Summer 1-1-2017

Social Metacognition in Computer Supported Collaborative Learning Environments: A Comparison in an Online and Face-To-Face Information Literacy Course

Marcia Elizabeth Rapchak

SOCIAL METACOGNITION IN COMPUTER SUPPORTED COLLABORATIVE LEARNING ENVIRONMENTS: A COMPARISON IN AN ONLINE AND FACE-TO-FACE INFORMATION LITERACY COURSE

A Dissertation

Submitted to the School of Education

Duquesne University

In partial fulfillment of the requirements for

the degree of Doctor of Education

By

Marcia Rapchak

August 2017

SOCIAL METACOGNITION IN COMPUTER SUPPORTED COLLABORATIVE LEARNING ENVIRONMENTS: A COMPARISON IN AN ONLINE AND FACE-TO-FACE INFORMATION LITERACY COURSE

By

Marcia Rapchak

Approved May 3, 2017

Misook Heo Professor, School of Education, Instructional Technology (Committee Chair)	Gibbs Kanyongo Associate Professor, School of Education, Educational Foundations and Leadership (Committee Member)
Sara Baron University Librarian Gumberg Library (Committee Member)	

ABSTRACT

SOCIAL METACOGNITION IN COMPUTER SUPPORTED COLLABORATIVE LEARNING ENVIRONMENTS: A COMPARISON IN AN ONLINE AND FACE-TO-FACE INFORMATION LITERACY COURSE

By

Marcia Rapchak

August 2017

Dissertation supervised by Dr. Misook Heo

Because of the advances in technology for education, online learning has become more prominent, especially in higher education. Computer-supported collaborative learning (CSCL) seems especially promising in allowing students to work together in ways that they have not been able to before, both face-to-face and online. Instructors use CSCL to engage students and to increase learning. CSCL requires that students regulate each other's learning through social metacognition; this allows the group as a whole to make use of the knowledge and skills of the group as they learn.

The purpose of this study was to compare the social metacognition of students in a CSCL environment for a face-to-face information literacy course and an online information literacy course. This allowed for the development of the Social Metacognitive Awareness Instrument (SMAI), which may be used by future researchers. When accounting for individual

metacognitive scores, students in the face-to-face version of the course had significantly higher social metacognitive awareness scores than students in the online version of the course. This study also found that students in groups had some similarities in social metacognitive scores. A student's metacognitive score was a significant predictor of their social metacognitive score.

The results of this study indicate that more intervention may be needed for effective group work online. This also supports the research that social metacognition is an independent construct, and so social metacognition or socially-shared regulation should continue to be studied as an important factor in group work. The study also supports the research that indicates that individual metacognition can predict social metacognition. Thus, it is possible that improving individual metacognitive abilities will improve social metacognitive abilities.

DEDICATION

I would like to dedicate this dissertation to my husband, Taylor Rapchak. Thank you for your endless support and love through this journey. I cannot wait for our journeys to come.

ACKNOWLEDGEMENT

I would like to acknowledge the work of my dissertation committee through this process. My committee chair, Dr. Misook Heo, went above and beyond in her support, and I am very thankful. I also want to express thanks to Dr. Gibbs Kanyongo to meeting with me several times regarding my methodological and statistical problems and helping me work through those. Thanks to Dr. Sara Baron for agreeing to be on my committee and providing excellent feedback, all while juggling her leadership position as University Librarian. All of you provided invaluable insight and effort in this process.

I also would like to express my gratitude to the Instructional Technology staff, faculty, and fellow students. Throughout the process, I felt well-supported and that I was part of a community. The students' best interest were kept in mind as the program went through some changes, and the transition process was made as smooth as it could be. Thank you to cohort 7 and my adopted cohort, cohort 6, for your support and comradery.

I want to thank my friends who supported me, listened to me complain about the stress of a doctoral program, did not give me too much of a hard time for occasionally doing work instead of having fun, and gave me a needed distraction occasionally.

Many thanks to my colleagues at Gumberg and the instructors of Research and Information Skills Lab who let me survey their students. I would not have been able to complete this dissertation without your willing cooperation and support.

I am forever thankful for my family, especially my parents. They encouraged me through this process, but more importantly, have always encouraged my curiosity and love for learning. I am thankful for all my family (in-laws, of course, included!) for their continued support and love.

I am thankful for my cat, Schroedinger. He always made the stressful days better.

Finally, I am thankful for my husband, Taylor. I could not imagine a better partner. His endless, uncomplaining, unflinching support through this process made it possible, and I am forever grateful to have him in my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AASL	American Association of School Libraries
ACRL	Association of College and Research Libraries
AECT	Association of Educational Communications and Technology
AILI	Awareness of Independent Learning Inventory
ALA	American Library Association
CSCL	Computer-Supported Collaborative Learning
IL	Information Literacy
K-12	Kindergarten through 12^{th} grade
LMS	Learning Management System
MAI	Metacognitive Awareness Instrument
MALQ	Metacognitive Awareness Listening Questionnaire
MARSI	Metacognitive Awareness of Reading Strategies Inventory
MCAI	Metacognitive Activities Inventory
MOOC	Massive Open Online Courses
MSLQ	Motivated Strategies for Learning Questionnaire
SMAI	Social Metacognitive Awareness Instrument

Chapter I

Introduction

Technology in Higher Education

Walk into any classroom at a college or university, and one will most likely see some sort of technology being employed. From projectors, to Smartboards, to computer labs, to mobile devices, instructors use technology in many ways to make their instruction more dynamic and engaging. What much of the research in instructional technology attempts to establish is the impact these technologies have on student engagement and learning.

The history of technology in higher education is a long one, though it was not always used effectively. In the 1950s to early 1960s, a few universities and colleges used instructional television, but this was not found to be very beneficial, most likely because of the quality of the instruction (Reiser, 2001). With computers in the classroom, instructors began focusing on word processing and writing skills (Thomas, 1985). As software developed and computers became networked, computers could be used for simulations (Doran & Klein, 1996), in-class research (Livingstone & Shepherd, 1997), and playing educational games (Amory, Naicker, Vincent, & Adams, 1999).

In the 20th century, technology in the classroom became varied and more prolific as mobile devices became the norm. From the laptop to the smartphone, students began bringing their technology with them. Instructors found ways to have students interact with these devices in the classroom as they learn, from using iPads for problem-based learning (Omori, Wong, & Nishimura, 2013), to using smartphones as classroom response systems (Imazeki, 2014). Regardless of the new technology that is introduced in the future, instructional technologists must determine what technology applications increase learning, and what particular use increases learning.

Computer Supported Collaborative Learning

One way to use technology to a more potent effect in the classroom is to encourage student-student interaction through Computer Supported Collaborative Learning (CSCL). Through a social constructivist lens, CSCL posits that when students work with technology together as peers, they generate and share knowledge in ways that deepen learning. CSCL not only relates to distance or online education, but can be implemented in face-to-face courses as well (Buraphadeja & Kumnuanta, 2011). It can also be used to increase the sense of community in face-to-face courses taught in a computer laboratory. Studies of knowledge acquisition in CSCL have found that students typically learn more in groups than working as individuals (Lipponen, Hakkarainen, & Paavola, 2004; Zhao & Chan, 2014). Some argue, however, that CSCL research should focus on group cognition rather than individual cognition (Stahl, 2010; Stahl, Korschmann, & Suthers, 2006). If the focus of collaborative learning is to collectively increase knowledge, then perhaps educators should be measuring progress of the group rather than the individual students. At this point, though, education emphasizes individual achievement as a measure of success.

Working with peers can motivate students and allow them to set goals for their own learning based on the performance of others (Järvelä, Häkkinen, Arvaja, & Leinonen, 2004; Tempelaar, Wosnitza, Volet, Rienties, Giesbers, & Gijselaers, 2013). This sort of self-regulation, of which metacognition is an important aspect, can have a positive impact on learning, especially online learning (Azevedo, 2005; Broadbent & Poon, 2015; Dabbagh &

Kitsantas, 2004). Encouraging group regulation and metacognition in CSCL courses can lead to better student performance and learning.

Online Learning in Higher Education

Technology has significantly impacted higher education, most notably through the advent of online learning. Online learning enrollment in higher education has increased over the past ten years, with 32% of higher education students taking at least one course online in 2011 (Allen & Seaman, 2013). In 2014, 28.5% of students took an online course, with 14% taking only distance courses (U.S Department of Education, 2016). Comparing that with the 20% who took an online course in 2008 and the 16% who took an online course in 2004 (U.S. Department of Education, 2011), online education continues to grow rapidly. Faculty support, however, remains low while administrative support continues to increase (Allen & Seaman, 2013; Jaschik, & Lederman, 2014; Picciano, Seaman, & Allen, 2010).

How does online learning compare to face-to-face learning? Can learning outcomes be met online in the same way that they can be met in the traditional classroom? In a meta-analysis of 45 studies that covered learners at nearly all levels of education, from middle school, high school, college, professional and graduate schools, and professional training, researchers found online students performed slightly better than those students in a traditional classroom (Means, Toyama, Murphy, & Baki, 2013). Additionally, they found students in blended learning environments performed significantly better than those in traditional environments (Means et al., 2013). In a response to the initial report from 2009 that spawned this article, however, another report showed that when focusing on postsecondary, full-semester courses, online courses did not show any advantage over face-to-face courses (Jaggars & Bailey, 2010). Additionally, the authors argue that the studies of college-level, full semester courses included advanced and/or highly prepared students, and that students who are lower performing in general are at a greater disadvantage when taking online courses (Jaggars & Bailey, 2010). Indeed, in a large study of a community college system, Xu and Jaggars (2013) found that students enrolled in online versions of courses were significantly more likely to drop the course and to receive a lower grade, though they did not differentiate between synchronous and asynchronous online courses. In studies of graduate students, learning outcomes were not significantly different for asynchronous online or face-to-face students (de Jong, Verstegen, Tan & O'Connor, 2013), for face-to-face students and students in an asynchronous course with some collaborative chat (Reisetter, LaPointe, & Korcuska, 2007), or for students enrolled asynchronously, face-to-face, and in a hybrid course (York, 2008).

Though online learning may not be ideal for all situations, the research indicates that, in most cases, it is an equally effective method of instruction when compared to the face-to-face classroom (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011). Online learning will most likely not be disappearing any time soon, and thus research into what makes online instruction effective can improve the online educational experience. In a meta-analysis of 74 empirical studies, Bernard et al. (2009) found that student interaction with other students, the course content, and the instructor all had a significant positive impact on achievement and student attitudes. Notably, though, student-content and student-student interaction had a significantly larger effect size than student-teacher interaction (Bernard et al., 2009). Improving the online experience for learners by strengthening and enriching these interactions is a goal for many instructors.

An Introduction to Metacognition

The term metacognition has been attributed to John Flavell (1979) and is defined as "knowledge and cognition about cognitive phenomena" (p. 906), or, in other words, one's understanding of one's thinking. Flavell (1979) claimed this was something that children struggle with, but develops over time. Metacognition includes the understanding of cognition (metacognitive knowledge) as well as metacognitive skills that allow one to regulate one's cognition (Veenman, Van Hout-Wolters, & Afflerbach, 2006), also called metacognitive control (Dunlosky & Metcalfe, 2009). Metacognitive monitoring is another aspect sometimes included in the definition of metacognition that allows individuals to assess their own learning strategies (Dunlosky & Metcalfe, 2009; Pintrich, Wolters, & Baxter, 2000); however, other researchers include this under metacognitive regulation (Schraw & Dennison, 1994). Metacognitive knowledge includes a demonstration of understanding of how cognition works and "universals of cognition" (Pintrich, Wolters, & Baxter, 2000, p. 47). Metacognitive control can be seen when individuals take on or change a certain task to better meet their cognitive goals. Metacognitive monitoring allows individuals to reflect on their own understanding of a topic.

Multiple studies have confirmed the importance of metacognition for student learning. In their meta-analysis of the Best Evidence Synthesis systematic reviews, Slavin and Lake (2009) found that metacognition was one of the three most important strategies to increase student learning. Additionally, in their meta-analysis of 51 studies on improving student study skills to increase learning, Hattie, Biggs, and Purdie (1996) found that training was most effective when metacognitive support was employed. This meta-analysis included studies of various age groups, from primary school students to university students. After conducting a meta-analysis of education literature, Wang, Haertel, and Walberg (1990) found that student metacognition was most important factor to predict learning. Metacognition, according to a systematic review of online learners from studies from 2004-2014, was positively correlated to academic outcomes, but this was a weaker correlation than in the traditional-learning studies (Broadbent & Poon, 2015).

