of sample, self-regulated learning variable, and academic performance variable. Examples of these categories of information include name of author, country of experiment, sample size, and type of SRL assessment measure (e.g., offline or online). Table 1 contains a summary of the general information variables that I obtained from the experiments. I anticipated that most of the experiments I would choose for my meta-analysis would report outcomes concerning several categories of constructs including self-regulated learning, cognitive or metacognitive strategies, and self-motivational variables. I coded all variables that pertained to the self-regulatory processes in Zimmerman's (2000) model of SRL into a single SRL variable. This approach did produce more data than I needed; however, it also increased my odds of identifying statistically significant relationships between CL and SRL.

Gathering information from experiment reports. As they conduct meta-analyses, researchers anticipate that they will encounter missing experiment information that would be beneficial to include during effect-size calculations and moderator analyses. When data such as demographic information were missing from a research report, I tried to obtain the information from other sources (e.g., governmental websites). Cooper (2010) has suggested evenly dividing sample participants into male and female when explicit gender composition is not available within an experiment, and for other kinds of variables he has recommended filling in missing values with the mean of all known values on the characteristic of interest. I estimate that I used these strategies for 5% of the data in this study. In the event that I was unable to locate or calculate required experiment information by imputation, I left the particular data field empty and retained other relevant information for that particular data record.

Concerning data independence, I collected information from research reports using independent samples as my unit of analysis. This approach allows a single article to contribute more than one result when researchers carry out interventions on independent samples of students. It is important to note that under these conditions, weightings are functionally equivalent whether the units of analysis used by researchers are independent samples within experiments or entire experiments (Cooper, 2010). Based upon the aforementioned guidelines, all of the samples within the experiments of the current study were independent.

Variable coding. I modified a coding protocol outlined by Lipsey and Wilson (2000) and adapted by Dignath, Buettner, and Langfeldt (2008) that is identified in Appendix A. Similar to the meta-analysis of Dochy, Segers, Van den Bossche, and Gijbels (2003), I also noted the types of assessment instruments that researchers used to evaluate the effectiveness of their interventions. This distinction concerned subject knowledge that is usually assessed by performance tests versus the application of knowledge about cognitive or metacognitive skills and strategies that researchers usually measure by interviews, questionnaires (e.g., self-report), simulation tasks, or observation (Winne, 2010).

Potential moderating variables and outcome variables. I tested two categories of variables for their potential moderating effects on student acquisition of SRL skills and knowledge: theoretical and methodological. The theoretical moderators included prior achievement, gender, race, socio-economic status, age of student, type of collaborative intervention, and academic subject. The methodological moderators included type of self-regulated measure and type of experiment publication. Table 1 also contains a summary of moderating variables.

Coding reliability. I coded each experiment in an objective manner by adhering to the coding protocol in Appendix A. After coding 20 experiments that involved many if not all of the moderators within my meta-analysis, I conversed with my advisor and another professor to review the protocol in an effort to improve coding reliability. Based upon the outcome of such conversations, I amended my coding protocol as instructed and changed seven existing records so that they complied with the improved protocol. Afterwards I coded my remaining 43 experiments using the improved protocol. One example of these interactions included discussions focused on moderators that led me to change age from a continuous to categorical moderator variable that differentiates young and older adolescent students. I initially analyzed age as a continuous variable, because treating the variable as continuous would result in the most power, compared to dichotomizing. Afterwards, I made change because there is a significant body of work that suggests students can increase their SRL skills and knowledge as they mature (Wigfield et al., 2011). Moreover, in order to determine if there was a statistically significant difference in the relationship between younger adolescent and older adolescent students, I divided my sample into two age groups: 10 – 13 and 14 – 17; I choose those age groups because they pertain to middle and high school students, students that researchers often discuss in the literature (Anderman & Patrick, 2012).

If the coding process required me to make a subjective judgment, I reviewed the appropriate experiment to gather evidence to support my conclusions. This approach helped ensure that I was representing the evidence as the original author(s) intended. If I was still uncertain of my coding decision after taking this step, I contacted my advisor to resolve the issue. When this occurred, my advisor and I decided upon a percentage to represent a term used by many researchers to describe a portion of their sample. In the event that both my advisor and I could not address the issue sufficiently, I performed additional research and/or contacted another professor with meta-analysis expertise to advise me of the proper resolution; this occurred one time when it was necessary to perform additional research to determine the best way to include experiments with incomplete data.

If effect size information was not readily available within an experiment that I wanted to include in my sample, I attempted to use inferential or descriptive data to compute the necessary statistics. Prior to completing these steps, I reviewed the calculation steps with the Comprehensive Meta-Analysis (CMA) (2014) staff to ensure that I would code this information correctly. CMA was the software package that I used to perform the meta-analytic computations in this study. I recoded the experiments in reverse order to check for any coding errors that I might have missed; this extra step is significant because evidence suggests that coding each experiment twice and resolving discrepancies through examination increases the reliability of data (Cooper, 2010; Rosenthal, 1978).

Data Analysis

Combining the results of my experiments included several steps: assessing the presence of, and if necessary mitigating the influence of, outliers, calculating effect-sizes, and summarizing the effects of CL on SRL with a random effects model**.** Before conducting main effects analysis, I visually and statistically examined the distributions of effect sizes and sample sizes to identify potential outliers (i.e., extreme data points). This was significant because sample-size outliers can have an outsized influence on regression coefficients that indicate the relationship between moderator and outcome variables such as prior achievement and the relationship between CL and SRL. This was also an important step because sample-size outliers can reduce standard error values that increase the weights assigned to effect-size estimates. Thus, sample size outliers clearly influence the magnitude of and variance associated with effect-size estimates that researchers use to interpret study results (Borenstein et al., 2009). Huffcutt and Arthur (1995) also indicated that effect-size outliers can have dramatic effects on the estimate of the relationship between variables in a meta-analysis and therefore it is clear that the inclusion of outliers may lead to invalid research conclusions.

I used the Grubbs (1950) test to identify and recalculate outlier values within my distribution of sample- and effect-sizes (Cooper, 2010). This procedure preserved the relative order of sample- and effect-sizes. Outlier testing identified, for example, that sample sizes for Hoek (1997) and Hoek et al. (1999) needed to be reset to the next largest sample size in the distribution, which was determined to be 105. Using the Grubbs test was also necessary because subsequent tests for publication bias assume normal disributions of sample data.

To perform main effects analysis, I calculated the average effect of collaborative learning methods on SRL outcomes for my sample. I used a weighted average procedure in the CMA software. These calculations provided the average standardized mean-difference effect sizes for my SRL outcomes. Some researchers adjusted intervention outcomes to take into consideration pretest differences between students; however, this was an infrequent occurrence and concerned less than 5 percent of my sample.

I calculated standardized effect sizes by dividing the difference between the intervention- and control-group means by the pooled standard deviation of the two groups (Borenstein et al., 2009). In order to increase the precision of the main effects estimates I calculated weighted averaged effect sizes (Borenstein et al., 2009). Because effect sizes are based on different samples of differing sizes, I adjusted, by a weighted factor (e.g., inverse variance), every effect size in order to avoid situations in which smaller and less precise samples with greater sampling error contributed as much to the mean effect size as larger samples did (Borenstein, Hedges, Higgins, & Rothstein, 2009). I calculated the mean effect size by weighting each sample-effect size by the inverse of its variance and this means that the relative size of the sample would be reflected in the mean effect size.

Within the current study, I only computed effect sizes for experiments that compared collaborative and individual methods of instruction. Because this meta-analysis did not include experiments that compared more than one intervention group with a control group, it was not required to collapse the data from different intervention groups to yield a combined mean and standard deviation. As a result, it was not necessary to compute an effect size for a control group versus a merged intervention group (Borenstein et al., 2009). These circumstances helped ensure statistical independence of the data within this meta-analysis.

Testing distributional assumptions. Larger experiments are more likely to produce statistically significant results for a given effect size; moreover, the editors of peer-reviewed journals are more likely to publish research reports of this type (Borenstein et al., 2009). Publication bias is the tendency of peer-reviewed journal staff to publish articles with effect sizes that are relatively larger than effect sizes produced by all conducted experiments (Cooper, 2010; Lipsey & Wilson, 2001). Therefore, it is possible that meta-analytic reviews drawing from publicly available work could report intervention effects that are not representative of the full universe of public and non-public data (Borenstein et al., 2009).

I addressed this problem in the current study by including unpublished dissertations; however, even with the inclusion of these experiments, there was still a possibility of publication bias. As a result, I also used several analytical procedures to assess the possibility of publication bias in my sample. First, I constructed two funnel plots, using CMA software: one that shows the relationship between effect size and standard error and another that shows the relationship between effect size and precision that is the inverse of standard error. In these diagrams, the vertical axis is either standard error or precision and the horizontal axis measures the treatment effects. Both funnel plots can be used to assess symmetry and it is a personal preference concerning which to use to detect asymmetry among experiments (Sterne & Egger, 2001; Terrin, Schmid, & Lau, 2005). Next, I visually inspected this plots to determine the possibility of publication bias. I expected larger experiments to demonstrate intervention estimates near the mean and that smaller experiments would produce a wider range of intervention estimates. The smaller experiments did not tend to cluster in one area of the plot; this suggested that that few or no experiments with negative or null results would be needed to produce a symmetrical distribution (Borenstein et al., 2009).

Because I needed to confirm that a number of experiments with negative or null results would not be needed to produce a symmetrical distribution, I used the trim and fill method included in CMA software to determine if I needed to adjust the observed effects for possible asymmetry due to publication bias (Duvall, 2005). Using this method, a researcher trims off the asymmetric outlying part of the funnel curve after estimating how many experiments are in the asymmetric part. Next, the researcher uses the remaining experiments to estimate the true center that is typically to the left of its previous value because the presence of publication bias tends to produce funnel plots that include small experiments with larger than average means and these types of experiments are usually trimmed from the distribution (Rothstein, Sutton, & Borenstein, 2005). In the last step of this method, a researcher replaces the trimmed experiments (e.g., adds imputed effect sizes to the distribution) and their missing counterparts around the center to produce a final estimate of the true mean and its variance based on the new funnel plot. I also used regression intercept tests (e.g., calculations to determine the relationship between effect-size and standard error) and rank correlation tests (e.g., calculations to determine the relationship between sampling variance and effect-size) to provide an empirical basis for interpreting my funnel plot results (Sterne & Edgar, 2005).