For adult online learners, self-regulation skills are important to successfully complete courses or training (Conrad, 2009; Lee, Choi, & Kim, 2013; Rakes & Dunn, 2010; Sitzmann, 2012). Lee et al. (2013) found that metacognition was the most important factor in student persistence in their study of why adult students dropped out or stayed in an online course. In a survey of graduate students in an online master's program, the most valued aspect of online learning was self-regulated learning (Northrup, 2002). Therefore, developing metacognitive skills in online learners is of particular importance for student success and matriculation.

Metacognition and CSCL

As online learning becomes available in a variety of formats with a variety of tools, there have been more opportunities for CSCL. CSCL enables collaborative knowledge production that supports student achievement over individual learning (Lou, Abrami, & d'Apollonia 2001). While students are engaged in this collaborative learning, they are expected to understand the metacognitive knowledge of the team as a whole, as well as to monitor and plan the group metacognitive functions (Chan, 2012). In other words, to be able to work collaboratively, students must consider their own understanding as it relates to the group, and must use the cognitive strengths of group members to achieve their goals. This understanding and regulation of the group cognitive process is called social metacognition (Chiu & Kuo, 2009; Niess & Gillow-Wiles, 2013). In a CSCL environment, technology can be used to support the collaborative efforts of the group, helping to scaffold cognitive and metacognitive processes of the individuals (see Figure 1). Social metacognition develops through a shared understanding and regulation of the cognitive efforts of the group.

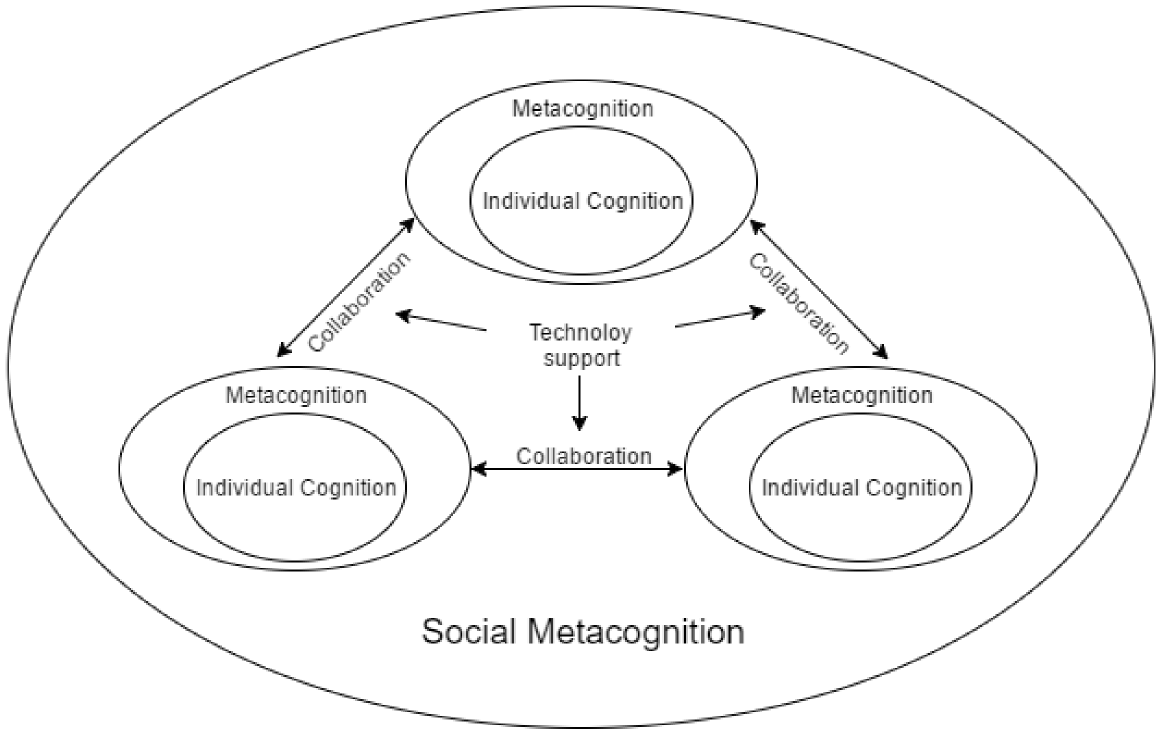

Figure 1. Social Metacognition in a CSCL environment

Researchers need an accurate measure of social metacognition to distinguish it from metacognition and understand the relationship between the two. Accurate measures of social metacognition could allow instructors to measure how technological interventions contribute to social metacognition. Currently, there is not a scale that directly measures social metacognition. CSCL could facilitate this social metacognition to generate the co-regulation of learning to maximize both individual learning and group knowledge production.

Assessing Metacognition

While a standardized instrument assessing social metacognition has not been established yet, various methods allow researchers to assess metacognitive activity in students working together. Transcript coding of student communication, like in forum discussions, think aloud protocols, and interviews, provides one method of assessing metacognition in learning environments (Akyol & Garrison, 2011; Lajoie & Lu, 2012; Meijer, Veenman, & van Hout-Wolters, 2006; Papanikolaou & Boubouka, 2010; Winne, 2010). In all of these cases, researchers collect and categorize student statements either in the online learning environment or to the researchers. For example, a statement may indicate knowledge of cognition or regulation of cognition, prompting researchers to identify additional statements of regulation earlier or later in the course. Likewise, there may be metacognitive statements after a particular technological or pedagogical intervention in the class.

Another method of assessing metacognition is through a self-report instrument. These include the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991), the Metacognitive Activties Inventory (MAI) (Schraw & Dennison, 1994), and the Awareness of Independent Learning Inventory (AILI) (Elshout-Mohr, van Daalen-Kapteijns, & Meijer 2004). These instruments require students complete a questionnaire, and can be used in pre- and post-test experiments or to compare student metacognitive awareness after various instructional interventions.

These assessment methods have their advantages and disadvantages that will be explored more fully in Chapter 2, but they provide a basis for research into social metacognition. Co-regulation of cognition and shared regulation of cognition, where learners work within the group or as a group, respectively, to monitor, plan, and make decisions, has been analyzed through transcript analysis (Janssen, Erkens, Kirschner, & Kanselaar, 2012; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013; Lajoie & Lu, 2011) and logs of individual activity online (Järvelä et al., 2013). Though assessment of metacognition may appear in the assessment of some co- and shared-regulation research, the assessment of social metacognition is limited at this time.

Purpose of the Study and Research Questions

The main purpose of this study is to compare social metacognition for students in an CSCL, information literacy course online and face-to-face to see if they are similar. In CSCL environments, social metacognition, like metacognition, could be positively correlated with student achievement and student retention, but instructors and instructional designers must have an accurate method of measuring social metacognition to research this relationship. This study investigated a measure of social metacognition within CSCL in a higher education environment through the modification of an existing instrument assessing metacognition. The study examined the reliability and validity of the instrument and the parsimonious factor structure of the measurement. Additionally, the study revealed if the instrument provides information unique to social metacognition. If the instrument was found to be reliable and valid, it could be used by researchers, instructors, and instructional designers to assess and plan technological and pedagogical interventions in CSCL. If students in online and face-to-face sections of the course had different social metacognitive scores, this could indicate that more intervention is needed in one format than the other to improve social metacognition. This study developed the social metacognitive instrument and compare student social metacognitive scores using the following research questions:

RQ1: To what extent does the two-factor model of metacognition (knowledge of cognition and regulation of cognition) apply to social metacognition?

RQ2: What is the relationship between individual metacognition and social metacognition?

RQ3: To what extent do students in groups in a CSCL environment in higher education agree on their ratings of social metacognition?

RQ4: How does social metacognition for students in an online information literacy course compare to the social metacognition of students taking a face-to-face information literacy course?

These questions will allow for the development and validation of a social metacognition instrument that can be used in CSCL. Additionally, it will allow researchers to see if and how metacognition and social metacognition are related. Finally, it will indicate whether social metacognitive scores differ after the same collaborative project is completed by students in online and face-to-face courses.

Significance of the Study

This study will develop a scale based on the Metacognitive Awareness Inventory that may be used in assessing social metacognition. With the focus on CSCL and social constructivism, researchers may wish to consider not simply individual cognition and metacognition, but also social cognition and metacognition. If the instrument proves to be valid and reliable, it can provide a quick assessment method that is less time consuming for researchers than coding student communication. With a direct measurement of social metacognition, instructors can quantify how collaborative work contributes to the regulation and understanding of cognition for a group rather than an individual. Understanding the relationship between CSCL environments and social metacognition can assist instructors in making pedagogical and technological interventions that develop the social metacognition of members working in a group. Researchers and instructors could use this instrument to reveal if students in CSCL environments need scaffolding and direct instruction to develop their social metacognitive awareness, or if this awareness is developed through collaborative assignments. Additionally, this study will determine the relationship between individual metacognition and social metacognition. This could allow instructors to determine whether developing individual metacognition will improve social metacognition, or if social metacognition should be developed separately. Furthermore, this instrument could be used to demonstrate how social metacognition aligns with student performance. While one study found a weaker correlation between metacognition and online performance (Broadbent & Poon, 2015), more research is needed in this area. This research study will also compare social metacognitive awareness scores of students completing the same collaborative project online and in the face-to-face environment. This could help to indicate whether or not more social metacognitive scaffolding is needed for one environment or the other.

If there are validation issues with the instrument, this will be an important step in finding an appropriate method of assessing social metacognition. Additionally, if there is not a significant relationship between the social metacognition instrument ratings and the metacognition instrument ratings, perhaps an entirely new instrument needs to be developed to measure social metacognition.

Although coding can provide a view into social metacognition, students may not always explicitly communicate their metacognitive processes (Snyder & Dringus, 2014). Additionally, since a CSCL environment can be a combination of collaboration with a computer and face-to-face collaboration, some metacognitive processes could be spoken. While there are limitations with a social metacognitive self-report instrument (Winne, 2010), providing another method of assessing social metacognition could allow researchers to triangulate the social metacognitive activity of students in CSCL through coding, tracking computer activity, and using the instrument.

Ultimately, having a social metacognitive instrument will allow instructors to better develop instruction for CSCL and other collaborative environments. Whether through providing better collaboration scripts, including more individual metacognitive exercises, creating more effective group projects, or a combination of all the above, instructors can deepen student learning through improved pedagogical strategies that support and develop social metacognition both in face-to-face courses and online.

Definition of Terms

Collaborative learning: Group members meet a goal through shared expertise, consensus building, and shared responsibilities (Panitz, 1999).

Computer-supported collaborative learning: A learning environment where students use electronic means to work together and share information (Woo & Reeves, 2007).

Constructivism: An educational theory that proposes that learning occurs when students interact with their environment (Dewey, 1938; Jonassen, 1994).

Cooperative learning: Group members have interdependence and common group goals, but individual and independent effort is required (Smith, 1996).

Information literacy: A set of abilities that allows an individual to interact effectively and ethically with the information environment (ACRL, 2015).

Knowledge of cognition: Part of the two-factor model of metacognition, an understanding of what one knows about one's own knowledge and learning abilities. Also called metacognitive knowledge (Flavell, 1979; Pintrich, Wolters, & Baxter, 2000).

Regulation of cognition: Part of the two-factor model of metacognition, an ability to control how one learns. Also called metacognitive control (Veenman, Van Hout-Wolters, & Afflerbach, 2006).

Metacognition: Thinking about one's own cognitive processes (Flavell, 1979).

Metaliteracy: A recognition of students as both producers and consumers in the information environment (Mackey & Jacobson, 2010).

Social constructivism: An educational theory that proposes that learning occurs through social interaction (Palincsar, 2005; Vygotsky, 1978).

Social metacognition: Thinking about a group's cognitive processes (Chiu & Kuo, 2009).

Chapter II

Literature Review

Technology in Education

To look at the impact of CSCL environments on social metacognition, it is important to understand the history of technology in education. Computers have had a place in the classroom for several decades. While computers were accessible remotely to schools in the 1970s, in the 1980s, microcomputers allowed them to be placed into schools and classrooms (Bigum, 2012). In the 1990s, despite increased access to computers in the classroom, use of these computers did not increase as much as expected (Cuban, 2001). Even in a 2009 survey in the United States, only 69% of the teachers surveyed indicated that they or their students used computers for educational purposes in class “sometimes” or “often”, despite 97% of the teachers having a computer in the classroom (Gray, Thomas, & Lewis, 2010).

Computers and laptops are not the only technology that can be used, with 72% of instructors in the 2009 survey indicating that they used (at least sometimes or often) projectors, 13% indicating that they use videoconferencing sometimes, 57% indicating that they use interactive whiteboards, and 35% indicated that they use classroom response systems (Gray, Thomas, and Lewis, 2010). As technology becomes more dynamic and mobile with developments like the smartphone and tablets, students not only can engage in self-directed learning (Flewitt, Messer, & Kucirkova, 2015), but they themselves can become digital creators, creating digital stories and other digital content to present information in new ways (Alismail, 2015). While educational technology is not used by every teacher, it has had a large impact on the learning experience of most students in the United States. Students entering higher education have most likely had an experience with learning with technology before they begin their college classes.

Technology for Online Learning

Educational technologies have also allowed for online learning. While distance education has been around since the 1700s with correspondence courses, courses taken by mail, being advertised in the early 1700s (Willis, 1993), online courses were offered for the first time in the 1990s (Harting & Erthal, 2005). Online learning itself found its genesis from computer conferencing using Internet capabilities (Garrison, 2009). Online learning is an extension of distance learning that allows access to educational environments despite barriers of location and workplace obligations, but it has provided more opportunities for collaboration and co-learning than traditional distance education (Garrison, 2009). As technologies became more robust to allow for more interaction, not just between students and the content of the course through notes, readings, or lectures, but between students and other students, and between students and the instructor, increased adoption of online learning has occurred in both higher education and K-12 schools.

Online learning provides a flexible means for education regardless of place and time. While online learning may occur formally, it can also be an informal means of providing instruction. Massive Open Online Courses (MOOCs), badges, and online gaming all provide online learning that occurs outside a formal educational environment. Online learning can also be paired with face-to-face instruction, often called blended learning, so that some of the learning occurs through the use of technology in an online environment, and some of it occurs in a classroom or other in-person environment. Different technologies allow for different levels of interaction and instruction in online learning. For example, discussion boards and forums allow students and instructors to communicate asynchronously, meaning that the students and instructors do not interact in real time. Instructors can also provide direct instruction through videos, podcasts, and text. For synchronous communication, software like Adobe Connect, Google Hangouts, and GoToMeeting provide a way to integrate video conferencing, chat and polling in real time.

A popular way of providing online instruction is through a Learning Management System (LMS). This contains the tools to provide the entire online learning experience, including not only methods of communication, like voice emails and announcements, but also areas for instructors to place course content, assignment submission areas, spaces for students to post to journals and blogs, and wiki spaces. Many LMSs allow instructors to upload videos, post podcasts, and link to other instructional materials. Blackboard, Canvas, EdModo, and Moodle are all examples of LMSs.

Research on online learning covers a wide variety of topics, including comparison of face-to-face courses, effective teaching strategies, and student and instructor attitudes and preparation. While a meta-analysis has found that online instruction leads to similar or more learning than face-to-face environments, the researchers also found a lack of studies comparing outcomes in K-12 settings (Means, Toyama, Murphy, & Baki, 2013). Empirical research comparing distance education and face-to-face learning outcomes for K-12 students does exist, but much of the experimental and valid studies appear in the literature on higher education (Bernard et al., 2009; Means et al., 2013). More research is needed to confirm that K-12 has similar outcomes when comparing distance and face-to-face instruction. While this study does not address K-12 education, the methods used could be used to explore social metacognition in a K-12 environment.

Online Learning in K-12 Environments

The number of K-12 students enrolled in some sort of online education makes up about 16% of the entire student population (Watson, Pape, Murin, Gemin, Vashaw, 2014). The 2013-2014 school year saw a 6.2% increase in student enrollment from the previous year (Watson et al., 2014). Thirty states and the D.C area have schools that were entirely online in 2014-2015 (Watson et al., 2014). Much of the online education for students comes during high school, with a variety of courses being offered for high school students nationally (Watson et al., 2014). Additionally, online learning allows high school students to enroll in college courses for credit (Picciano, Seaman, Shea, & Swan, 2012).

Despite the growth in K-12 online education over the last twenty years, there remains a lack of evidence-based literature indicating that online learning is as or more effective for students than face-to-face learning (Barbour, 2013). A meta-analysis of studies comparing online learning with face-to-face learning in online environments found that only fourteen studies collected could be included (Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004). The meta-analysis found that online students performed as well as students in face-to-face classrooms (Cavanaugh et al., 2004). In a more recent meta-analysis that looked at all levels of students, K-12 students online did perform better than face-to-face students, but the effect size was not significant (Means et al., 2013). Perhaps as strategies for increasing metacognition and social metacognition are used online, comparative studies will show that online learning in K-12 environments are as successful as face-to-face environments.

Technology in the Higher Education Classroom

Like the K-12 environment, computing has had a major impact on higher education, though, like the K-12 environment, the pedagogical impact was slow. Surveys in the 1990s indicated that lecturing was still used by a majority of the faculty, and that less than a fifth of instructors used computer-supported instruction (Cuban, 2001). It is notable, though, that in 2013-2014, the HERI survey of undergraduate instructors indicated that less than half of the instructors used lecturing as their major instructional approach, and over 50% of faculty used online discussion boards (Eagan et al., 2014).

In a survey of higher education and corporate executives in 2008, online collaboration tools were selected as the most likely to improve the quality of academia in the near future (The Economist Intelligence Unit, 2008). Blogs, wikis, social networking sites, and cloud-based tools like Google Drive provide students various methods of interacting, collaborating, co-creating, and engaging with learning in new ways (Dabbagh & Kitsantas, 2012). Along with allowing for more student-centered learning, new technologies have allowed for expanded offerings of online learning for higher education students. These new methods can impact the way that students interact with each other and with their instructors, which could also have an impact on their social metacognitive skills.

Online Learning in Higher Education

Across institutions of higher education, the importance of online learning has become clearer to their long-term strategy of success (Allen & Seaman, 2013). In the fall of 2011, over 6 million students were taking an online course, and online enrollment continues to increase each year (Allen & Seaman, 2013). In 2012, only 13.5% of institutions surveyed had no courses offered online, and 62.4% had entire programs online (Allen & Seaman, 2013). Nearly 30% of graduate students in the United States were enrolled in distance classes, with 22% in programs entirely online in the fall of 2012 (Ginder & Stearns, 2014). This is double the percentage of undergraduate students in online programs (Ginder & Stearns, 2014). With an overwhelming majority of institutions of higher education implementing online courses and the majority launching online programs, administrators and researchers have focused on finding methods to best support and encourage students and faculty in online learning.

Barriers continue to exist to online learning in higher education, despite its widespread implementation. In 2012, according to chief academic officers, only about 30% of faculty at higher education institutions believed online learning to be legitimate and valuable (Allen & Seaman, 2013). Additionally, faculty fear that online learning could be used to replace them, are required to invest more time and resources to create effective online learning, and oftentimes do not wish to teach courses that have been pre-created (Bacow, Bowen, Guthrie, Lack, & Long, 2012). Faculty training and support are required to assuage fears of faculty and administrators who venture into online learning.

Students themselves may also experience barriers to learning online. Difficulties with time management and meeting deadlines are frequently cited by students as a reason that they did not complete a course (Kizilcec & Halawa, 2015). Student difficulties with accessing course content and using the technology can also be a barrier to student persistence in a course (Hart, 2012). Additionally, a student's feeling of isolation between herself and the instructor, along with her isolation from other students, can contribute to a student's lack of success in an online course (Hart, 2012).

Creating a conducive learning environment online can be difficult because of the distance in space and perhaps also time among learners and teachers. Closing this distance has several pedagogical implications. According to Moore's (1989) influential definition of interaction, participants in online environments engage in three different types of interaction: learner-content, learner-learner, and learner-instructor. Students benefit most from having interaction at all levels when taking an online course (Bernard et al., 2009). Instructors must design and facilitate courses that include all three types of interactions to create the most effective learning environment. Notably, though, student-content interaction and student-student interaction has a greater impact on student learning than student-instructor interaction (Bernard et al., 2009). Thus, instructors of online learning must give students opportunities to engage with both the course content and their peers in the learning process. Collaborative learning through group projects, peer instruction and tutoring, and asynchronous and synchronous discussions provide this peer interaction, and could contribute to social metacognitive abilities.

Information Literacy

With the development of instructional technology comes the abundance of information resources available in a variety of formats, not only in the print form. As information and formats proliferate, students need to understand how to best find the resources that fit their needs. Information literacy has traditionally been defined as the ability to find, access, evaluate, and use information ethically and effectively (ACRL, 2000). In 1989, the American Library Associated started a Presidential Task Force to investigate information literacy (Cassell & Hiremath, 2011). The American Association of School Libraries (AASL), working with the Association of Educational Communications and Technology (AECT), developed information literacy standards for students in K-12 in 1998 (Cassell & Hiremath, 2011). In 2000, the Association of College and Research Libraries (ACRL) developed its *Information Literacy Competency Standards for Higher Education*. As new technologies allowed for more student participation in being information creators, some librarians felt that the Standards needed to be revised. In 2015, ACRL developed the *Framework for Information Literacy in Higher Education*. This new framework is influenced by threshold concepts, metacognition, and metaliteracy. Threshold concepts are necessary to understand a discipline and also transform the way that a student views a discipline (Meyer & Land, 2003). Metaliteracy focuses on students not only as consumers of information, but also as those who share and create information in collaborative environments (Mackey & Jacobson, 2010). As the information environment becomes more participatory and more complex, information literacy requires higher order thinking and metacognitive skills.

Information Literacy Instruction

Information literacy instruction takes place in a variety of venues and is taught by a variety of experts. School media specialists, guided by the AASL standards, work with teachers to acquaint students to research (Cassell & Hiremath, 2011). Academic librarians provide information literacy instruction, guided by the ACRL Standards and Framework, by having "one-shot" sessions where they meet with a class and go over basic research skills, by providing online modules, tutorials, and research guides, and by teaching for credit courses, to name a few. Many of the learning theories that shape the way technology is used in the classrooms are shaping the way that information literacy is being taught as well.

Learning Theories that Support Technology Use

Constructivism

Constructivism is a learning theory that states that students learn through their interaction with their environment. In constructivism, the teacher takes on a role as a facilitator to help the learner interact with their environments, allowing them create new knowledge (Dewey, 1938). For constructivist theorists, experiences create reality rather than vice versa (Jonassen, 1994). For Piaget (1968), a child psychologist influential in constructivist theory, learners must adapt to these experiences either through assimilation or accommodation. Learners have schemas that allow them to understand the world, and as they encounter new information, they either assimilate it into their existing schemas, or they accommodate the information by creating a new schema (Piaget, 1968). In constructivism, students learn at an individual pace with the assistance of the instructor (Powell & Kalina, 2009). Learning always happens in context (Janssen, Erkens, Kirschner, & Kanselaar, 2010); thus, the focus of education is not to instruct, but to create learning (Barr & Tagg, 1995).

A constructivist approach to teaching means that students' prior experiences are considered in the construction of the curriculum and that questioning and dialogue are used to generate discussion (Rovai, 2004). In the online environment, the constructivist teacher moves between expert and tutor, providing information and guiding students metacognitively (Rovai, 2004). The constructivist teacher also includes both individual work and group work so that students can become independent and collaborative learners (Rovai, 2004). Since authentic work is a key component of learning from a constructivist viewpoint (Honebein, Duffy, & Fishman, 1993), students should be given an opportunity to apply learning to authentic tasks in an online learning environment (Rovai, 2004). This shift is mirrored in the use of technology in the classroom, with a shift towards using technologies so that students can create content as a manner of authentic and independent learning.

Social Constructivism

Social constructivism, often attributed to Vygotsky (1978), focuses on the interaction of the learner with others. Vygotsky's social constructivism shows us that individuals create and are created by systems (Wells, 2000). Their involvement in systems allows them to continuously learn and change as they interact with others, bringing in their own knowledge, tools, and experiences. The classroom should become a "collaborative community" where students work together to explore and solve problems relevant to their situations (Wells, 2000). Because social constructivism focuses on how social interactions not only generate knowledge, but also the mental models in which learners integrate this knowledge, the individual cannot be considered independently from the social context (Palincsar, 2005).

An important aspect of Vygotsky's theory is the concept of scaffolding. Children work with adults to move through what is possible for them at their current state of development to the next level (Vygotsky, 1978). The zone of proximal development is the area between these states, and this changes as students become able to accomplish more and more on their own, and the zone of proximal development continues to expand to more difficult or complex skills (Vygotsky, 1978). The support that a student receives to achieve what they need to learn next is called scaffolding (Powell & Kalina, 2009). Learning also occurs as students interact with each other. For all learners, including adult learners, collaborating allows students to scaffold for each other and learn from their social interactions (Powell & Kalina, 2009). Students achieve more in a collaborative environment than they would have on their own.