Random effects models. Because the current study reviewed a number of experiments conducted by researchers operating independently, it is unlikely that all of the experiments are functionally equivalent or equally efficacious (Borenstein et al., 2009). I took into account such differences by applying a random effects model that allowed a variance in both the estimated and the true effect between the individual experiments (Cooper, 2010). Unless only minimal between-experiment variation is found, researchers have demonstrated that random-effects models outperform fixed-effects models due to substantial differences in standard error estimation that influence effect-size calculations (Brockwell & Gordon, 2001). Therefore, fixed-effects models have a tendency to produce higher Type 1 error rates if effect sizes are heterogeneous (Higgins & Thompson, 2004).

I calculated the standard error and inverse variance weights for an effect size statistic using these formulas: $SE = \sqrt{v_i + v_\Theta}$ where v_i represents the within-experiments sampling variance component for each experiment and v_Θ represents the between-experiments variance component (i.e., a constant). I calculated v_i the standard error for standardized mean difference (SMD) effect sizes as follows: $SE_{SMD} = \sqrt{\frac{n_t+n_c}{n_t n_c} + \frac{ES_{smd}^2}{2(n_t n_c)}}$ where n_t and n_c are the sample sizes for the treatment and control groups (Borenstein et al., 2009). I calculated v_Θ using CMA software.

Heterogeneity. To determine if my sample intervention effects varied across experiments I conducted a test of homogeneity of effect size estimates. This test helped me determine whether my sample had more variability across effect sizes than expected from sampling error. As described by Lipsey and Wilson (2001), this test of homogeneity was conducted using the *Q-statistic* that I calculated as follows: $Q = \sum_{i=1}^{k} w_i \, (ES_i - \overline{ES})^2$ where w_i is the inverse variance weight for the ith effect size; ES_i is the ith effect size; i = study number; and $\overline{ES}$ is the weighted mean of *k* effect sizes. A mean ES with a Q-statistic that exceeds the critical chi-square value (with *df* = k - 1) is assumed to be heterogeneous across experiments.

In addition to the Q-statistic, I calculated an I^2 value for my meta-analysis; I^2 is itself a function of Q. This statistic estimates the percentage of total observed variance, between and within experiments, that is attributable to between-experiment differences. A large I^2 value indicates the need for moderator analyses to explain these between-experiment differences (Borenstein et al., 2009). I calculated I^2 by means of the following equation: $I^2 = \frac{x^2 - df}{x^2} \times 100$. In this equation, X^2 is the chi-squared heterogeneity statistic and *df* is the degrees of freedom (e.g., number of experiments in the current sample).

Analyzing moderator effects. I did not group any of my moderating variables into clusters to examine their collective influences on the relationship between CL and SRL. One might take this step, for instance, when examining how several personal, behavioral, or environmental factors moderated the relationship between CL and SRL. In this manner, a researcher could investigate how gender, age, and prior achievement moderated the relationship between CL and SRL; however, this level of analysis was not necessary based upon the requirements of my research questions. To analyze the impact of experiment characteristics on the variability of the effect-size distributions, I performed an analysis of variance for categorical variables using the moderating variables as independent variables.

When I determined that statistically significant differences existed between methods of CL, I performed post hoc comparisons to identify the differences between means amongst the various intervention groups. In particular I calculated $t = (\frac{X-Y}{SE})$ where X and Y are the means for two intervention groups and SE is the standard error of the difference of the two means that was computed with the formula $\sqrt{\frac{2\sigma^2}{n}}$ (Howell, 2010).

I also performed meta-analytic regressions for continuous variables, using the moderating variables as independent variables. Meta-regression is an exploratory method for examining the influences of one or more environmental, personal, or behavioral covariates on the SRL outcomes. In many primary experiments, researchers use the *z*-test to assess the statistical significance of a single variable. In this meta-analysis, I used the *Q*-test to assess the impact of a single covariate (Borenstein et al., 2009). Therefore, the value of *Q* statistic represents the dispersion explained by the relevant covariate.

During moderator analysis I also calculated R^2 that is the proportion of variance explained by a moderator variable. R^2 is based on the explained variance as a proportion of the original variance. Hence, $R^2 = \sigma^2_{explained/\sigma 2_{total}}$. I performed this calculation for each potential moderator variable.

Summary

To answer my research questions, I first performed a search for literature concerning CL and SRL. This search helped me identify mechanisms that students use to acquire SRL skills and knowledge during CL. The search also identified several experiments that I could use in my meta-analysis. Next, was a systematic review of theoretical and empirical evidence and is a replicable and explicit method to identity, select, and analyze relevant experiments (Cooper, 2010). Next, I used the quantitative results of the literature search and systematic review to perform a meta-analysis and interpret the results of my sample (e.g., individual experiments) based upon the magnitude of effect size (Cooper, 2010) and other factors described above. I used the results of the meta-analysis to answer my research questions. This approach allowed me to describe relationships between CL methods and the acquisition of self-regulatory skill in terms of moderating variables such as student age, use of technology, and academic domain, and to discuss implications for future research and instructional practice.

Research Questions and Expected Outcome(s)

1. What is the overall relationship (e.g., main effect) between CL and SRL?
    a. I expected a positive relationship between all CL methods and SRL
        i. I answered this research question as part of my main effect meta-

analysis and based my expectations upon research discussed in my literature review.

2. How does the relationship between CL and SRL vary according to theoretical moderators?
    a. I expected prior achievement to have a positive influence on the relationship between CL and SRL
    b. I expected females to demonstrate a stronger relationship between CL and SRL than males.
    c. I expected racial classification to moderate the relationship between CL and SRL.
    d. I expected SES to have a positive influence on the relationship between CL and SRL.
    e. I expected the relationship between CL and SRL to increase as students grow older.
    f. I expected PBL and IL to demonstrate the strongest relationship with SRL. I also expected that RT methods of instruction would have a weaker association with SRL than either PBL or IL
    g. I did not expect the year of publication to moderate the relationship between CL and SRL.
        i. I expected the relationship between CL and SRL to be stronger in math and science courses than other subjects. I answered this research question, including all of its subparts, through my moderator analysis and based by expectations upon research discussed in my literature

review.

3. How does the relationship between CL and SRL vary according to methodological moderators?
    a. I anticipated that offline SRL measures would demonstrate a stronger relationship between CL and SRL than online measures would.
    b. I anticipated that study classification would moderate the relationship between CL and SRL. In particular, peer-reviewed, published experiments would demonstrate a stronger relationship between CL and SRL than unpublished experiments would.
    c. I did not expect fidelity of implementation to moderate the relationship between CL and SRL.
        i. I answered this research question, including all of its subparts, through my moderator analysis and based my expectations upon research discussed in my literature review.

CHAPTER 4

RESULTS

In this chapter I present results including descriptive statistics along with analyses for heterogeneity, main effects, and moderators that are relevant to the three main hypotheses. I also address publication bias and how this factor influenced the results of the current study. The standardized mean difference effect sizes for each experiment are presented along with visual depictions of these estimates in the forest plots that are in Appendix B.

Descriptive Analyses of the Experiments

I examined the full texts of 111 articles for experiments to include in this meta-analysis. Of these, 64 were excluded for the following reasons: 18 included non-adolescent samples or the age of participants was unclear; 20 did not include a control group; 10 did not provide sufficient or clear statistics from which to calculate effect sizes; six did not qualify as CL interventions, and 10 included students with learning disabilities. After these exclusions, 47 individual articles remained. Because several of these articles included multiple experiments with independent samples, I ultimately found 63 experiments in which a SRL intervention group was compared to a control group that used non-CL methods of instruction. Fifty-seven of the experiments that met my criteria for inclusion used a sampling scheme based on convenience (Teddlie & Yu, 2007), meaning that investigators usually recruited participants based on their availability and willingness to participate. Brady (1990) used stratified random sampling to assign students to each of her 3 experimental conditions while

Hogan et al. (2000), Collen (2011) and Sancilio (1992) used purposeful sampling to carefully select students with diverse backgrounds, without low SES, and below average reading skill, respectively. 4,107 participants were involved in the experiments included in this meta-analysis. Sample sizes ranged from very small (10) to large (200); the median sample size was 65. I used CMA and Excel (Microsoft, 2007) software to conduct all statistical analyses. Table 3 contains a summary of the sample characteristics. All of the experiments in this meta-analysis provided information about age, gender, subject domain, experiment classification, type of collaborative intervention, publication year, and type of SRL measure. There were a limited number of experiments concerning computer and physical education content, online measures of SRL, and inquiry learning and collaborative methods of learning designated as modeling. Results concerning these moderators should be interpreted with caution because of their low statistical power. It should be noted that 19 experiments used interventions based upon instructional theories that did not readily conform to categories (e.g., PBL) initially defined within the current study. These experiments were coded as peer-assisted learning and included because they did incorporate collaborative methods of instruction such as observational learning or information sharing amongst peers.

Table 3

Summary of Sample Characteristics

Variables	*Number of experiments with data on variable*	*Percentage of 63 total experiments*
Prior achievement	23	36.51
Gender	63	100.00
Race/culture	31	49.21
Socio-economic status	29	46.03
Age of student	59	93.65

Collaborative method		
Cooperative	16	25.40
Inquiry	6	9.52
Modeling	4	6.35
Peer assisted	19	30.16
Problem based learning	9	14.29
Reciprocal teaching	9	14.29
Subject domain		
Computer/technology	5	7.94
Language arts	18	28.57
Math	20	31.75
Physical education	5	7.94
Science	15	23.81
Type of SRL measure		
Offline	60	95.24
Online	3	4.76
Study classification		
Dissertation	16	25.40
Peer reviewed journal	47	74.60
Fidelity of implementation		
Yes	6	9.53
No	57	90.47

Concerning methodological moderators, some researchers whose experiments are in this meta-analysis used discourse analysis, think-aloud protocols or computer data files to capture SRL data online. Other researchers used surveys, such as the MSLQ, and/or assessments, such as tests to assess knowledge of reading comprehension strategies, to capture SRL data offline. No experiment used both online and offline measures to determine how collaborative learning might foster SRL. Doctoral students produced all unpublished experiments. Effect size data were not readily available within most of the experiments in this meta-analysis. When this occurred I used descriptive data (e.g., sample size, mean, standard deviation) to compute the necessary effect sizes.