For a social constructivist setting up an online course, it is important that the interactions students have with the instructor and other students are meaningful (Woo & Reeves, 2007). Like constructivists, social constructivists believe that learning happens most effectively when students are faced with authentic tasks and real-world problem solving (Woo & Reeves, 2007). In the computer-supported collaborative environment, students interact with each other using web-based tools to discuss, collaborate, and work on authentic problem-solving (Woo & Reeves, 2007). When students work together in an online environment, they can interact with individuals from different backgrounds who may have different perspectives (Stacey, 2007). This exposure to other ways of thinking is an essential component of social learning.

Social Presence

Social presence refers to the sense that, in a communication scenario, one is communicating with a "real" person (Short, Williams, & Christie, 1976). Social presence depends on two factors, according to Short et al. (1976) in their work on telecommunications: immediacy and intimacy. Immediacy refers to the amount of psychological distance between communicators, what Moore (1993) would call transactional distance. Intimacy relates to physical closeness (Short et al., 1976). Communicators use body language and nonverbal cues to indicate intimacy to generate social presence, but too much intimacy is uncomfortable, so individuals adjust to maintain a socially-appropriate level of intimacy (Short et al., 1976). Both intimacy and immediacy can be conveyed in a verbal way (Gunawardena, 1995); personal topics can generate intimacy, and psychological distance can be conveyed with a cold or formal message.

For CSCL, social presence is necessary for effective collaboration (Gunawardena, 1995). Social constructivism purports that CSCL can encourage the exchange of differing and different ideas in a way that leads to problem-solving and knowledge construction, but this will only be effective if students feel they are part of a learning community (Gunawardena, 1995). In the online environment, social context, like familiarity with others and informal relationships in the CSCL environment, can increase social presence (Tu & McIsaac, 2002). Online communication that is emotive and clear, and interactivity, as already discussed, through immediate, casual, and inviting communication between participants, can also increase social presence (Tu & McIsaac, 2002).

Despite the physical distance of online learners, social presence can still be a strong factor in group cohesion. Undergraduate students conferencing online in a text medium in the

1990s indicated that they were able to feel strong social presence because of the participants' ability to project an identity, despite the lack of body language (Gunawardena, 1995). Ten years later, undergraduate students in online and face-to-face seminars showed no difference in perceived social presence (Francescato et al., 2006). Instructors must make an effort to ensure that social presence exists in the online environment. Strategies include responding in a timely manner to student emails, effectively moderating and contributing to discussions, using humor and less-formal methods of communication, making an effort to connect with students in a personal way, and giving students feedback throughout the course can increase social presence (Aragon, 2003). The relationship between social presence and social metacognition could be explored using the instrument developed in this study.

Collaborative Learning

Collaborative learning has already been mentioned as a method of student-student interaction that can increase learning from a social constructivist perspective. As described by the authors of *Collaborative Learning Techniques* (Barkley, Cross, & Major, 2014), collaborative learning requires certain qualities: structured group work, effort by all students, and a deepening of knowledge. Students learn more when working together, as seen in a meta-analysis of the literature comparing learning in groups with individual learning at all student levels, including undergraduate, graduate, and professional training (Pai, Sears, & Maeda, 2015).

In a study of the critical thinking ability of students, undergraduates in the collaborative learning group demonstrated better critical thinking skills than those who learned individually, though both groups performed equally well on a recall test (Gokhale, 1995). Students working in collaborative groups to problem solve or carry out a task perform better than students who work individually (Kirschner, Kirschner, & Janssen, 2014). When students are asked to recall information in groups, however, the groups often perform worse than individuals (Kirschner et al., 2014). In higher education, collaborative learning has been shown to be beneficial to learning for non-majors in an environmental science class (Chace, 2014), students in public speaking courses (Liao, 2014), and for students learning English as a second language (Pattanpichet, 2011). Collaborative learning is not only supported by current learning theories, but also finds empirical support from the relevant literature. This study may indicate whether collaborative learning contributes to social metacognition.

Cooperative Learning vs Collaborative Learning

While cooperative and collaborative learning have often been used synonymously, many theorists believe they have different meanings (Barkley, Cross, & Major, 2014). Cooperative learning is more structured because it is believed, from a constructivist perspective, that the teacher has the expertise to design a cooperative learning activity that will increase individual knowledge (Barkley, Cross, & Major, 2014). Collaborative learning, on the other hand, includes shared expertise, consensus building, and shared responsibilities in the process (Panitz, 1999). Cooperative learning includes interdependence and common group goals, but students are assessed for their own efforts (Smith, 1996). Collaborative learning requires students to work toward one goal and share one grade (Misanchuk & Anderson, 2001).

Cooperative and collaborative learning positively impacted individual learning achievement in online and blended learning environments in a study of undergraduate and graduate students (Nickel, 2010). Cooperative strategies, however, led to lower group achievement (Nickel, 2010). This is not surprising given the social constructivist approach of collaborative learning, which means that the group is invested in the entire project, not only the individual outcomes. Students were equally satisfied with either group learning approach

(Nickel, 2010). In an analysis of an online debate, those students in a cooperative (highly structured) group engaged in more critical thinking than did the collaborative (low structure) group (Joung & Keller, 2004). A meta-analysis indicated, however, that in the transfer of knowledge, cooperative and collaborative strategies were equally beneficial (Pai et al., 2015). Additionally, group interdependence, which would be an attribute of collaborative learning, has been shown to lead to increased learning and performance (Kirschner et al., 2014). In this study, students in an information literacy course completed a collaborative assignment that requires interdependence and critical thinking as a way to increase learning.

Collaborative Learning and Information Literacy

As higher-order thinking skills are embraced by instructors of information literacy, more collaborative learning and co-construction of knowledge has been implemented in information literacy instruction. A search for “information literacy” as a subject term in the database Library, Information Science & Technology Abstracts retrieves results from 1973 on, but a search for “information literacy” and “collaborative learning” as subjects in the same database retrieves results starting in 2006; this is a new development and still not widely written about as many of the articles retrieved focus on library spaces that encourage collaborative learning or librarians collaborating with faculty. Still, with the emerging focus on metaliteracy and the ability of students to contribute content to the digital world, more information literacy instructors will move toward collaborative learning where students share resources and engage in a dialogue around their understanding of information (Ravenscroft, 2011; Witek & Grettano, 2013). Students can work collaboratively with research tools that improve metacognitive skills, like collaborative concept mapping tools, social bookmarking, and social annotation tools (Lamb & Johnson, 2009). These “participatory technologies” allow students to negotiate the research process and co-construct knowledge as they research (Farkas, 2012). Many academic library classrooms have been redesigned to facilitate collaborative learning and student participation in information literacy instruction, and this appears to be a trend that will continue as most libraries in an Association of Research Libraries survey said they had plans to renovate their learning spaces (Brown, Bennet, Henson, & Valk, 2014). Because of the importance of collaborative learning on information literacy instruction, information literacy instructors should facilitate social metacognition so that students are able to meet group goals through shared thinking.

Computer Supported Collaborative Learning (CSCL)

CSCL continues in the line of social constructivism by using technology to support collaborative group work. In CSCL, students participate in knowledge communities using information and communication technology (Lipponen, 2002). Students navigate meaning and understanding together as a way to build shared knowledge (Brodahl, Hadjerrouit, & Hansen, 2011). Instructors take on a role as a collaborative participant and facilitator, rather than the source of knowledge (Hämäläinen, 2012). Computer tools can be used to ensure that students participate in a collaborative way in the construction of knowledge and in determining the answers to problems (Pear & Crone-Todd, 2002). CSCL does not mean that all instruction occurs online, but that the computer is used as a tool to support collaboration (Stahl, Koschmann, & Suthers, 2006).

In a meta-analysis where students of all levels used computer technology, the learning outcomes of individual students were significantly better when students worked in small groups than when they worked individually (Lou, Abrami, & d'Apollonia, 2001). Collaborative online learning has been found to be as effective in improving knowledge as collaborative learning in a face-to-face environment in a study of ten graduate seminars (Solimeno, Mebane, Tomai, &

Francescato, 2008). In a study of online collaboration comparing the performance of younger and older adults, older adults performed better in the collaborative environment than in the individual environment (Wolfson, Cavanagh, & Kraiger 2014). Younger adults did not see a significantly better or worse performance in the collaborative condition (Wolfson, Cavanagh, & Kraiger, 2014). Collaborative learning can lead to improved student learning, but it must be implemented appropriately to achieve positive results.

Creating an effective CSCL environment can be difficult because merely creating a group project does not ensure that the students are effectively collaborating (Hämäläinen, 2012). Collaborative scripts provide a way to scaffold appropriate collaborative interactions to improve learning (Hämäläinen, 2012; Kollar, Fischer, & Hesse, 2006). Such structuring of collaborative activity increases social presence and the effectiveness of group work (Aragon, 2003). With CSCL, not only can scripts be useful in managing the collaborative learning process, but online tools can be created and used that ameliorate issues in collaborative learning as well (Figueira & Leal, 2013; Saab, van Joolingen, & van Hout-Wolters, 2012). These tools help to structure and regulate group learning to make them more effective.

Regulation of learning, or metacognition, is very important for CSCL as the group moves through the problem-solving process (Saab, 2012). While there may be a collaboration script, there is no instructor to assist students as they regulate their learning while they are working collaboratively if CSCL is entirely online (Saab, 2012). Some older collaboration scripts for CSCL focused more on how to communicate and coordinate rather than metacognitive skills (Kollar et al., 2006). For example, some collaboration scripts specify a particular task or role that an individual should take (Dillenbourg, 2002). To improve CSCL collaboration scripts, providing metacognitive strategies to generate more effective social regulation could be beneficial to the group's ability to generate knowledge. Even without such scripts, participants in CSCL engage in group regulation of learning in a unique manner compared to face-to-face learning because they must make their own thinking explicit to the other members of the knowledge community (Lipponen, 2002). Metacognition plays an important role in CSCL, which has received more attention in the literature recently (Volet, Vauras, Khosa, & Iiskala, 2013). This study will continue this line of inquiry by researching social metacognition in CSCL.

Metacognition in Education

Metacognitive knowledge and regulation do not necessarily predict academic success, but do have a correlation to student achievement (Tosun & Taşkesenligil, 2011). Students at the college level have varying degrees of metacognitive knowledge and abilities to regulate their cognition (Young & Fry, 2012). Within the area of metacognitive knowledge, there are three categories: declarative, procedural, and conditional (Flavell, 1979). Declarative knowledge allows students to identify the types of strategies necessary for various cognitive activities and whether or not they can accomplish these tasks, whereas procedural knowledge focuses on how to use these. Conditional knowledge allows learners to identify the situation that would call for a particular strategy (Pintrich, Wolters, & Baxter, 2000). Strategies can be as simple as memorizing or as complex as problem solving, but these are accomplished in different ways in different scenarios.

Metacognitive monitoring, part of the regulation of cognition, allows learners to determine how easy or difficult something will be to learn, how well they have learned something, and judging their confidence in knowing something (Pintrich, Wolters, & Baxter, 2000). Other researchers have described metacognitive responsiveness as something similar, though not precisely the same (Meijer et al., 2013). This can include internal feedback during learning, being receptive to external feedback on one's own cognitive performance, and a general interest in cognitive performance (Meijer et al., 2013). Metacognitive accuracy is also a component of metacognitive monitoring, where students judge whether or not they have performed well on an exam or other activity. The elements of metacognition can be seen in Table 1.

Metacognitive control, part of the regulation of cognition, is considered the planning of learning. Learners set goals, determine what strategies they will use, and determine how much time and effort to put into the learning (Pintrich, Wolters, & Baxter, 2000). This is, of course, closely related to both monitoring and knowledge. After monitoring their own understanding, students may then make choices about their own strategies. Students must have metacognitive knowledge to be able to identify strategies for each learning situation.

Table 1

Metacognition

Facet	Facet Component	Description
Knowledge of Cognition	Declarative Knowledge	Knowledge about oneself as a learner and metacognitive strategies
	Procedural Knowledge	Knowledge about *how* to use metacognitive strategies
	Conditional Knowledge	Knowledge about *when* and *why* to use metacognitive strategies
Regulation of Cognition	Monitoring	Judging performance, confidence, and understanding
	Control	Planning learning strategies and setting goals

Metacognitive knowledge and the regulation of cognition may not always be accurate. Individuals may believe that they understand something that they do not, or they may take on learning strategies that are not the most beneficial to them. In several studies, though, positive metacognitive skills correlate to higher academic achievement in higher education (Chang, 2010; Inan, 2013; Lee, Choi, & Kim, 2013; Rampp & Guffey, 1999; Sharma & Bewes, 2011). Some studies have not found a significant relationship between metacognition and student achievement in higher education (Radovan, 2011; Uzun, Unal, & Yamac, 2013). These studies do not all use the same instrument to assess metacognitive strategies. Assessing metacognition in a similar manner or triangulating findings can allow for more consistent way to predict the relationship between metacognition and student achievement.

Self-regulation

Metacognition and self-regulation are sometimes used interchangeably (Dinsmore, Alexander, & Loughlin, 2008), but the terms are not entirely the same in the literature. One possible distinction is that self-regulation encompasses behaviors and motivation, not just cognition (Dinsmore, Alexander, & Loughlin, 2008), and thus metacognition would be a subset of self-regulation. While both require an understanding of contextual factors, self-regulation in particular seems to depend on the goals, motivations, and situation of the learning (Kaplan, 2008; Lajoie & Lu, 2012). Metacognition focuses on the knowledge and regulation of cognition itself.

Self-regulated learning includes goal-setting, task strategies, self-monitoring, self-evaluation, and adaptive help seeking (Kitsantas & Dabbagh, 2011). There are three stages to self-regulated learning: forethought, performance, and self-reflection. Self-regulated learners set goals and plan in the forethought processes stage, implement strategies that will help them to learn and monitor their learning in the performance processes stage, and then evaluate their performance in the self-reflection processes stage (Kitsantas & Dabbagh, 2011). Those students with well-developed self-regulation skills are more motivated and tend to learn more (Pintrich, 2003). Self-regulated learners have control over their learning process, and thus are more likely to be successful in online learning environments (Artino, 2008; Shea & Bidjerano, 2010).

As an aspect of self-regulation, self-efficacy is a student's own belief of their ability to achieve certain learning goals (Shea & Bidjerano, 2010). Those learners with strong self-efficacy will devote their time and energy to meet their goals and solve problems, whereas those without strong self-efficacy will focus on failure before they have even begun their efforts (Coutinho, 2008). While research has found that self-efficacy can contribute independently of metacognition for performance, both are correlated with higher-performing college students (Coutinho, 2008).

Attitudes toward learning, beliefs about abilities, and academic motivation are important to learning as aspects of self-regulation and academic success, but are beyond the scope of metacognition. Understanding that metacognition contributes only one piece to academic success is an important factor to consider when studying metacognition. Metacognition may not be a direct cause of academic achievement, but may play a role with other learning strategies to improve student cognitive habits and, therefore, student success.

Metacognition and Other Learning Strategies

Metacognition has been linked to a number of other learning strategies that increase student performance (Bartels & Magun-Jackson, 2009; Pintrich & De Groot, 1990). Undergraduate students with a high level of desire for achievement reported using higher levels of metacognitive strategies (Bartels & Magun-Jackson, 2009; Bouffard, Boisvert, Vezeau, & Larouche, 1995). Student fear of failure, which has been linked to avoidance of performance goals, had a negative relationship to metacognitive strategies in a study of undergraduate students (Bartels & Magun-Jackson, 2009). In another study of undergraduate students, metacognition was significantly related to delay of gratification, intrinsic motivation, self-efficacy, and time management (Bembenutty, 2007). Students with high levels of self-efficacy tend to use more metacognitive strategies, though academic performance had a stronger correlation with self-efficacy than metacognition (Coutinho, 2008). A weak negative relationship was found between metacognition and procrastination for undergraduate students (Wolters, 2003). Overall, metacognitive strategies correlate with other learning strategies and attitudes that positively contribute to student learning. Thus, it is possible that scaffolding and improving metacognitive ability in students can improve student outcomes.

For graduate and post graduate students learning in an online environment, metacognitive strategies have been positively correlated with self-efficacy, cognitive engagement, and emotional engagement (Pellas, 2014), as well as intrinsic motivation (Rakes & Dunn, 2010). Metacognition, however, has been negatively correlated with behavioral engagement, or active student participation in the online environment (Pellas, 2014), along with procrastination (Rakes & Dunn, 2010). Having a better understanding of the relationship between metacognition and other learning strategies will allow instructors to better predict student success and intervene and scaffold metacognitive skills that will improve student learning strategies.

Metacognition and Satisfaction

Metacognition has been positively associated with course satisfaction as well. In a survey of online undergraduate students, metacognitive self-regulation was positively correlated to satisfaction (Puzziferro, 2008). In a study of workplace e-training, those with higher metacognitive skills indicated higher satisfaction with the e-course (Johnson, Gueutal, & Falbe, 2009). Students with higher levels of satisfaction tend to have higher grades (Oja, 2011; Valentine 2003). While this is not necessarily a causal relationship, scaffolding metacognition to increase student achievement could also increase student satisfaction levels. Additionally, the link between social metacognition, other learning strategies, and student satisfaction could be further explored to see if the relationships among these is similar to that of metacognition.

Domain Specific or Domain General

Is metacognition domain-specific or domain-general? That is, do the metacognitive skills of learners extend throughout their education, from one field to another, or are there specific metacognitive skills relevant to each discipline? Some scholars argue that the mental processes involved in metacognition can be applied various domains (Schraw, 2001). Others focus on using domain-specific metacognitive strategies to enhance performance in a subject, like in science education (Künsting, Kempf, & Wirth, 2013) and mathematical reasoning (Kramski & Mevarech, 2003).

Researchers studying university students across domains found that metacognitive knowledge and regulation were domain-general, but that metacognitive accuracy was domain-specific, with humanities students correctly rating their performance on an exam significantly higher than science students (Scott & Berman, 2013). Everson, Tobias, and Laitusis (1997) found that there was some evidence for the generalizability of knowledge monitoring across domains. In their study of undergraduates instructed on metacognitive monitoring, metacognitive accuracy did not change over time (Nietfeld, Cau, & Osborne, 2005).

Comparing the metacognitive scores of undergraduates and graduates in education, Young and Fry (2008) found that there were no significant differences in knowledge of cognition scores using the Metacognition Activities Inventory (MAI). In the regulation of cognition, graduate students scored significantly higher (Young & Fry, 2008). If adult learners have different metacognitive regulating abilities (Schraw, 1994), then perhaps instructors can take action to improve the metacognitive regulation of students who are not performing at an acceptable level. Similarly, perhaps social metacognition can be developed in students through instructor intervention.

Criticisms of Metacognition

One criticism of metacognition is that it is difficult to determine what is cognition and what is metacognition since many of the strategies seem very similar (Livingston, 2003).

Additionally, some of the theoretical assumptions about metacognition, such as monitoring, control, and regulation are distinct, have been difficult to empirically support (Pintrich, Wolters, & Baxter, 2000). Indeed, the entire idea of a distinct and general metacognitive ability has been questioned due to the lack of reliable results from metacognitive accuracy assessment (Kelemen, Frost, & Weaver, 2000). A concern about scaffolding metacognition is that it can increase cognitive load so that it could negatively impact learning (Roll, Aleven, McLaren, & Koedinger, 2007). Some also argue that singling out metacognition rather than focusing on all the aspects of self-regulation does not benefit researchers, and that self-regulation provides a more thorough view of the behavioral aspects, not merely the cognitive ones (Zimmerman, 1995).

While the theoretical distinctions of metacognition may require further research, the facets of metacognitive knowledge and control have received empirical support (Schraw & Dennison, 1994). Metacognition has been shown to be beneficial to students' learning, and providing metacognitive scaffolding has been linked to higher individual achievement (Abdolhosseini, Keikhavani, & Hasel, 2011). Additionally, though self-regulated learning can provide a broader view of the elements linked to student achievement and learning, researching metacognition allows for focus on a complex construct within self-regulated learning.

Metacognition and Information Literacy

As information literacy instruction, especially in higher education, turns from a focus on skills to a focus on habits of mind, IL pushes students to consider their own thinking and understanding regarding information. Students must evaluate their own ability to engage in the information environment, and must understand how they can work collaboratively to share, remix, and produce information (Mackey & Jacobson, 2014). Additionally, as IL requires students to be able to identify a need for information and the skills to meet that information need, students need to be able to anticipate their ability to meet this need with the research strategies they have (Mackey & Jacobson, 2014). Thus, metacognition plays a central role in IL.

Various tools used by strategic researchers, the truly information literate, like concept maps, citation matrices, and evaluation models, scaffold metacognitive strategies and allow students to consider their own thinking processes throughout a research project (Houtman, 2015). While this may be the case, metacognition in the research process is not a guarantee, as even post-graduates involved in a research study did not apply metacognitive strategies as they evaluated websites (Madden, Ford, Gorrell, Eaglestone, & Holdridge, 2011). In a study of students using problem-based learning in a distance graduate course, about half of the students (n=7) used metacognitive strategies throughout the research process (Diekema, Holliday, & Leary, 2011). Encouraging students to use metacognitive strategies has been emphasized more in IL education (Mackey & Jacobson, 2014), but the impact of this new focus has yet to be seen. This study will explore whether a collaborative information literacy assignment correlates to high levels of social metacognition.

Social Metacognition

Social constructivism and collaborative learning have contributed to the development of a theory of social metacognition (see Figure 2). Just as individuals co-construct knowledge through collaboration, they may be engaged in co-regulating the cognition of the group and co-constructing the knowledge of the cognition of the group. Research indicates that social metacognition is something that is distinct from individual metacognition because it is produced by the collaborative work of a pair or group (Iiskala, Vauras, & Lehtinen, 2004; Iiskala, Vauras, Lehtinen, & Salonen, 2011). Psychologist Shea and his co-authors (2014) hypothesize that social metacognition, which they call system 2 metacognition, is used to make metacognitive representations to communicate with others about group tasks and to make judgments about the metacognitive activities of others. While understanding the individual processes and metacognitive skills of those collaborating in groups can be beneficial to researchers, research on group processes should include group level analyses (Arvaja, Salovaara, Häkkinen, & Järvelä, 2007). Research has only recently begun to look at interactions between participants, rather than individual expressions, as being indicative of individual cognition and metacognition (Arvaja et al., 2007).

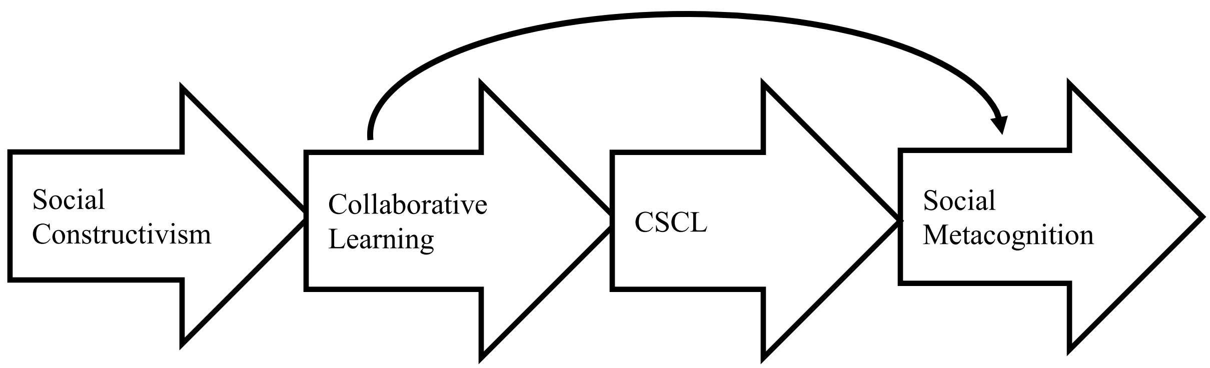

Figure 2. Relationship between Learning Theories / Strategies and Social Metacognition

According to educational researchers Chiu and Kuo (2009), social metacognition has the benefit of allowing group members to make explicit their metacognitive processes, along with allowing metacognitive effort to be distributed among the group members. By making the metacognitive work apparent, individuals can scaffold metacognitive processes for each other and improve individual metacognitive work along with improving the group's social metacognition (Chiu & Kuo, 2009). Undergraduate students working in pairs have been found to have more metacognitive activity than those working alone in problem solving (Derry, 1993). Teachers of younger students may first provide instruction for basic metacognitive skills, but then they can focus on creating a classroom learning environment that supports advanced and social metacognition (Chiu & Kuo, 2009). If metacognitive knowledge for adult learners remains relatively consistent over time (Young & Fry, 2008; Schraw, 1994), collaborative work could improve metacognitive regulation for individuals, as Chiu and Kuo (2009) suggest. The metacognitive scaffolding provided by the group members could model strategies for the knowledge of and regulation of cognition.