Sample Distribution and Outliers

Prior to performing any effect size computations, data checks for errors and outliers were performed (Borenstein et al., 2009; Tukey, 1977). If coding or data entry errors were identified, I corrected the necessary information, for instance, according to article information or revised effect-size computations. Because publication bias tests assume normality, the Grubbs (1950) test was used to identify outliers in my distributions of sample- and effect-sizes. When I detected an outlier, I reset its value to the next closest value in the distribution (Cooper, 2010). I repeated this process until outlier testing no longer identified an outlier. Table 4 summarizes the results of this process.

Table 4

Summary of Outlier Processing

Study Name	Year	Original Sample or Effect Size Value	Final Sample or Effect Size Value
Hoek +	1997	200	105
Hoek et al.+	1999	200	105
Kramarski & Mizrachi1*	2003	2.58	2.14
Ocasio*	2006	-2.55	-0.52
Schunk & Swartz 1*	1993	1.72	1.69
Schunk & Swartz 2*	1993	2.20	2.11

Note: Experiments with a + indicate samples sizes that were modified by Grubbs test.

Experiments with an * indicate effect sizes that were modified by Grubbs test.

Assessing the Risk of Publication Bias

Several analyses were used to assess the likelihood that intervention effects obtained during this meta-analysis were overstated due to publication bias. It was unclear whether the funnel plot depicted in Figure 2 was symmetrical around the intervention mean and this indicated the need to assess the presence of publication bias. The trim and fill method adjusts the distribution of effect-sizes within a meta-analysis to counter the effect of potentially missing studies (Rothstein et al, 2005). The results of the trim and fill procedure in Table 4 indicated that no additional effect sizes were needed to improve the symmetry of the plot based upon a random effects model; the sensitivity analysis for the impact of potentially missing experiments was statistically non-significant. Rank-correlation and regression intercept analyses provided similar evidence of funnel plot symmetry. These highly sensitive statistical tests can indicate bias when it is not evident using trim and fill procedures (Rothstein et al, 2005). The rank correlations between intervention effect size and sampling variance were statistically non-significant, which is evidence against the presence of publication bias. A statistically significant relationship was not obtained when effect size was regressed on experiment precision ($\frac{1}{s.e.}$) and consequently this does not indicate asymmetry consistent with publication bias. In sum, all tests to detect the presence of publication bias were negative. Therefore within this meta-analysis, sampling error was most likely random, and experiment effect-sizes were distributed symmetrically about the main-effect estimate represented by the diamond-shaped symbol that is displayed in Figures 2 and 3.

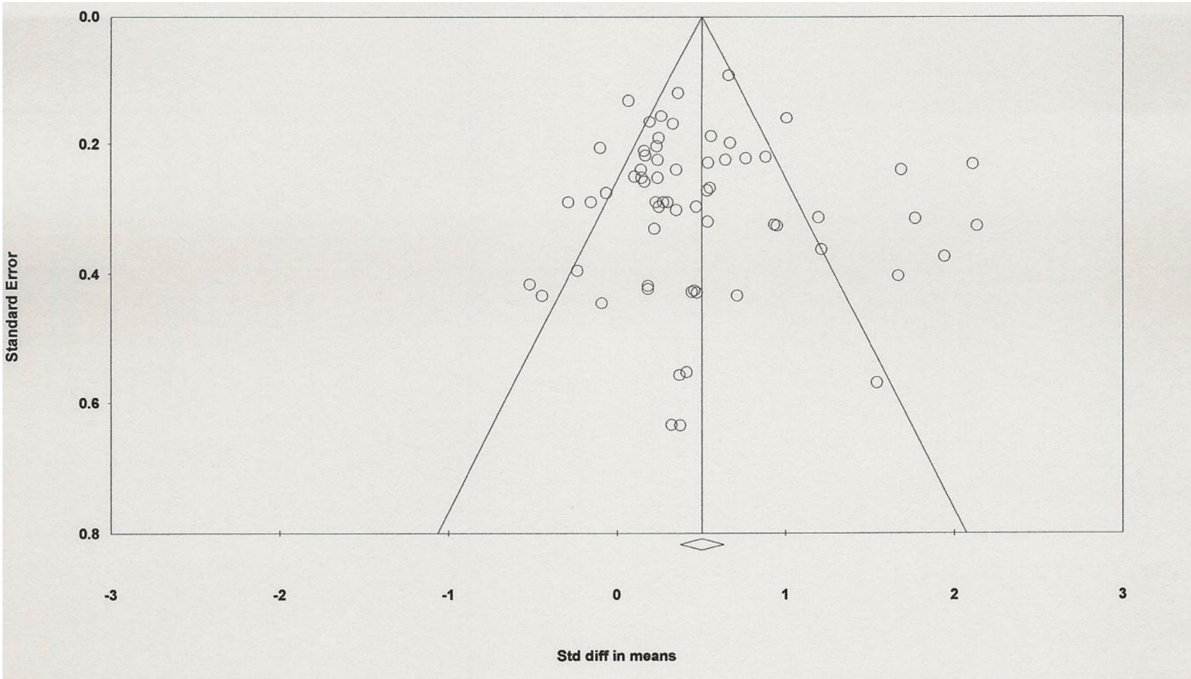


Figure 2. Funnel plot of SRL outcomes

Table 5

Summary of Analysis to Assess the Risk of Publication Bias

	Rank correlation		*Regression intercept*			*Trim-and-fill method*	
Outcome	*Tau*	*p*-value (2-tailed)	Intercept (SE)	95% Confidence Interval	*p*-value (2-tailed)	Number of trimmed experiments	Adjusted point estimate
SRL or self-regulated learning process	0.11	0.19	0.31	-1.01 – 1.62	0.64	0	– –

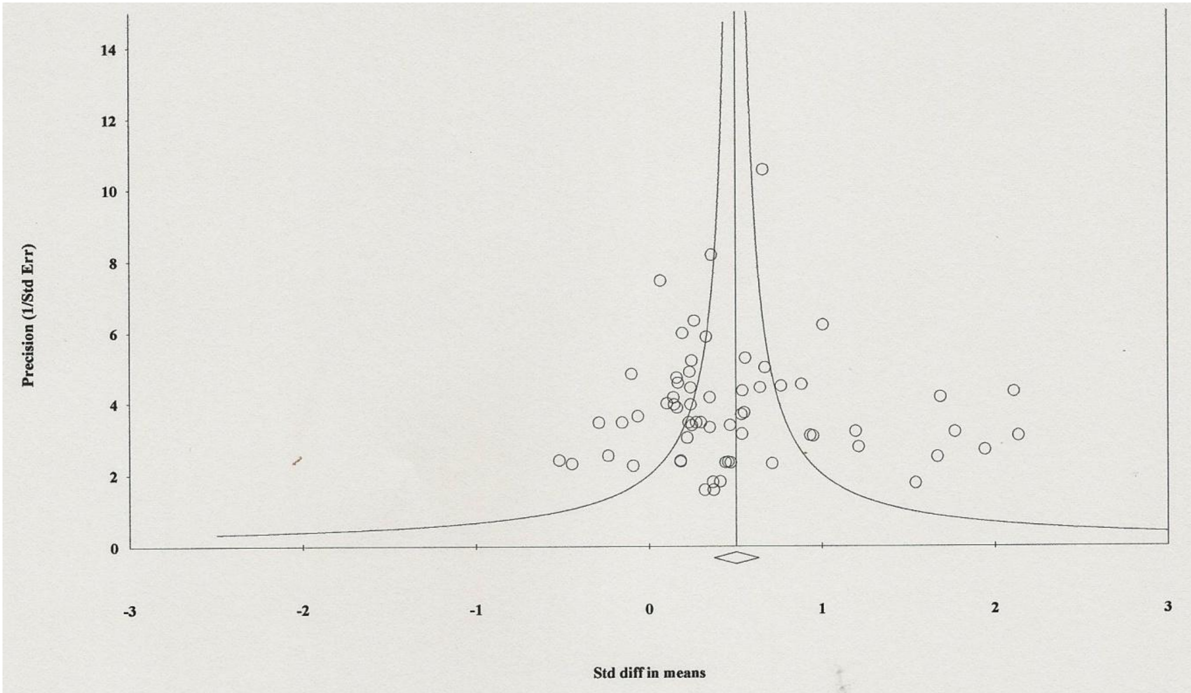


Figure 3. Funnel plot of precision

Research Questions and Hypotheses Tested

Hypothesis 1. The first hypothesis was that a positive relationship exists between CL and SRL. In order to test this hypothesis, I calculated 63 effect-size estimates. From these, the overall random effects weighted average effect size estimate was .50 [z = 7.64, $p < .01$; *SE* = 0.07; 95% CI = 0.38, 0.63)]. According to Cohen's (1988) guidelines for quantifying mean-difference effect sizes [i.e., small (0.20), medium (0.50), and large (0.80)], the weighted average effect size estimate was medium, and indicated a positive and statistically significant relationship between CL and SRL, supporting Hypothesis 1.

I evaluated whether there was statistically significant heterogeneity in two ways. First, I used the chi-square (Q) statistic to test the hypothesis that 100% of the heterogeneity was due solely to sampling error (Rothstein et al., 2009). Q is a value that indicates the level of dispersion of all effect sizes around the mean effect size which is calculated using Q = (

$\frac{X-Y}{SE_X})^2$ where X is the observed effect size, Y is the predicted effect size and SE_X is the standard error of the effect sizes (Borenstein, Hedges, Higgins, & Rothstein, 2014). It is important to note that the predicted effect size is the mean effect size of all experiments when determining the overall relationship between CL and SRL.

The Q value for the overall relationship between CL and SRL was statistically significant, $Q(62) = 255.05$, $p < .001$) and its value indicates that the heterogeneity was higher than what would be anticipated strictly from sampling error. The I^2 value indicated that 75.69% of the total variance was due to between-experiment variance and not to sampling error alone. Because these statistics suggested that moderators might be used to explain some of the between-experiment variance, moderator analysis was warranted to determine how behavioral, personal, and environmental influences might moderate the relationship between CL and SRL.