Social metacognition works similarly to metacognition. Students in groups have knowledge of cognition, but this appears as an understanding of who has the expertise in the group (Siegel, 2011). For the regulation of social cognition, students must monitor their knowledge as well as the knowledge of others in a public way, along with making sure that goals are met (Siegel, 2011). Instructors must keep in mind that an individual's prediction of another's knowledge is often based on their own knowledge (Jost, Kruglanski, & Nelson, 1998). For example, students trying to predict another's knowledge are more accurate when they are both working with the same information (Molinari, Sangin, Dillenbourg, & Nüssli, 2009). Encouraging students to understand the unique knowledge of each group member and creating activities that allow students to exchange this unique knowledge improves group performance (Kirschner et al., 2014).

In an online environment, social metacognition can be used to improve the creation of correct knowledge. For example, in a study of asynchronous discussions in an online high school math course, social metacognition through questions, disagreements, and correct evaluations of others' statements increased the likelihood of original, correct ideas being generated in the discussion (Chen, Chiu, & Wang, 2012). These discussions did not include any teacher facilitation, but Chen et al. (2012) hypothesize that this could assist in generating correct responses from students and metacognitive activity. Similarly, in a study of conversations in small groups solving math problems, successful peer collaboration for high school students in included offering ideas for feedback and monitoring others' thinking (Goos, Galbraith, & Renshaw, 2002). In a meta-analysis of socially-shared regulation, only three articles indicated through an empirical study a connection with learning outcomes, but all three found that higher levels of socially-shared regulation were positively correlated with improved performance (Panadero, Kirschner, Järvelä, Malmberg, & Järvenoja, 2015). With the advantages of metacognition and social metacognition, instructors may wish to explore how to increase metacognitive and social metacognitive strategies in students.

Scaffolding Metacognition

Since metacognitive strategies provide such a benefit, instructors wish to see that their students employ them. Metacognitive abilities are not necessarily automatic for students, but often must be learned. While a study of online discussions indicates that there is metacognitive activity that takes place in those discussions, it does not appear that students, even graduate students, employ all the metacognitive strategies available to them (Snyder & Dringus, 2014). Metacognitive abilities can be taught and improved upon through scaffolding and integrating metacognitive activities into assignments (Chalmers & Nason, 2005; Molenaar, van Boxtel, & Sleegers, 2010). Students who received metacognitive scaffolding in one study had higher GPAs than students who did not receive metacognitive instruction (Abdolhosseini, Keikhavani, & Hasel, 2011). Metacognitive scaffolding can also improve collaborative learning. In a study of 67 students in an online university course, Cacciamani et al. (2012) found that facilitator support and metacognitive reflection led to an increase in students' engagement in knowledge building. Students were prompted in the discussion board to engage in metacognitive reflection in this study, specifically asking them to consider the learning strategies that worked well for their collaboration (Cacciamani et al., 2012). The supportive facilitator rather than the oppositional facilitator led to better knowledge building (Cacciamani et al., 2012). In a study of children aged 10-12, researchers found that metacognitive scaffolding through a computerized attention management system could be used to increase metacognitive activities in small groups (Molenar, Boxtel, & Sleegers, 2010). This system helped students orient, plan, and monitor their performance, asking students to do things like write learning goals and create mind maps (Molenar, Boxtel, & Sleegers, 2010). In a study of 82 university students using a collaboration script in a problem-based learning scenario online, the researchers found through discussion analysis that collaboration with group members online helped learners with their planning, goal determining, strategic knowledge, and self-knowledge (Papanikolaou & Boubouka, 2010). This script asked students to develop assessment criteria and provide feedback on other students' work (Papanikolaou & Boubouka, 2010).

Azevedo (2005) suggests that computer-based learning environments could scaffold metacognitive and self-regulating knowledge in hypermedia (where media like graphics and sound are linked to text through hyperlinks) environments. Research indicates that the adaptive capabilities of a system providing scaffolding is, at this point, inferior to human facilitators (Azevedo, 2005). Still, finding a tool that will assist students in their regulation of their learning could lead to increased understanding of a topic. In an experiment of university students, researchers found that a metacognitive support device that provided training and prompts as students learned about a topic did not significantly differ from the control group in recall and knowledge, but did significantly increase transfer skills (Bannert, Hildebrand, & Mengelkamp, 2009). In another study, history undergraduates who used a metacognitive online tool had improved recall ability compared to the control group, but not improved comprehension (Poitras, Lajoie, & Hong, 2012). Pedagogical agents that prompt undergraduate students to self-test, connect knowledge to their previous understanding, and summarize, along with providing feedback on their performance for these metacognitive tasks, show increased learning efficiency scores when compared to a control group or those who received prompts but no feedback (Azevedo et al., 2012). Metacognitive tools can differ in their structure and in their effect on learning, and more research is required to understand their appropriate use.

Scaffolding Social Metacognition

Students working in pairs who are not working interdependently may actually find that metacognitive prompting from their partners actually diminishes their performance (Crook & Beier, 2010). Thus, social metacognition must be scaffolded to be beneficial to learners. According to Järvelä and Hadwin (2013), there is little research on how CSCL tools can assist in developing metacognition in collaborative learning. They argue that research in CSCL should include information about shared metacognition and how regulation of learning in a collaborative environment leads to better understanding (Järvelä & Hadwin, 2013). Computer-based pedagogical tools, like pedagogical agents, and mirroring tools, like visualization tools, can contribute to collaborative metacognition, but these tools have not been fully explored in the literature for this purpose (Järvelä & Hadwin, 2013).

Some studies covering tools to scaffold metacognition in CSCL do exist, however. In a study of 10th grade students collaborating online, researchers found that those who received instruction on how to better collaborate and those who received instruction and used the Collaborative Hypothesis Tool, a metacognitive scaffolding tool, showed significantly more regulation of team activities than those students collaborating without instruction or the tool

(Saab, van Joolingen, & Hout-Wolters, 2012). Additionally, they found that support in both instruction and with an online tool resulted in a significant positive correlation between team regulation and team performance (Saab, van Joolingen, & Hout-Wolters, 2012). Thus, through both instructor facilitation and collaborative tools that scaffold appropriate metacognitive activities in CSCL, students can work more effectively together. When first-year community college students used a collaborative annotation tool in an English course, they showed higher levels of metacognitive activity and reading comprehension (Johnson, Archibald, & Tenenbaum, 2010). This was not statistically different, however, from working collaboratively to compare student responses to those responses of an expert (Johnson et al., 2010). Another study by Pifarre and Cobos (2010) indicated that a collaborative tool called KnowCat improved metacognitive skills of students in a CSCL environment. Using this tool, students scaffolded each other's learning as they collaboratively constructed knowledge (Pifarre & Cobos, 2010). Through KnowCat, the social metacognitive abilities of the students were improved throughout the process because of the intervention of the tool (Pifarre & Cobos, 2010). In another study of college students, groups who used a metacognitive collaborative tool more often had higher levels of positive interdependence and group regulation (Kwon, Hong, & Laffey, 2013). The metacognitive tool did not improve individual performance, but it did support higher perceived group performance (Kwon et al., 2013).

Individual metacognitive abilities can act as a scaffold within the group process to improve other individual's metacognition and the social metacognitive process (Chiu & Kuo, 2009). In a study of 7th and 8th graders, individual metacognitive scaffolding increased metacognitive activity in the group, while social metacognitive scaffolding had no significant impact on metacognitive activity (Zion, Adler, & Mevarech, 2015). Students using a feedback tool in a CSCL environment at a Finnish university did not see an improvement in group regulation (Panadero et al., 2015). Groups composed of individuals with high levels of self-regulation abilities did predict higher levels of socially shared regulation in the group (Panadero et al., 2015).

Collaborative editing tools like wikis have been used to enhance the understanding of students as well as to encourage metacognitive skills. In Aharony's (2009) study of using a wiki for an undergraduate course through a content analysis, the researcher found that, of students' constructive, original comments, most were "deep comments," or comments that use metacognitive skills and deeper thinking processes. Social media tools like blogs and wikis have been rated by graduate students as increasing metacognition (Blaschke, Porto, & Kurtz, 2010), but more research should be conducted to better understand the degree to which these tools contribute to metacognition and social metacognition. Even interactive whiteboards have been found to increase the social metacognition of students working in groups – in this case, medical students – when compared to students using a traditional whiteboard (Lajoie & Lu, 2011). This study will provide an instrument to help measure the impact of technological and pedagogical interventions on social metacognition.

Assessing Metacognition in Education

Finding an appropriate way to assess metacognitive activities of learners continues to be a challenge. Measurements can occur online, during the metacognitive activity, or offline, either before or after the metacognitive activity (Azevedo, Moos, Johnson, & Chauncey, 2010). Online methods include think-aloud protocols and performance judgments. Offline methods include self-report questionnaires and interviews. All of these methods have their advantages and disadvantages. Examining the advantages and disadvantages can indicate an effective approach for assessing social metacognition as well.

Validity

Validity is the degree to which the tested variable is indeed being tested. There are three types of validity: content validity, criterion-related validity, and construct validity. Content validity examines if a test or survey adequately covers all aspects of a concept. Per DeVellis (2003), content validity becomes more difficult to determine when the concept is not clearly defined. For metacognition, it is difficult to recognize the range of questions or attributes that can represent an appropriate sample of all metacognitive aspects. Criterion-related validity is also called predictive validity. This is the relationship between that which is being tested and the outcome being measured. For metacognition, different means of assessment can be conducted at the same time to determine if there is criterion-related validity. While some instruments are compared with standardized tests, metacognition has been found to only have a moderate correlation to standardized intelligence tests (Pintrich et al., 2000). Since metacognition is not the same as the outcome shown by an intelligence test, the criterion-related validity of metacognition should not be linked to intelligence. Even when compared to student achievement, metacognition can be correlated, but it is not a causal relationship (Schunk, 2008). For causal relationships, metacognition and changes in learning should be linked (Schunk, 2008). Focusing on specific learning outcomes will allow researchers to see what metacognitive processes generate differences in student learning (Winters, Greene, & Costich, 2008).

According to Pintrich et al. (2000) and their overview of metacognitive assessment methods, most of the methods of assessing metacognition fail in their construct validity. Construct validity examines how the concept is related to other variables. Metacognitive knowledge may not be directly correlated with a standardized intelligence test, but has been shown to correlate to other measures that are more closely related with metacognition (Pintrich et al., 2000). Thus, if another task or attribute is positively correlated with a valid metacognitive assessment rating, then a new metacognitive assessment rating should also be positively correlated to that task or attribute to a similar degree. This will indicate construct validity of the new metacognitive assessment.

Reliability

Reliability is degree to which a test can be repeated with similar results. One method of determining reliability is to assess internal consistency, which indicates the degree to which the items in a test correlate with one another. Crombach's coefficient alpha is a measure often used to indicate internal consistency (DeVellis, 2003). This does not indicate what the construct being measured is, but it does indicate if the items are measuring the same construct (Veenman, 2011). A Cronbach's alpha of .80 or higher indicates good internal reliability (Field, 2013). Split-half reliability shows the degree to which half the items of the test correlate with the other half. Test-retest reliability correlates results over two administrations of the same scale with the same individuals. A generalizability study, or *G* study, shows when a particular facet changes, like the setting of test administration, if the results of the test change. If the variability in the results are due to the facet, then the generalizability coefficient will be low (DeVellis, 2003). This means that the variance in results is due mostly to the facet, not the individual performance of those being tested. Unfortunately, the *G* correlations of metacognitive accuracy judgments has been found to be low (Kelemen et al., 2000).

Reliability of other metacognitive skills tends to be high, with some exceptions (Pintrich et al., 2000; Veenman, 2011). For online methods of assessment and other assessment methods that require coding student responses, interrater reliability, the degree to which the raters agree, must be high to be useful (Schellings, van Hout-Wolters, Veenman, & Meijer, 2013). To benchmark interrater reliability, Cohen's kappa is used (Graham, Milanowski, & Miller, 2012). A high Cohen's kappa is over .80, and over .60 is the minimum acceptable level (Graham et al., 2012).

Self-Report Instruments

Self-report instruments are offline metacognitive assessment instruments that ask the learners to indicate what strategies they use for their learning. These can be given before or after a task, and can be distributed and processed quickly (Veenman, 2011). As with all self-report instruments, there are limitations. Social desirability bias, where respondents over-report what they consider to be positive responses and under-report what they consider to be negative responses, is a concern with any self-reporting instrument (DeVellis, 2003), and can play a role in surveys that involve educational outcomes (Miller, 2012). Students may not understand scale items or may not be able to connect those items with the strategies they use (Pintrich et al., 2000).