Hypothesis 2. The second hypothesis concerned how the relationship between CL and SRL varied according to theoretical moderators (i.e., prior achievement, gender, race, social-economic status, student age, collaborative instruction method, and subject domain). Because prior achievement elevates self-efficacy beliefs that are crucial to SRL skills and knowledge (Zimmerman, 2001), I predicted that prior achievement would have a positive influence on the relationship between CL and SRL. Twenty-three experiments included prior achievement data, which I coded as a continuous variable; I used meta-regression to assess whether this variable was a potential predictor of SRL. The z value was statistically non-significant, [$z = -1.09$, $p = .27$] and indicated that the meta-regression coefficient for prior achievement was not helpful in explaining variance in the effect sizes of the relationship between CL and SRL. The *Q* test of the model was also statistically non-significant, *Q* = 1.19, and this moderator was not helpful in explaining a portion of the between-experiments variation as noted by its near zero R^2 value of .01. Table 6 contains a summary of how prior achievement, a personal influence, along with other continuous moderators influenced the relationship between CL and SRL.

I expected females to demonstrate a stronger relationship than males between CL and SRL because of the results of my literature review (e.g., Pajares, 2002) that indicated females frequently outperform males on a number of SRL measures. I coded gender as a continuous variable that represented the percentage of males within a particular sample and used meta-regression to determine if this variable was a potential predictor of the relationship between CL and SRL. The *z* value was statistically non-significant, [z = -1.17, p = .24] and indicated that the meta-regression coefficient for gender was not helpful in predicting the relationship between CL and SRL and this moderator was not helpful in explaining a portion of the between-experiments variation as noted by its near zero R^2 value of .01.These results did not confirm my expectations.

Table 6

Summary of Continuous Variables

Variable						Heterogeneity	
	Point estimate	Standard error	Lower limit	Upper limit	*z*	R^2	*Q*
Prior achievement	-0.01	0.01	-0.03	0.01	-1.09	0.01	1.19
Gender	-0.88	0.75	-2.35	0.60	-1.17	0.01	1.36
Race	-0.16	0.38	-0.90	0.59	-0.41	0.00	0.17

Socio economic status	-0.10	0.31	-0.72	0.51	-0.32	0.00	0.10
Publication year	-0.01	0.01	-0.03	0.01	-1.50	0.00	2.24
Age	0.02	0.03	-0.05	0.08	0.43	0.00	0.19

Note: *z* test of point estimate; *Q* test of model and R^2 indicates proportion of total between study variance explained by model.

I expected that the racial classification of students would moderate the relationship between CL and SRL. This was hypothesized because of the differential influences of culture and nationality between racial groups of students (Neber & Keller, 2002; Salili et al., 2001). Race was coded as a continuous variable that represented the percentage of students who were identified with the majority race of the respective experiments. Meta-regression was conducted to assess this variable as a potential moderator of the relationship between CL and SRL. The results based upon 31 experiments were found to be statistically non-significant, $z = -0.41$, $p = .68$ and indicated that the meta-regression coefficient for race was not helpful in predicting the variance in the relationship between CL and SRL, as noted by its zero R^2 value. These findings did not support my hypothesis concerning this moderator.

The results of my literature review suggested that high social-economic status (SES) has a stronger relationship with SRL than low economic status (Orr, 2003; Pino-Pasternak & Whitbread, 2010). Accordingly, I expected social-economic status to moderate the relationship between CL and SRL such that higher SES would be associated with larger effect sizes. Using the percentage of students receiving free or reduced-price lunch as a proxy for SES, I coded this variable as a continuous moderator and used meta-regression to assess if this variable was a potential predictor of the relationship between CL and SRL. The results, based upon data from 25 experiments, were found to be statistically non-significant, and indicated that the meta-regression coefficient for SES was not helpful in predicting the relationship between CL and SRL. This moderator was not helpful in explaining the between-experiments variation as noted by its zero R^2 value. These findings did not support my hypothesis concerning this moderator.

I anticipated that the relationship between CL and SRL would increase as students matured, because evidence has shown that older students possess more cognitive capacity to process information than younger students do (Wigfield et al., 2011; Zimmerman, 2002b). I initially decided to code the variable as a continuous variable; however, results using age as a continuous variable were statistically non-significant. These results are displayed in Table 6. Afterwards, I coded age as a categorical variable with two categories, one category for ages 10 – 13 and another category for ages 14 – 17 because they pertain to middle and high school students, students that researchers often discuss in the literature (Anderman & Patrick, 2012). The results indicated that there was not a statistically significant difference [$Q(1) = .827$; $p = .36$] between the effect-sizes estimates of older and younger students; thus age as a continuous or categorical moderator was not statistically significant. The associated R^2 value of .01 was not helpful in explaining between-experiment variance and these findings did not support my assumptions.

Next I investigated whether the other categorical variables moderated the main effect of CL and SRL (see Table 7). First, I examined the influence of collaborative instructional methods, an environmental influence, on the relationship between CL and SRL. I made two predictions. First, I expected PBL and IL to demonstrate the strongest influence on the relationship between CL and SRL. Second, I expected that RT or cooperative methods of instruction would have weaker associations with SRL than either PBL or IL. I made these assumptions because during RT and cooperative learning, students often rely upon teachers for observational learning (Slavin, 2011), whereas Schunk and Zimmerman (1996, 2007) indicated that peers are better sources for observational learning. The latter is the reason I presumed that PBL and IL interventions would demonstrate the strongest influence on the relationship between CL and SRL.

Several collaborative learning methods, for example cooperative learning [z_{coop} = 4.72, ($p < 0.01$)] demonstrated statistically significant results. More importantly, the results from 63 experiments indicated that there was a statistically significant difference [$Q(5)$ =14.09; p=.02] between the effect-size estimates for various methods of collaborative learning; consequently collaborative learning methods was a statistically significant moderator. The associated R^2 value indicated that this variable was helpful in explaining a small portion, seven percent, of between-experiment variance. RT experiments did not produce a statistically significance mean effect size estimate. This was not a surprise because RT methods, as outlined in chapter 2, often emphasize external sources of regulation, and therefore do not foster the highest levels of SRL skill and knowledge. Table 7 contains a summary of how collaborative learning methods (i.e., an environmental influence) moderated the relationship between CL and SRL.

Table 7

Summary of Categorical Variables

Subgroup	Effect size and 95% confidence interval						Heterogeneity	
	Studies	Point estimate	Standard error	Lower limit	Upper limit	*z*	R^2	*Q*
Age							0.01	0.83
Early	46	0.47	0.08	0.31	0.63	5.95**		
Late	17	0.60	0.12	0.36	0.83	4.93**		
Type of method							0.07	14.09*
Coop	16	0.55	0.13	0.23	0.81	4.27**		
Inq	6	0.64	0.20	0.25	1.03	3.19**		
Modeling	4	1.34	0.26	0.84	1.84	5.25**		
PA	19	0.40	0.11	0.18	0.62	3.60**		
PBL	9	0.34	0.17	0.01	0.67	2.02*		
RT	9	0.31	0.19	-0.07	0.68	1.60		
Subject domain							0.01	7.36
Com	5	0.25	0.23	-0.20	0.69	1.09		
LA	18	0.71	0.12	0.47	0.96	5.72**		
Math	20	0.38	0.12	0.15	0.62	3.29**		
PE	5	0.23	0.22	-0.21	0.66	1.03		
Sci	15	0.61	0.14	0.35	0.88	4.53**		
SRL measure							0.00	0.11
Offline	60	0.50	0.07	0.36	0.63	7.25**		
Online	3	0.60	0.28	0.05	1.14	2.15*		
Experiment classification							0.07	3.72**
Dissertation	16	0.29	0.13	0.04	0.54	2.27*		
Peer review	47	0.72	0.09	0.55	0.89	7.74**		

Note: * indicates *p*=<.05; ** indicates *p*= < .01; *z* test of point estimate; *Q* test determines if there is a statistically significant difference between members within a subgroup.

I performed post hoc comparisons because I was interested in the difference between mean effect sizes from amongst the various intervention method. Table 8 contains the aforementioned calculations and indicates that various collaborative instructional methods had differential effects on the relationship between CL and SRL skills and knowledge. This is evident because most of the pairwise comparisons demonstrated statistically significant results.

Table 8

Summary of Pairwise Comparisons

Groups compared	*t* test *p*
Cooperative – Inquiry	0.24
Cooperative – Modeling*	< .01
Cooperative* – PA	< .01
Cooperative* – PBL	< .01
Cooperative* – RT	< .01
Inquiry - Modeling*	< .01
Inquiry* – PA	< .01
Inquiry* – PBL	< .01
Inquiry* – RT	< .01
Modeling* – PA	< .01
Modeling* – PBL	< .01
Modeling* – RT	< .01
PA – PBL	0.24
PA – RT	0.12
PBL– RT	0.72

Note: * indicates subgroup with larger effect size.

Overall, the findings for this moderator variable did confirm some of my predictions. Experiments using cooperative interventions had higher mean effect-size estimates than experiments using PBL or PA interventions that included varied types of CL instructional methods. Experiments that demonstrated the highest impact on the relationship between CL and SRL used learning methods that closely aligned with those developed by Zimmerman (2001) and his associates and were coded as modeling. Such experiments incorporated observational learning that ultimately lead to the development of multiple levels of SRL skills and knowledge.

The final theoretical moderator evaluated in the current study was subject domain. I hypothesized that the relationship between CL and SRL would be relatively stronger in math and science courses than in other subjects. I made this prediction because many instances of

CL require students to solve math- or science-based problems (Webb & Mastergeorge, 2003) that encourage the use of learning strategies and metacognition (Byrnes, 2009a; Sinatra & Taasoobshirazi, 2011). Moreover, during math and science courses students frequently use PBL that fosters SRL (Zimmerman & Lebeau, 2000).

Concerning subject area, the results from 63 experiments indicated that there was not a statistically significant difference [$Q(4) = 7.36$; $p = .12$] between the effect-size estimates for various subject domains and as a result, subject domain as a moderator was not statistically significant. The R^2 value for this subgroup was not useful in explaining between-experiment variance. These results did not support my assumptions.