The Motivated Strategies for Learning Questionnaire (MSLQ) is an instrument that assesses students motivation, cognitive, metacognitive, and resource management strategies (Pintrich, Smith, Garcia, & McKeachie, 1991). Twelve questions in the instrument that study metacognitive strategies focus on reading and studying. Five items from the MSLQ were used by researchers studying metacognition of adult online students who dropped out and those who completed a course (Lee, Choi, & Kim, 2013). They found that the Crombach alpha for the internal reliability of the metacognitive questions was .71 (Lee, Choi, & Kim, 2013). Students who completed online courses had significantly higher metacognitive ratings than students who dropped out (Lee, Choi, & Kim, 2013). In a study of graduate students, the effort regulation scale of the MSLQ had a coefficient of .58 (Rakes & Dunn, 2010). In the original development of the instrument, the internal consistency coefficients ranged from .62 to .93 for the Motivational subcales and from .52 to .80 for the Learning Strategies subscales, which includes metacognitive strategies (Pintrich et al., 1991). This is not a strong relationship. The confirmatory factor analysis also does not fit the model well (Pintrich et al., 1991). Additionally, the effect sizes of the predictive validity analysis generated by comparing scores on the MSLQ and final grades are small, ranging from -.27 to .44, and averaging .22 (Pintrich et al., 1991). In another test of predictive validity, metacognitive strategies had a small (r=.30), positive correlation to the course grade (Pintrich, Smith, García, & McKeachie, 1993). The MSLQ has been significantly correlated (r=.64) to the MAI, another metacognitive self-report instrument (Sperling, Howard, Staley, & DuBois, 2004).

The Metacognitive Activities Inventory (MAI) focuses on the two-pronged definition of metacognition, knowledge and regulation of cognition (Schraw & Dennison, 1994). While Schraw and Dennison (1994) began with eight subdivisions within these two facets, the exploratory factor analysis supported a two-factor model. The experiments conducted by Schraw and Dennison (1994) on this instrument validated this approach with an internal consistency of .88 to .93. In a study of undergraduate students, the MAI was given as a pre-test and a post-test. The internal consistency coefficient for knowledge of cognition was .73, and then increased to .80 in the post-test. The internal consistency coefficient for regulation of cognition was .83, and increased to .89 for the post-test (Jones, Antonenko, & Greenwood, 2012). The Turkish versions of the MAI, tested on 607 university students, was found to have a .95 internal consistency coefficient for the entire scale and between .93-.98 for the subscales

(Akin, Abaci, & Cetin, 2007). Additionally, the test-retest reliability coefficient was .95 (Akin et al., 2007).

Knowledge of cognition and regulation of cognition as indicated by the MAI has been positively linked to student performance of college students (Hammann & Stevens, 1998). First-year college students who scored higher on the MAI were less likely to drop a college course (Sperling et al., 2004). Young and Fry (2008) found that scores on the instrument in both knowledge of cognition and regulation of cognition correlated with end-of-course grades and overall GPA for both undergraduate and graduate students, though the correlation was not large. This contrasts with the study by Sperling et al. (2004), which showed a negative correlation with SAT math and both knowledge and regulation of cognition as assessed by the MAI, and no correlation between the MAI and SAT verbal or the high school average GPA. In a study of Turkish first-year university students, the MAI was a predictor of academic success in an English course, but only a small one (Tok, Özgan, & DÖġ, 2010). Metacognitive regulation of college students in Europe was positively correlated with higher quality writing, but metacognitive knowledge was not correlated to writing quality (Lehmann, Hähnlein, & Ifenthaler, 2014). Thus, the construct validity of the MAI is unclear at this point, but should be explored further to see if the MAI can predict student performance.

Researchers developed a metacognitive instrument that included knowledge of cognition, objectivity, problem representation, subtask monitoring, and evaluation, based on the Jr. MAI and the How I Solve Problems instrument (Howard, McGee, Shia, & Hong, 2000). This was piloted on students from ages 10 to 19. The internal consistency was an alpha of .935 (Howard et al., 2000). The factor analysis supported a five-factor model (Howard et al., 2000). Three of the facets were significantly correlated with content understanding of science for students from grades 5-12 (Howard, McGee, Shia, & Hong, 2001). Four of the facets were significantly correlated with problem solving in science (Howard et al., 2001).

The metacognitive questionnaire used by Scott and Levy (2013) was an attempt to develop a five-item instrument combining factors of the the MAI, the Inventory of Metacognitive Self Regulation (IMSR) (developed from the MAI), and O'Neil's Self-Assessment Questionnaire (SAQ). What the researchers found is that a two factor model was the most appropriate method of assessing metacognition based on the eigenvalues, scree test, and variance (Scott & Levy, 2013). They also found that the two factors had strong internal consistency, with metacognitive knowledge having a Cronbach's alpha of .85 and metacognitive regulation having a Cronbach's alpha of .87 (Scott & Levy, 2013). Thus, an instrument with a two-factor model may be a stronger method of assessing metacognitive awareness.

Some metacognitive self-report instruments are domain-specific. One of these is the Metacognitive Awareness Listening Questionnaire (MALQ). This has been used to show the correlation between metacognitive awareness and listening performance for students learning another language (Rahimirad & Shams, 2014; Vandergrift, Goh, Mareschal, & Tafaghodtari, 2006). Another is the Metacognitive Awareness of Reading Strategies Inventory (MARSI). High ratings on this have been correlated to higher reading ability in students from grades 6-12 (Mokhtari & Reichard, 2002). In a study of ninth-grade students, however, there was not a correlation between ratings on the MARSI and reading ability (Cromley & Azevedo, 2006). The Metacognitive Activities Inventory (MCAI) assesses the metacognitive activities of chemistry students. The instrument has a high level of reliability, with Cronbach's alpha levels of higher than .85 for a pre- and post-test administration of graduate and undergraduate students (Cooper & Sandi-Urena, 2009). In this study, only students with a final letter grade of A had a significantly higher MCAI score when compared to students receiving another grade (Cooper & Sandi-Urena, 2009).

While the two-factor model is supported in the literature (Schraw & Dennison, 1994; Scott & Levy, 2013), other researchers argue that the instrument needs to consider three aspects of metacognition, and none does so yet (Pintrich et al., 2000). As far as some researchers are concerned, metacognitive knowledge, metacognitive judgments and monitoring, and metacognitive control are the three factors of metacognition (Pintrich et al., 2000). Metacognitive judgments allow learners to make predictions about how easy or difficult something is to learn, and whether they know something and have answered correctly (Pintrich et al., 2000). Metacognitive control refers to planning strategies and setting goals (Pintrich et al., 2000). The Awareness of Independent Learning Inventory (AILI) developed by Elshout-Mohr, van Daalen-Kapteijns, and Meijer (2004) attempts to assess metacognition from a three-factor approach. Responsiveness (metacognitive judgments, sensitivity to metacognitive situations, and curiosity about metacognition), awareness of metacognitive experiences, and the importance of metacognition are the unique components of the AILI because MSLQ and the MAI do not test those aspects, only knowledge and regulation of cognition (Meijer et al., 2013). AILI has been shown to be reliable and valid (Vrugt & Oort, 2008). A shortened version of the AILI, used to measure knowledge of cognition, regulation, and responsiveness, had a high Cronbach alpha level for all items ($\alpha = .88$) (Vrugt & Oort, 2008). Additionally, Meijer et al. (2013) found in their study of university students that the AILI provided generalizable findings on learning-related metacognition based on a *G* coefficient of .82. They found in a test-retest condition that metacognitive knowledge and regulation stayed more consistent over time than responsiveness, but the test-retest coefficients were low (Meijer et al., 2013). After a confirmatory factor analysis was conducted on both the AILI and the MSQL, the factors of the AILI had a moderate correlation to the MSQL cognitive and metacognitive factors (Meijer et al., 2013).

Table 2

Metacognitive Self-Report Instruments

Instrument Name	Instrument Citation	Instrument Variables
Motivated Strategies for Learning Questionnaire (MSLQ)	Pintrich, Smith, Carcia, and McKeachie (1991)	Motivation, cognition, metacognition, resource management
Metacognitive Awareness Inventory (MAI)	Schraw and Dennison (1994)	Knowledge and regulation of cognition
How do You Solve Problems?	Howard, McGee, Shia, and Hong (2000)	Knowledge of cognition, objectivity, problem representation, subtask monitoring, and evaluation
Metacognition Questionnaire	Scott and Levy (2013)	Knowledge and regulation of cognition
Metacognitive Awareness Listening Questionnaire (MALQ).	Vandergrift, Goh, Mareschal, and Tafaghodtari (2006)	Metacognitive awareness for learning another language

Table 2. (Continued)

Instrument Name	Instrument Citation	Instrument Variables
Metacognitive Awareness of Reading Strategies Inventory (MARSI)	Mokhtari and Reichard (2002)	Metacognitive awareness for reading
Metacognitive Activities Inventory (MCAI)	Cooper and Sandi-Urena (2009)	Metacognitive awareness for chemistry
Awareness of Independent Learning Inventory (AILI)	Elshout-Mohr, van Daalen-Kapteijns, and Meijer (2004)	Metacognitive responsiveness, metacognitive experiences, and understanding the importance of metacognition

There are some concerns regarding the construct validity of the self-report assessments (Pintrich, Wolters, & Baxter, 2000). For one, the theory regarding the various aspects of metacognition beyond two factors does not seem to match with the findings from the instruments used, like the MAI (Pintrich et al., 2000). The taxonomy by Meijer et al. (2006) also has granularity that is too fine given the findings of various metacognitive instruments. Given how far-reaching metacognitive knowledge can be, it is hard to say that an instrument can measure it in a few questions (Pintrich et al., 2000). Additionally, as Winne (2010) argues, self-report instruments may have little meaning and reliability if students are supposed to respond to their class experience or global experience when different contexts may generate different metacognitive experiences. Thus, researchers and instructors may wish to use self-report instruments after specific interventions, as this study does.

Coding

Some researchers use transcript coding to determine the quality and category of student discussions (Lajoie & Lu, 2012; Papanikolaou & Boubouka, 2010). Meijer, Veenman, and van Hout-Wolters (2006) provide a taxonomy of six metacognitive activities, including orientation, planning, executing, monitoring, evaluation, and elaboration, that allows researchers to categorize transcripts. While constructs exist for analyzing transcripts regarding both knowledge and regulation of cognition (Akyol & Garrison, 2011), there is the concern that students may not always explicitly communicate their metacognitive processes (Snyder & Dringus, 2014). Other methods of assessment that require coding include interviews and think aloud protocols (Winne, 2010).

Follow up interviews after student learning can allow for more complex responses than what is found in a self-report instrument (Wilson, 1997). In a study of sixth graders completing math problems, researchers found that the interview did not provide much data beyond the questionnaire (Wilson, 1997). Perhaps the age of the students limited their ability to reflect on their cognitive and metacognitive processes. Being able to understand where a student is not using metacognitive strategies through an interview can allow a teacher to provide metacognitive intervention to improve a student's learning ability (Israel, Bauserman, & Block, 2005). In a study of university students, high-achieving students did not describe their metacognitive processes with more precision than low-achieving students, nor did they describe more metacognitive strategies, but their strategies are more organized in temporal and hierarchical structure (Romainville, 1994). The students with almost no metacognitive strategies and who did not believe that they needed to adjust their cognitive strategies to improve performance in this study had very low scores (Romainville, 1994). Thus, interviews can provide insight into metacognitive processes, though they do have the limitation of being a self-report assessment.

Think aloud assessment requires students to describe their thought process and why they made particular cognitive moves as they perform a task (Bannert & Mengelkamp, 2008). While there is a concern that think aloud assessment may generate more metacognitive activity than what is naturally occurring, a study of university students found that the think aloud and silent learning control group showed no difference in learning performance (Bannert & Mengelkamp, 2008). Interrater reliability for coding the think aloud data was Kappa .79 (Bannert & Mengelkamp, 2008). Ratings of think aloud protocols of elementary children solving world problems had no significant relationship to student achievement (Desoete, 2008). It is important to note that think aloud data has the limitation of being essentially a self-report method (Winne, 2010). The idea that students can express all the metacognitive functions as they are occurring seems unlikely, even with students in higher education.

Think-aloud protocols and questionnaires have been compared to determine if they are correlated in a number of studies (Jacobse & Harskamp, 2012; Schellings et al., 2013). These correlations tend to be low, which shows that respondents are perhaps not very accurate in their understanding of their metacognitive abilities (Jacobse & Harskamp, 2012; Schellings et al., 2013). Self-report instruments that more closely model what is assessed in the think-aloud protocols show greater correlation (Schellings et al., 2013).