Summary. Collaborative learning method was the only theoretical moderator associated with hypothesis two that demonstrated a positive and statistically significant mean effect size estimate. Most of the effect-size estimates within that subgroup were in the small to moderate range; however, collaborative interventions that emphasized observational learning and self-motivational beliefs, among other constructs described in Zimmerman's theory of SRL, demonstrated large effect size estimates. It is also important to note that many of my hypotheses were not upheld by the findings for hypothesis two.

Hypothesis 3. The third hypothesis concerned how the relationship between CL and SRL varied according to methodological moderators: SRL measurement type (i.e., offline or online) and experiment classification (i.e., peer reviewed, non-peer-reviewed, or unpublished). I hypothesized that experiments that used offline measures of SRL, such as the LASSI or MSLQ, would demonstrate higher mean effect sizes than experiments that used online measures of SRL, such as think-aloud protocols. I made this assumption because offline methods of data collection are typically used to capture stable characteristics of SRL

(Zimmerman & Moylan, 2009; Winne, 2010) that I presumed would best represent SRL characteristics demonstrated by students.

The results from experiments indicated that there was not a statistically significant difference [$Q(1) = .827$; $p=0.36$] between the effect-size estimates that were recorded for online and offline experiments; thus SRL measurement as a moderator was not statistically significant. The associated R^2 value of zero was not helpful in explaining between-experiment variance. Moreover, the results for online experiments must be interpreted with caution because of low statistical power.

Concerning experiment classification, I did not retrieve any experiments from unpublished sources such as conference proceedings, although that particular source was originally identified as a publication type that might contain significant information about the relationship between CL and SRL. I hypothesized that experiments that were published in peer-reviewed journals would demonstrate the highest mean-effect sizes concerning the relationship between CL and SRL. I made this assumption because published experiments tend to have higher effect sizes, due to editorial guidelines for academic journals as well as other reasons. The findings of this study support these assumptions for two reasons. First, the results from 63 experiments indicated that experiments of both publication subgroups were statistically significant [$z_{dissertation} = 7.28$, $p \leq 0.01$; $z_{peerreview} = 2.13$, $p = 0.03$] and there was a statistically significant difference [$Q(1) = 3.722$; $p=0.05$] between the effect-sizes estimates demonstrated amongst the two publication types.

Second, mean effect-size estimates of published experiments were nearly 2 times larger than those calculated from unpublished experiments which, in all cases, were produced by PhD students as part of their dissertation requirements. These results are in line with the expectation that the effects reported in published experiments are generally larger than those reported in unpublished experiments (Lipsey & Wilson, 2001). Like collaborative learning method, the associated R^2 value for experiment classification was helpful in explaining a small amount, seven percent, of between-experiment variance.

The researchers of six experiments in the current study used FOI techniques, with various levels of rigor, to improve student outcomes. Sporer and Brunstein (2006) observed and videotaped teachers who performed their CL intervention. Such teachers also completed questionnaires and protocols that research assistants checked for intervention adherence. Sungur and Tekkaya (2006) trained one teacher to perform their CL intervention and after teacher training was complete, they performed classroom observations to assess FOI adherence. They also held subsequent meetings with the teacher to ensure that she was conducting the intervention appropriately and contacted the teacher several times a week to address fidelity to process or fidelity to structure difficulties that occurred.

Collen's (2011) two experiments indicated the most comprehensive use of FOI because it incorporated several fidelity to process and fidelity to structure techniques that closely aligned with the theory argued for in O'Donnell's (2006) work. The remaining two experiments did not use as many FOI techniques (e.g., one element of FOI). Specifically, Johnson-Glenberg (2000) and King (1998) only incorporated one element of fidelity to structure each, which were teachers' use of instructional protocol booklets to enhance treatments and visual assessment of student engagement with intervention treatments, respectively.

It is important to note that the experiments of the researchers who incorporated FOI demonstrated an average effect size that was virtually identical, 0.49 versus 0.51, with the 57 experiments of researchers who did not incorporate FOI measures. The associated *Q* test value, 0.01, for heterogeneity was statistically non-significant, p = 0.95 and this indicated that studies that included FOI were not associated with increased acquisition of SRL skills or knowledge. Table 9 summarizes the effect sizes of experiments that included FOI processes.

Table 9
Experiments That Included Fidelity of Implementation

Study Name	Year	Effect size
Collen 1	2011	0.18
Collen 2	2011	0.44
Johnson-Glenberg	2000	0.71
King	1998	0.55
Sporer & Brunstein	2009	0.33
Sungur & Tekkaya	2006	0.66

Results Summary

The results of the experiments in the present study indicate that CL has a positive relationship with SRL. The effect-size estimates indicated that environmental factors (e.g., instructional methods) contributed to the positive relationship between CL and SRL. Interventions that incorporated modeling demonstrated the largest mean effect-sizes. Experiment classification, a methodological moderator, was a statistically significant predictor of variance in the effect sizes. However, neither collaborative learning method nor experiment classification explained a large portion of between-experiment variation. The effect-size estimates of the individual experiments that contributed to those results are summarized in Appendix C. Appendix D contains the references for such experiments

It is also important to note that the results of the current study indicated that the relationship between CL and SRL was seemingly unaffected by gender, prior achievement, socio-economic status, or race, all of which are personal influences. Likewise, three environmental influences: reciprocal teaching, computer and physical education instruction, among other factors, did not explain a statistically significant amount of the variance in effect sizes concerning the relationship between CL and SRL. A summary of the main results of this study is provided in Appendix E.

CHAPTER 5

DISCUSSION

Researchers (Ashman & Conway, 2004; Collen; 2011; Kramarski & Gutman, 2006;Webb, 2013) have argued that students who are engaged in SRL or CL can overcome academic challenges. Yet, the relationship between CL and SRL has remained unclear. Using meta-analysis, I explored the relationship between CL and the SRL skills and knowledge that are required for academic success for adolescent students. Scholars have also desired additional knowledge about the relative strength of the relationships between various collaborative learning methods and the acquisition of SRL skills and knowledge. The extent to which the relationship between CL and SRL varies across adolescence and subject areas has also remained unclear. The current study used meta-analysis to investigate these gaps in the scholarly literature by determining how CL interventions in 63 experiments affected SRL processing, compared to non-CL conditions.

The majority of the 63 experiments came from peer-reviewed journals and used cooperative or peer-assisted learning methods in language arts, math, or science content domains. Values for prior achievement, race/culture, and SES, all of which were moderator variables, were unavailable in more than 50% of the sample. Although there was adequate statistical power to calculate effect sizes for my proposed moderator variables, a limited number of experiments concerned computer and physical education content, online measures of SRL, and inquiry learning and collaborative methods of learning designated as modeling. I have interpreted these results with caution because of their low statistical power. It is important to note that the experiments in this study primarily concerned middle school students who self-reported their SRL performance (i.e., nearly 80% of the students in this study were between the ages of 10 and 13 and more than 90% of the researchers used offline measures of SRL to analyze student performances).

Summary of Major Findings

The overall relationship between CL and SRL. The results of this meta-analysis indicated an overall weighted average effect size of 0.50. By comparison, Graham and Perin (2007) in their meta-analysis of writing instruction for adolescent students found that intervention experiments using self-regulated strategy development (SRSD), a method that features many social cognitive principles described by Zimmerman (2000), demonstrated a large mean effect size that was slightly greater than one. Dignath et al. (2008) and Hattie et al. (1996) also found positive and statistically significant relationships between instructional interventions and SRL skills and knowledge for students; the experiments in these two articles demonstrated mean effect sizes in the medium (.69) and small (.45) ranges. Although there is some variation among the research questions and methods among the four meta-analyses, they all provide evidence that collaborative instructional methods have a positive relationship with student SRL skills and knowledge.

Variation in the relationship between CL and SRL according to theoretical factors. I expected moderator analysis to indicate that females would outperform males in terms of the development of SRL skills because there is a long history of gender differences concerning SRL performance. The results of the current study do not corroborate the findings of previous research (i.e., Anderman & Young, 1994; Meece & Painter, 2008). It was also surprising that there was not a statistically significant difference between the effect size estimates for three pairs of CL methods: problem-based learning and peer-assisted group, problem-based learning and reciprocal teaching, and cooperative and inquiry learning. This may indicate that many of the instructional methods reported in this meta-analysis used similar learning strategies to help students develop SRL skills and knowledge. O'Donnell (2006) and Webb, Franke, De, Chan, Freund, Shein, and Melkonian (2009), among others, have noted this similarity and indicated that collaborative learning methods rely upon strong discourse and social skills for success; perhaps such skills have a role in the development of SRL for students. A clear resolution of this issue cannot be reached based upon the findings of this study, but Newman (2002) and Roschelle (1992) have both indicated that help-seeking and reaching consensus through iterative conversations fosters metacognition and strategy use that are essential to successful SRL.

Experiments that used RT interventions did not demonstrate a statistically significant relationship with SRL. These findings are quite different from the findings reported in Rosenshine and Meister's (1994) review of RT interventions. It is possible that an insufficient sample size contributed to the statistically non-significant results (Borenstein et al., 2009).

Although many of the collaborative experiments in the current study used a gradual fading of scaffolding, less than 20% of the experiments explicitly integrated Zimmerman's (2000) theory of how to help students acquire multiple levels of SRL skill and knowledge (e.g., Ashman & Conway, 2004; Kuo et al., 2012). Notably, the results of this study indicated that collaborative experiments that included steps to foster multiple levels of SRL skill and knowledge, as Zimmerman (2000) has described, were associated with some of the strongest relationships between CL and SRL skills and knowledge. Such interventions were coded modeling and were efficacious in several subject domains, including math, science, and language arts.

I found no evidence that prior achievement or socio-economic status affected the relationship between CL and SRL, nor was this lack of evidence expected given the prior findings by Bandura et al. (1996), Caprara et al. (2008), and Zimmerman and Schunk (2008) who all have suggested that SES and prior achievement both influence SRL. I also did not find evidence that race significantly affects the relationship between CL and SRL. I coded race as a continuous variable representing the percentage of the majority population in the sample. The results from this potential moderator might have been more informative if experiments had included data that would allow me to code specific racial information for each group in the sample.

Variation in the relationship between CL and SRL according to methodological factors. The strength of the relationship between CL and SRL was virtually the same for both online and offline measures of SRL. This finding suggests that in many cases, both online and offline measures methods of data collection are acceptable ways to gather information concerning student SRL activities during CL however this interpretation must be taken with caution because of the limited number of experiments with online measures of SRL. Finally, results indicating relatively large effect-size estimates for peer-reviewed experiments were expected because it is commonly accepted that peer-reviewed experiments demonstrate statistically significant findings and therefore relationships between constructs, more often that unpublished experiments will (Rothstein et al., 2005).

Finally, use of FOI procedures, did not seem to moderate the relationship between CL and SRL. Two factors may have contributed to these findings. First, only a small number of researchers used FOI processes and limited statistical power may have prevented the detection of possible relationships. Second, there is considerable debate concerning the definition of FOI and these circumstances may indicate that researchers were not measuring the same construct across the studies in this meta-analysis.

Limitations of the Findings

Even though rigorous systematic procedures (Cooper, 2010) were used to locate and screen eligible experiments, meta-analyses are vulnerable to bias because there is no way of ensuring that every eligible experiment has been included (Rothstein, Sutton, & Borenstein, 2005). Inadequate reporting practices (e.g., lack of sample or statistical information) in the CL and SRL literature made it difficult for me to include some experiments in this meta-analysis, even when they appeared to be high-quality work. A related limitation is that experiments of differing quality received equal weight even though I excluded experiments that did not meet the quality standards defined in chapter three. It is also important to note that the majority of the experiments in this study did not use FOI measures and one could argue that this circumstance potentially limits the validity of those studies' findings because there is uncertainty concerning what types of CL researchers actually used. Moreover, only a small number of researchers reported FOI processes therefore it is unclear if all collaborative interventions were implemented as originally planned and these circumstances may limit the validity of study findings.

While the results of this meta-analysis do synthesize effect sizes concerning interventions to promote SRL during CL, such interventions only partially explained the heterogeneity in the effect sizes, indicating that other factors may have influenced the relationship between CL and SRL. Social cognitive theory assumes reciprocal relationships between personal, behavioral, and environmental factors and the unexplained heterogeneity found within the current study may pertain to relationships between constructs that the current study did not tease apart. Even more, a statistically significant relationship between CL and SRL may reflect a casual role in SRL development; yet, this conclusion cannot be inferred from the current study. Instead, the synthesis of effect-size data in this meta-analysis provided insight into the overall relationship between CL and SRL along with how social cognitive factors moderate the relationship between CL and SRL.

The experiments in this meta-analysis did not include follow-up (e.g., 90 days after intervention) assessments. Nor did any of the experiments include longitudinal data on the relationship between CL and SRL. This means that an important limitation of the conclusions drawn from this meta-analysis is the lack of knowledge concerning the permanence of the relationships found; it is possible that the relationships identified in this study could fade over time.

Theoretical Implications and Future Research

Zimmerman (2002a) hypothesized that self-regulation is a cyclical process as depicted in Figure 1. Self-regulatory processes, such as planning to use a specific task strategy, and concomitant beliefs, such as self-efficacy beliefs, help make up three related phases of self-regulation: forethought, performance, and self-reflection. Many of the experiments within the current study examined the relationship between CL and one or more of the SRL skill levels defined by Zimmerman (2001). While some of the researchers may have used slightly different terminology to describe a particular SRL skill level, it is important to note that the findings of these experiments indicate a statistically significant, positive relationship between CL and SRL. Some of these experiments include, but are not limited to, Ashman and Conway (2004) and Kuo et al. (2012), who examined how CL is associated with the self-control and self-regulated levels of SRL skill, along with Couzijn and Rijlaarsdam (2005) and Uttero (1992) who examined how CL is associated with the observation and emulation levels of SRL skill.

The researchers of the experiments within the current study also examined most of the self-regulatory processes and self-motivational beliefs in Zimmerman's (2001) theories of SRL. Examples of these experiments include Sungur and Tekkaya (2006) and Dyer (1993) who investigated self-motivational beliefs that pertain to the forethought phase of SRL. Chapman (1997) investigated learning-strategy use, Johnson-Glenberg (2000) investigated imagery (i.e., a visual proxy, for instance of a concept or text passage intended to enhance learning), and Tsai (2009) investigated engagement, all of which relate to the performance phase of SRL. Finally, Telzer (1993) investigated attributions of past learning and Dyer (1993) investigated attitudes towards future learning events, both of which relate to the self-reflection phase of SRL. Because the aforementioned experiments investigated self-regulatory processes defined in Zimmerman's model of SRL, this study provides both theoretical and empirical evidence as to why there is a statistically significant positive relationship between CL and SRL.

At the same time, the research in this study has identified gaps in scholarly knowledge that require investigation about factors that might affect the relationship between CL and SRL. Defensive and environmental structuring behaviors, along with the relationship between group and personal goals, were not examined within this meta-analysis. Defensive behaviors involve activities students take to protect their egos (Zimmerman, 2000) and environmental structuring includes students' initiated behaviors to arrange and/or manage their surroundings in ways that help them learn more effectively (Zimmerman, 1989). The relationship between group and individual goals pertains to how students balance environmental and personal sources of regulation (Zimmerman, 2000); this is an important point because students must identify with both individual and group goals for optimal SRL (Järvelä & Järvenoja, 2010; Larson, 2010). Research that investigates how these personal, behavioral, and environmental factors moderate the relationship between CL and SRL would help address a scholarly need that exists.

Many of the articles in this study, such as Zimmerman and Kitsantas (1999) and Schunk and Swartz (1993), addressed the important linkages between self-efficacy and various self-regulatory processes that foster SRL. Only a few experiments, for instance Sungur and Tekkaya (2006), emphasized the importance of task interest during CL. Zimmerman and Cleary (2009) along with Hidi and Ainley (2008) have conceptualized this self-motivational belief as playing a part in both the forethought and performance phases of SRL. Research that investigates how task interest moderates the relationship between CL and SRL would help fill a current void in scholarly knowledge.

Several potential moderating relationships identified in this study provide research topics that should be investigated in future work. Notwithstanding the results of the current study, an important issue concerns whether the relationship between gender and SRL is stronger in CL or traditional, lecture-based learning environments. To my knowledge, extant research has not addressed this research question; however, it may provide insight into performance differences that males and females display concerning the development of SRL skills and knowledge. Specifically, contextual differences (e.g., intellectual challenge, task interest, peer group affiliation) between CL and traditional methods of instruction may be associated with gender differences concerning the development of SRL skills and knowledge.

In recent decades, research has indicated that prior knowledge has a positive association with the acquisition of new skills (Bandura, 1997; Zimmerman & Schunk, 2008). The results of this study did not substantiate that association. Because of the exploratory nature of this research, additional investigation is required to understand why prior knowledge was not associated with the acquisition of SRL skills and knowledge during CL. Perhaps learning with others reduces the influence of a construct that is widely theorized to affect the acquisition of new skills. Scholars also require additional research on how age might moderate the relationship between CL and SRL, particularly for students aged 14–18. In this meta-analysis, 78% of the experiments were about students ages 10–13; therefore, there is a continuing need to investigate the relationship between CL and SRL for older adolescence students.

The literature in this study e.g., Iiskala et al., 2004; Roschelle, 1992 also indicated the need to investigate how individual differences in metacognitive skills might affect the use of task strategies during collaborative learning. Metacognition is an important self-regulatory process during CL (Salonen, Vauras, & Efklides, 2005) because students use metacognitive skills to influence the behaviors of other students, for example choosing a task strategy, as well as to help facilitate group activities such as planning group presentations after finishing an assignment (Whitebread, Bingham, Grau, Pasternak, & Sangster, 2007). Moreover, during CL students use metacognitive knowledge about their own performances in order to choose and use effective task strategies, behaviors that help students acquire SRL skills and knowledge.

Notwithstanding the work of Hogan (1999), Kramarski and Mizrachi (2006) and Saab et al. (2012) among others, there continues to be a need for research that examines what types of verbal interactions facilitate an adolescent's shift from social (e.g., peers) to personal (e.g., self-efficacy) sources of regulation. Future researchers should attempt to categorize verbal interactions during CL as they pertain to the four levels of self-regulatory skill described by Zimmerman (2000). Experiments of this type would allow researchers to uncover relationships among self-regulatory processes and sources of regulation (e.g., peers). Such research could also have important implications for teaching because it might reveal when using peers for instructional purposes is likely to help students acquire SRL skills and knowledge.

The researchers of numerous experiments (e.g., Chan, 2001; Hogan, 1999; Kramarski & Mizrachi, 2006; Saab et al., 2012) in this meta-analysis used discourse analysis to capture and analyze verbal interactions as students helped each other use self-regulatory skills to complete collaborative tasks, such as achieving mutual comprehension of text (Iiskala et al., 2011), that are necessary for joint problem-solving (Zimmerman & Lebeau, 2000). Unlike the position stated by Hadwin et al. (2011), I think that researchers require *both* individual and group level data to analyze individual SRL performance during CL. Specifically, using online measures of SRL, trace data left behind by students as they work, and behavior observations would help capture complex SRL processes during CL (Greene & Azevedo, 2010; Perry & Winne, 2013; Winne, 2010).

Video-recording student behaviors during CL should be a key component to a multimodal approach to SRL data collection. It is important because it can help researchers gain insight into the types of SRL processes that occur during CL. The researchers of three experiments in the current study videotaped student activities during CL. Wong et al. (2002) videotaped students' study activities and identified a positive relationship between self-explanation strategy knowledge and use and the acquisition of SRL skill. Kramarski and Mevarech (2003) videotaped and analyzed student interactions and determined that giving and receiving elaborated help is more strongly related to SRL skill development than giving or receiving final answers without elaboration. Collen (2011) videotaped small-group sessions that allowed for the documentation of metacognitive processes as well as learning strategy use, both of which Collen used for future student lesson planning.

Researchers have also used video recording to provide insight into triggers of self-regulatory processes and the movement through SRL phases. For example, De Backer et al. (2012) used video recordings to analyze college student cognition, such as self-monitoring and learning strategy use, during CL. Other researchers have used video recordings during CL to analyze how students regulate their motivation (Määttä, Järvenojä, & Järvelä, 2012), use learning strategies (Järvenojä, Järvelä, & Veermans, 2008), and use metacognition to coordinate the activities of peers (Iiskala, Vauras, Lehtinen, & Salonen, 2011). Analyses of these types of videotape data indicate positive relationships between motivation, cognitive strategy and metacognitive strategy use during CL. Other benefits of using video recording during CL include the capability of viewing learning episodes multiple times, which can improve coding reliability and provide researchers with both verbal and non-verbal evidence of SRL, which Schunk and Zimmerman (1997) stressed is an important aspect of CL. It is important to note that Whitebread and Pino-Pasternak (2013) have provided extensive guidelines on how to identify and code nonverbal indicators of SRL during CL.

Educational Implications

Implementing an instructional method that helps students acquire SRL skills and knowledge is not without challenges, however, as many researchers have found (Webb, Franke, Ing, Chan, De, Freund, & Battey, 2008). Several experiments in this study (e.g., Baird & Penna, 1996; Larson & Brown, 2007) highlighted circumstances that could thwart the acquisition of SRL skills during CL. Iiskala et al. (2011) emphasized that some educators may not adequately monitor or assist group and individual regulatory efforts during collaborative tasks. Many of the authors suggested that students did not have the necessary social skills to regulate their learning effectively (e.g., how to disagree in a polite manner) in small groups (Cary, Johnson & Johnson, 2008; King, 1998; Webb et al., 2002); this circumstance would, of course, place additional responsibility upon teachers.

Other researchers (Hogan et al., 2000; Salonen et al., 2005) implied that CL groups often contain students with incompatible intellectual skills and that student grouping of this type would undermine student attempts to regulate their learning. Examples of such conditions include student metacognitive skills that limit learning from feedback during discourse (Chapman, 1997; Mevarech, 1999), and inadequate emotional skills, for instance the ability to be empathetic towards others' mistakes (Larson & Brown, 2007; Wang & Eccles, 2013). Making a similar argument, Dopkins, Stright, and Supplee (2002) also hypothesized that individual differences, for example self-monitoring for calculation errors, in adolescent abilities may explain the variances in SRL skills that students display during collaborative learning. Lastly, O'Donnell (2006) implied that differences in students' goal orientations (e.g., process vs. outcome goals) could also constrict SRL success, and the results from Sungur and Tekkaya's (2006) work support this assumption.

Therefore, it is evident teachers must take measures to ensure SRL success during

CL. Teachers must consider student attributes when constructing collaborative groups, because certain students may be better served by working on individual assignments (Webb & Mastergeorge, 2003) and some students may be better suited than others to assist peers (Iiskala et al., 2011). In addition, Webb and Palinscar (1996) along with Newman (2002) implied that teachers should provide students with skills to give and receive help from other collaborative learners, a task strategy that fosters SRL (Newman, 1996; Zimmerman, 2000). Moreover, teachers should encourage respect, responsibility, and open discourse within their classrooms (Brown et al., 1993; Chan, 2001). Respect is essential because successful SRL requires students to divulge gaps in their knowledge (Zimmerman, 1989). Responsibility is also a requirement because all participants must lead the learning process at some point (Slavin, 2011). Amicable conversation is important as well; without it, a large portion of the verbal interactions that foster SRL knowledge and skill cannot occur during CL (Chan, 2001; Palinscar & Brown, 1984; van den Boom, Paas, & van Merriënboer, 2007).

Instructional Recommendations. Zimmerman (2002b) has also described several principles that teachers can use to design activities to help students acquire SRL skills in CL classrooms. Addressing all of the principles is beyond the scope of this meta-analytic review; however, one key principle is the use of self-control skills during the performance phase of SRL (Larson & Brown, 2007; Telzer; 1993; Wang & Eccles, 2013; Zimmerman, 2000). Two methods for self-control are checking one's task strategy accuracy, for example by re-examining answers to mathematics problems, and by rating one's answers in relation to a peer's answers during CL. It is important to note that several experiments within the current student for example, Nichols (1996) and Wang (2011) indicated how these behaviors helped students acquire SRL skills and knowledge; tasks of this nature encourage academic self-management that promotes flexible approaches to problem solving and adaptive task-strategy use (Zimmerman, 2002b).

Another key educational principle is the use of learning tasks that require the kind of self-observation identified with the performance phase of SRL (Zimmerman, 2000). Self-observation is important because observing one's behaviors can enlighten and motivate. Self-observation often involves self-recording, where instances of SRL behavior are recorded along with their time, place, and frequency of occurrence (Schunk & Zimmerman, 1996). Personal journals are useful tools for self-recording and a student can use the information gained to determine how well he or she is progressing toward learning goals; moreover, self-observations of progress help to instill a sense of self-efficacy for continuing to advance one's SRL skills and knowledge (Schunk & Zimmerman, 1997). Video recording and reviewing one's prior learning attempts is also a way students can perform self-observation (Jeong & Hmelo-Silver, 2010). Indeed, within the current study Couzijn and Rijlaarsdam (2005) and King (1998) identified how reviewing video recordings foster SRL skills such as self-reflection processes which improves future learning. The major implication of this meta-analysis for instructional practice is that multiple types of collaborative learning interventions have positive relationships with SRL skills and knowledge that foster academic success (Schunk & Zimmerman, 2007; Zimmerman & Schunk, 2008). Evidence supports this opinion for multiple subject domains and ages during adolescence. Therefore, educators should use CL to foster SRL.

Conclusions

Although the benefits of SRL and CL, on their own, are well known (Webb, 2013; Zimmerman, 2001), researchers and educators required a better understanding of how CL contributes to the acquisition of SRL skills and knowledge during adolescence. This meta-analysis investigated the relationship between the two constructs, along with variables that might affect the relationship, to address that need.

CL involves instruction during which teachers arrange students into small groups that assist each other in learning classroom material (O'Donnell, 2006; Webb & Palinscar, 1996). During CL, small groups of students engage in cyclical verbal interactions (Kuo et al., 2012; Roschelle, 1992; Takala, 2006) that stimulate the practice and use of self-regulatory behaviors in *all* phases of SRL (Zimmerman, 2000). One example of these relationships occurs when peer negotiations result in a student changing his or her writing revision strategies during CL (Anderson, 2000; Couzijn & Rijlaarsdam, 2005). Verbal interactions function as task strategies during CL (Chan, 2001; Saab et al., 2012; Webb & Mastergeorge, 2003) and this frequent CL mechanism strengthens the relationship between CL and SRL skills and knowledge.

The relationship between CL and SRL was positive and statistically significant because several aspects of collaborative tasks provide a mechanism for students to acquire SRL skills and knowledge. One example of this mechanism is how collaborative learning tasks reduce the number of teacher-student interactions as compared to other instructional methods, which permits students to practice self-regulatory skills such as self-reflection (Brady, 1990; Collen, 2011; Van Grinsven & Tillema, 2006). Other instructional elements of collaborative tasks that help students acquire SRL skills and knowledge include providing students with a choice of learning activities (Ashman & Conway, 2004; Sungur & Tekkaya, 2006; Tsai, 2009), having students participate in specialized roles (Collen, 2011; Wang, 2011), and assigning students authentic problems that pique their interest (Dyer, 1993;

Nichols, 1996).

Indeed, the learning processes students engage in during CL in many ways mirror the self-regulatory processes in Zimmerman's (2000) phases of SRL. CL emphasizes goal directed behaviors that pertain to the forethought phase of SRL (Mevarech, 1999; Nichols, 1996). CL requires the use of task strategies and metacognition and these self regulatory processes pertain to the performance phase of SRL (King 1998; Wong et al., 2002; Zimmerman, 2000) and CL and SRL both require students to review their learning plans and this behavior concerns the self-reflection phase of SRL (Couzijn & Rijlaarsdam, 2005; Kwon, 2006).

During CL many thinking processes become public knowledge and therefore students have access to models displaying task and metacognitive strategies (Johnson-Glenberg, 2000; King, 1998) and instances of these types of behavior help foster the first and second levels of SRL skill (Zimmerman, 2002a). In CL, students perform tasks aimed at strengthening critical thinking skills (Hogan, 1999; Kwon, 2006) and this instructional approach requires students to spend a significant portion of their time discussing challenging concepts, which helps foster SRL (Hadwin, Järvelä, & Miller, 2011; Saab et al., 2012). By reviewing, clarifying, and modifying, their prior statements, students devise effective solutions to collaborative tasks (Hohn & Frey, 2002; Sungur & Tekkaya, 2006) and this process follows a cyclical pattern similar to SRL (Hmelo-Silver, 2004:Zimmerman, 2002).

Students often engage in problem solving exercises during CL (Kuo et al., 2012; Wang 2011; Webb & Mastergeorge, 2003) and both SRL and problem solving approaches are cyclical by nature (Bruning et al., 2004; Zimmerman, 2000). During problem solving exercises students frequently exchange information, such as stating the time (Hogan, 1999;

Iiskala et al., 2011; Kramarski & Mizrachi, 2006) and providing help (Olson, 1990; Uttero, 1992; Zimmerman, 1989) to monitor and control the use of self-reflection, a key process in the cyclical nature of SRL and problem solving approaches (Byrnes, 2009; Mevarech, 1999; Zimmerman, 2000).

Models are a key part of the social cognitive perspective on learning (Bandura, 1977) and their explanations regarding the use of cognitive processes helps students remember and perform relevant SRL processes that they have observed (Ashman & Conway, 2004). This is a frequent occurrence during CL and practicing self-regulatory skills that models display helps students foster the self-control level of SRL skill (Brown, 2002; Olson; 1990). CL also requires student to demonstrate their SRL skills in a dynamic environment such as participating in a class discussion (Collen, 2011; Iiskala et al., 2010) or during role specialization (King, 1998; Webb & Palinscar, 1996). Demonstrating these types of behaviors during CL is evidence of the highest level of SRL skill (Kuo et al., 2012; Uttero, 1992; Zimmerman, & Kitsantas, 1999) and these actions explain why CL has a positive and statistically significant relationship with SRL.

Therefore, it is evident that environmental factors can affect the relationship between CL and SRL. Overall, in this meta-analysis, the relationship between CL and SRL was positive and statistically significant. CL methods that included observational learning, among other social-cognitive learning processes, demonstrated the strongest effect on the relationship between CL and SRL. It is also clear that experiment classification demonstrated small and medium effects on the relationship between CL and SRL. In the end, a significant body of research emphasizes how CL can help students become self-regulated learners (e.g., Wolters, 2011) at the same time stressing that students with proficient SRL skills and knowledge will transition from childhood to adulthood in a more successful manner than students without such SRL skills and knowledge (Caprara et al, 2008; Zimmerman, 2001).

Appendix A

INFORMATION CODED IN EXPERIMENTS

Report Characteristics:

1. Author names
2. Year
3. Report type (i.e., peer-reviewed journal, non-peer-reviewed journal, unpublished)
4. Meta-analysis (i.e., Y, N)

Setting Characteristics:

1. Country
2. Community type (e.g., urban, suburban, rural)
3. School type (e.g., public, private)

Sample Characteristics:

1. Sample identification number
2. Sample ID
3. Defining characteristic of sample (i.e., regular ed.)
4. Race
5. Gender
6. SES
7. Characteristics of overall sample
8. Characteristic defining sample subgroups (e.g., student achievement level)
9. Subgroup label (e.g., high achieving, low achieving)
10. Subgroup size
11. Percentage free or reduced lunch
12. Average age
13. Median age
14. Age range of students
15. Students' grade level
16. Students' grade range
17. Percentage male
18. Percentage majority population

Self-Regulated Learning Variables:

1. Author label of SRL variable
2. SRL measure name
3. SRL measure citation
4. Did researchers create or adapt measure
    (a) If so, how did researchers create or adapt measure
5. Reliability of the SRL measure
6. Type of measure (e.g., self-report, behavior during task, speech during task)
    a. Online or offline measure
7. Prior achievement

Academic Performance Variables:

1. Academic subject

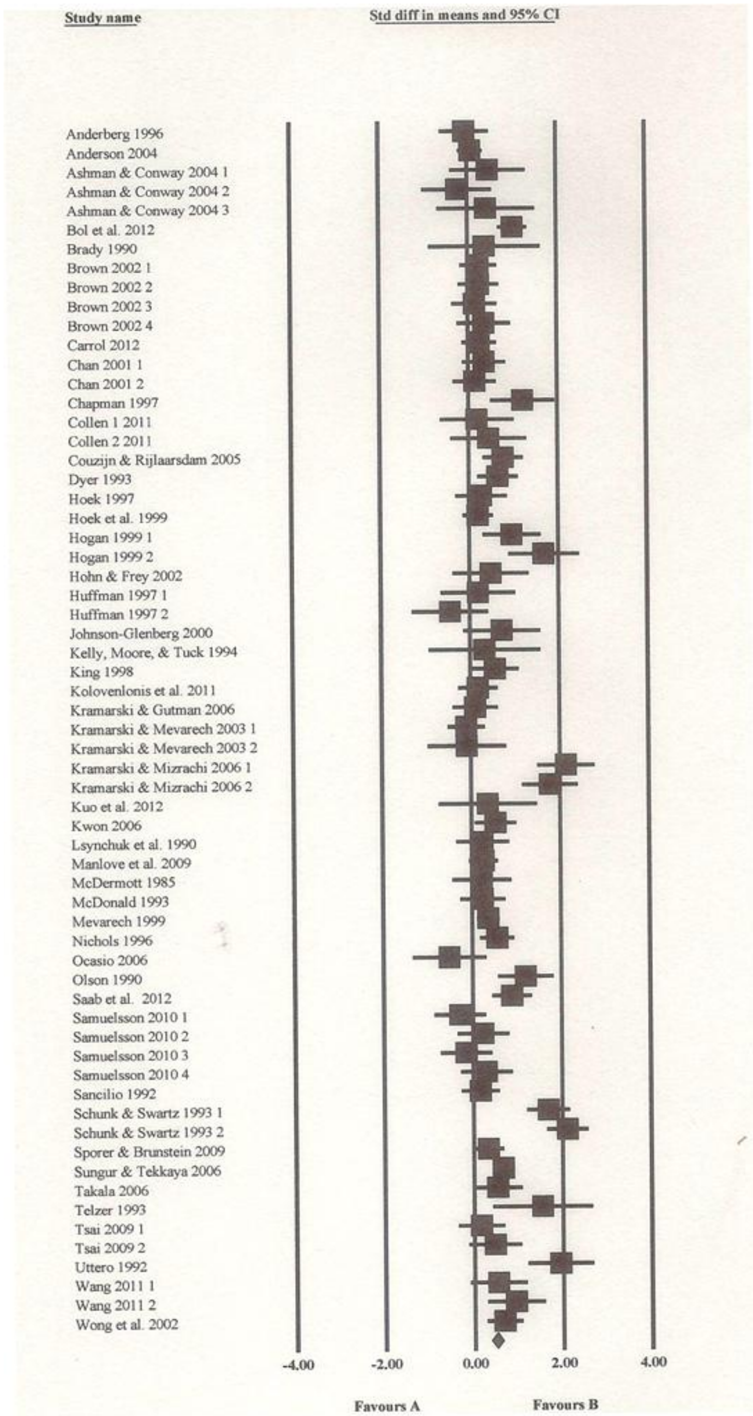
Effect Size Information:

1. Correlation coefficient
2. Probability value
3. Sample size
4. SRL mean
5. SRL standard deviation
6. Academic mean
7. Academic standard deviation
8. Relevant inferential statistics
9. Method of calculating the correlation

Note: Adapted from A. Dent (2011), *The relation between self-regulated learning and academic achievement across childhood and adolescence: A research synthesis* by (Duke University Department of Psychology and Neuroscience; received from the author on November 16, 2012).

Appendix B

FOREST PLOT



Appendix C

SUMMARY OF EXPERIMENT EFFECT-SIZES

Study Name	Year	Effect size
Anderberg	1996	-0.06
Anderson	2004	0.07
Ashman & Conway 1	1993	0.46
Ashman & Conway 2	1993	-0.23
Ashman & Conway 3	1993	0.41
Bol et al.	2012	1.01
Brady	1990	0.38
Brown 1	2002	0.24
Brown 2	2002	0.24
Brown 3	2002	0.15
Brown 4	2002	0.35
Carroll	2012	0.25
Chan 1	2001	0.35
Chan 2	2001	0.14
Chapman	1997	1.21
Collen 1	2011	0.18
Collen 2	2011	0.44
Couzijn & Rijlaarsdam	2005	0.77

Dyer	1993	0.64
Hoek	1997	0.27+
Hoek et al.	1999	0.20+
Hogan 1	1999	0.95
Hogan 2	1999	1.67
Hohn & Frey	2002	0.47
Huffman 1	1997	0.18
Huffman 2	1997	-0.44
Johnson-Glenberg	2000	0.71
Kelly, Moore, & Tuck	1994	0.32
King	1998	0.55
Kolovelonis et al.	2011	0.17
Kramarski & Gutman	2006	0.11
Kramarski & Mevarech 1	2003	-0.10
Kramarski & Mevarech 2	2003	-0.09
Kramarski & Mizrachi 1	2006	2.14*
Kramarski & Mizrachi 2	2006	1.77
Kuo et al.	2012	0.37
Kwon	2006	0.54
Lsynchuk et al.	1990	0.25

Manlove et al.	2009	0.26
McDermott	1985	0.22
McDonald	1993	0.24
Mevarech	1999	0.36
Nichols	1996	0.56
Ocasio	2006	-0.52*
Olson	1990	1.20
Saab et al.	2012	0.88
Samuelsson 1	2010	-0.29
Samuelsson 2	2010	0.23
Samuelsson 3	2010	-0.15
Samuelsson 4	2010	0.30
Sancilio	1992	0.16
Schunk & Swartz 1	1993	1.69*
Schunk & Swartz 2	1993	2.11*
Sporer & Brunstein	2009	0.33
Sungur & Tekkaya	2006	0.66
Takala	2006	0.54
Telzer	1993	1.54

Tsai 1	2009	0.16
Tsai 2	2009	0.47
Uttero	1992	1.94
Wang 1	2011	0.54
Wang 2	2011	0.93
Wong et al.	2002	0.67

Note: An * or + indicate studies with effect sizes or sample sizes that were modified because of Grubbs testing.

Appendix D

ARTICLES INCLUDED IN META-ANALYSIS

Anderberg, A. (1996). The effects of reciprocal teaching techniques on reading comprehension for limited English proficient students. *ProQuest, UMI Dissertations Publishing.*

Anderson, K. L., (2004). *The effects of participation in guided reflective writing program on middle school students academic self-efficacy and self-regulated learning*. (Unpublished doctoral dissertation).

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Asterisk indicates articles with more than one experiment. + indicates article that included fidelity of implementation processes.

Appendix E

SUMMARY OF VARIABLE RELATIONSHIPS

	Variable	Moderation	Size of effect	Pairwise comparison
Hypothesis 1				
	Overall relationship		M	
Hypothesis 2				
	Prior achievement			
	Gender			
	Race/culture			
	Socio economic status			
	Age of student			
	Early (10 - 13)			
	Late (14 - 17)			
	Collaborative method	Y		
	Cooperative		M	
	Inquiry[a]		M	
	Modeling[a]		L	
	Peer assisted		S	
	Problem based learning		S	
	Reciprocal teaching		S	
	Cooperative – Inquiry			0.24
	Cooperative – Modeling*			< .01
	Cooperative* – PA			< .01
	Cooperative* – PBL			< .01
	Cooperative* – RT			< .01
	Inquiry – Modeling*			< .01
	Inquiry* – PA			< .01
	Inquiry* – PBL			< .01
	Inquiry* – RT			< .01
	Modeling* – PA			< .01
	Modeling* – PBL			< .01
	Modeling* – RT			< .01
	PA – PBL			0.24
	PA – RT			0.12
	PBL– RT			0.72

	Subject domain		
	Computer[a]		
	Language arts		
	Math		
	Physical education[a]		
	Science		
Hypothesis 3			
	Type of SRL measure		
	Offline		
	Online[a]		
	Experiment classification	Y	
	Dissertation		S
	Peer reviewed journal		M
	Fidelity of implementation[a]		
	Yes		
	No		

Note: [a] indicates a variable with low statistical power and Y indicates a variable that has moderation effects on the relationship between CL and SRL. Guidelines for quantifying effect size; small (S; 0.20), medium (M; 0.50), and large (L; 0.80). Values of *t*-test statistics were used to compare group means and * indicates the subgroup with the larger effect size.

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