Given the issues with the above methods of assessment, Winne (2010) suggests that computer-based learning environments (CBLEs) can allow researchers to track metacognitive activity through "traces," or computer evidence of cognitive and metacognitive activity from a learner as they work with a text or program. For example, intelligent tutoring systems can document the activity of students as they seek help in CBLEs (Aleven, Roll, & Koedinger, 2010). An important consideration is that metacognitive activity may not be represented by all student action in a CBLE (Winters et al., 2008). The nature of self-regulatory processes means that they are not all explicit in student activity (Ibabe & Jauregizar, 2010).

In a study of 13-year-olds, logfiles of activities of students studying otter populations were collected (Veenman, Bavelaar, De Wolf, & Van Haaren, 2014). The logfiles accounted for approximately 40% of the variance for learning performance, similar to those of think-aloud and observation methods (Veenman et al., 2014). The correlation to overall intelligence was low (Veenman et al., 2014), which is a similar finding to other studies (Pintrich et al., 2000). Information on the reliability of logfile analysis is limited, and the small numbers of participants because of the work researchers must complete to properly assess the logfiles, cause concerns about the sustainability of this method of assessment (Stankov & Kleitman, 2014). Researchers must make subjective judgments about the metacognitive strategies the logfiles indicate (Veenman, 2011). It is also unclear if this method has content validity because it may not be measuring metacognition, since this is not typically an explicit process (Veenman, 2011).

It is difficult to say whether online or offline methods are the best way to assess metacognition because both have their advantages and disadvantages. Online methods like think aloud and logfiles appear to have the most construct validity (Veenman et al., 2014). These are time-consuming methods, however, that must be given at the individual level, and thus the ability for researchers and instructors to easily replicate such methods is questionable (Stankov & Kleitman, 2014). Additionally, online methods can be distracting, can cause cognitive overload, and may only capture learner behavior, rather than metacognition (Veenman, 2011). For offline methods, there are several validity problems. Behavior may not match self-reports

(Veenman, 2011). Learners may not remember what they do, and this can be seen especially when a self-report instrument is used in a general way and/or is gathered without specifically relating to a task (Veenman, 2011). Using self-reports in a way that is more connected to a task can improve results (Schellings et al., 2013), though there is still the risk of students claiming to use metacognitive skills that they do not employ in reality (Veenman, 2011).

Assessing Social Metacognition in Education

For students working collaborative face-to-face, social metacognition has been assessed using observation methods (Iiskala et al., 2011; Khosa & Volet, 2014; Rogat & Linnenbrink-Garcia, 2011). In assessing the social metacognition of ten-year-old students, researchers reached an agreement of 96%, finding that social metacognition events were created by shared problem-solving (Iiskala et al., 2011). University students in another study who showed high levels of group metacognitive monitoring in problem solving also showed higher cognitive activity based on coding of observational data (Khosa & Volet, 2014). These studies require a small number of participants given the involved coding process.

In a meta-analysis on socially shared regulated learning, the researchers found that self-report instruments were not used much in the research as compared to self-regulation research (Panadero et al., 2015). One study used a questionnaire about student attitudes toward group work, called the Students' Appraisals of Group Assignments (SAGA) (Volet & Mansfield, 2006). The other study used the Adaptive Instrument for Regulation of Emotions (AIRE), which focuses on student emotions and goals in group regulation (Järvenoja, Volet, & Järvelä, 2013). Because of the lack of self-report instruments used in social metacognition and socially shared regulation, more research should develop, validate, and include these in the repertoire of assessment for collaborative learning (Panadero et al., 2015).

Thus far, coding of CSCL activities (logfiles) has been the method of assessing social metacognition (Duffy et al., 2015; Hurme, Palonen, & Järvelä, 2006; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013). This research has revealed that groups of students who engage in more regulatory activities will achieve stronger learning outcomes as a group (Järvelä et al., 2013). Duffy et al. (2015) used coding of team activities to find that team leaders were more often engaged in planning of cognition and other team members were engaged more often in monitoring cognition. In a study of secondary school students completing math problems in groups, computer notes were coded for metacognitive activity (Hurme et al., 2006). Inter-rater reliability was not high, with Cohen's Kappa value at .53 (Hurme et al., 2006).

In CSCL environment, it can be difficult to capture all metacognitive activity (Hurme et al., 2006). When categorizing the messages of an asynchronous discussion board, researchers found little evidence of all metacognitive skills, but recognized that the nature of metacognitive activity means that it is not always explicit (Snyder & Dringus, 2014). A social metacognition self-report instrument could reveal whether metacognitive awareness of team leaders and team members are impacted by their roles, and could also help to identify co-constructed metacognitive activity that is not represented in computer logs. The results of a social metacognition self-report could be compared to other assessment methods to reveal whether these are correlated. A strong correlation between an analysis of computer log file and a social metacognitive self-report instrument would mean that the social metacognitive instrument would be a valid and more reliable method of assessing social cognition. A social metacognitive instrument that correlates to group performance could be used to assess what methods improve social metacognition, allowing instructors and instructional designers to properly scaffold group work in CSCL environments.

Summary

The confluence of social constructivism and advances in distance education has led to CSCL in higher education. When students work together to construct knowledge, they also work to regulate each other's cognition and share metacognitive knowledge and regulation. This social metacognition can be scaffolded through instructor intervention and through the explicit explanation and expression of metacognitive strategies of those students in a group. The most valid and reliable method to assess metacognition and social metacognition eludes researchers.

Chapter III

Methodology

Introduction

Given the importance of metacognition in education and the rise in CSCL, finding a way to measure the intersection of these themes, social metacognition, will allow instructors and researchers to understand the benefits of CSCL to shared metacognition. This study compared social metacognition in an information literacy course online and face-to-face so that researchers and instructors can better understand how social metacognition develops in collaborative work; how individual metacognitive skills impact CSCL; the relationship between social metacognition, achievement, and other learning factors; and how social metacognition can be improved.

Research Questions

This study's main goal is to indicate whether a social metacognitive awareness instrument would show whether or not students online and face-to-face had similar social metacognitive scores. To do so, the following research questions were explored:

RQ1: To what extent does the two-factor model of metacognition (knowledge of cognition and regulation of cognition) apply to social metacognition?

RQ2: What is the relationship between individual metacognition and social metacognition?

RQ3: To what extent do students in groups in a CSCL environment in higher education agree on their ratings of social metacognition?

RQ4: How does social metacognition for students in an online information literacy course compare to the social metacognition of students taking a face-to-face information literacy course?

Hypotheses

H_1: Social metacognition, as measured by the social metacognitive instrument (SMAI), does not fit a two-factor model

H_2: Individual metacognitive scores (knowledge of cognition and regulation of cognition) will predict social metacognition.

H_3: Students in the same groups will show agreement in their social metacognitive ratings.

H_4: Students in the face-to-face version of the information literacy course will have higher levels of social metacognition than students in the online course.

Null Hypotheses

H_{01}: Social metacognition will fit the two-factor model of knowledge of social cognition and regulation of social cognition.

H_{02}: Individual metacognitive scores (knowledge of cognition and regulation of cognition) will have no relationship with social metacognitive scores.

H_{03}: Students in groups will demonstrate little agreement in their social metacognitive ratings.

H_{04}: Students in the face-to-face and online versions of the information literacy course will have similar levels of social metacognition.

Expected Results

Given the successful indication of the reliability of the MAI (Jones, Antonenko, & Greenwood, 2012; Schraw & Dennison, 1994), the instrument on which the social metacognition instrument used in this study is based, it was expected that the Social Metacognitive Awareness Inventory (SMAI) would prove to be a consistent measure of the same latent variable (social metacognition) through the data analysis. This would indicate internal validation. Internally validated instruments adequately measure a latent variable and can be used again in other studies.

Due to the prevalence of the two-factor model in studies of metacognition, regardless of instrument used (e.g. MCAI, Cooper & Sandi-Urena, 2009; MAI, Schraw & Dennison, 1994; Metacognition Questionnaire, Scott & Levy, 2013), it was anticipated that this instrument would support a two-factor model, knowledge of cognition and regulation of cognition, in social metacognition. Though this was the anticipated result, the researcher acknowledged the possibility that other factors could emerge from this research study.

The anticipated result of this study was a positive correlation between students' individual metacognition and students' social metacognition as measured by the instruments. Studies have shown that individual metacognitive abilities can scaffold their group's metacognitive activity (Panadero et al., 2015; Zion, Adler, & Mevarech, 2015; Zion, Adler, & Mevarech, 2015). It was also anticipated that this correlation would be moderated by group membership, which would be seen in a significant intercept model in multilevel modeling. Since the Social Metacognitive Awareness Inventory (SMAI) scores measure an individual's assessment of how the group performed in knowledge and regulation of social metacognition, it was anticipated that the members in the group will have similar scores.

In comparing social metacognition of students in the online version of the course with students in the face-to-face version of the course, it was anticipated that students would have differing levels of social metacognition. While there are not studies comparing social metacognition in online and face-to-face environments, a study comparing working expert groups in asynchronous, synchronous, and face-to-face environments showed that face-to-face groups regulated group processes more effectively than the asynchronous group (Becker-Beck, Wintermantel, & Borg, 2005). Students in online classes have been shown to have higher levels of individual metacognition after the course than those in face-to-face courses (Michalsky, Zion, & Mevarech, 2007). Despite this finding, others have found that groups online have greater difficulty resolving issues and have more problems with participation from group members (Smith, Sorensen, Gump, Heindel, Caris, & Martinez, 2011). Because the online course is asynchronous, it was anticipated that the students in the face-to-face version of the course would have higher levels of social metacognition because the class included more group work and more exposure to group members.

Research Methodology

The research study took place after students completed a collaborative assignment in information literacy courses. The course from which participants were asked to participate is an information literacy course required for undergraduates at a mid-sized university in a Northeastern state of the United States. The course includes students from multiple disciplines and covers academic integrity, searching library resources, and evaluating information; it is offered both face-to-face and online. Whether the course is face-to-face or online, much of the course materials is online, and students work through the research process collaboratively on their own, Internet-connected devices. Both versions of the course include a final, group assignment that asks students to research a topic in their groups and cite and evaluate the research that they find. Their final, collaborative assignment was created on Google Docs, Dropbox, or the wiki in the LMS Blackboard so that all students could access, edit, and comment on the document. Both online and face-to-face versions of the course were included in the study.

At the end of the course, consenting students completed the Metacognitive Awareness Inventory (MAI) and the Social Metacognitive Awareness Inventory (SMAI), along with a short demographic questionnaire. A confirmatory factor analysis (CFA) was used to determine if the social metacognitive instrument contains two factors, and item factor analysis determined internal validity. A multilevel linear model analysis (MLM) was performed to determine if individual metacognitive scores predicted group metacognitive scores, and if group membership impacts this relationship. An analysis of covariance (ANCOVA) was conducted to compare social metacognitive scores in the online version of the information literacy course and the face-to-face version of the course, after considering the covariate of individual metacognitive scores.

Participants

Undergraduate students enrolled in one of the versions of the information literacy course with a collaborative final research assignment were recruited to complete the survey through contact with their instructors. There are approximately twenty sections of the course, and each has about 30-38 students, so this is a population of 680 each year. Most students who take one of the information literacy courses are Freshmen. Minimum cases required for a confirmatory factor analysis (CFA) are debated in the literature. Some researchers state that at least 200 participants are required (Marsh & Hau, 1999). Others say that the rules should be at least 5 cases per variable (Bentler & Chou, 1987). A two-factor model with loadings of .5 and eight indicators required 160 cases per a Monte Carlo analysis (Wolf, Harrington, Clark, & Miller, 2013). Kline (2005) recommends 100-200 cases. To determine model fit, Lawley and Maxwell (1971) say that 51 more cases than variables would be needed. If communalities are high and factors have many variables, then sample sizes of 60 are acceptable (MacCallum, Widaman, Zhang, & Hong, 1999). Worthington and Whittaker (2006) state that 10:1 items per factor indicates that 150-200 cases are acceptable. There is clearly no standard, agreed-upon sample size for CFA. For this study, 150 student responses were sought because the factors have many variables (11 for knowledge of social cognition and 30 for regulation of social cognition) but communality was not known until after data collection.

Multilevel linear models (MLM) are needed when data is nested (Field, 2013). Collaborative learning lends itself to multilevel linear models because it does not assume independence but does not also ignore individual differences when both individual and group data is collected (Kenny, Mannetti, Pierro, Livi, & Kashy, 2002; O'Dwyer & Parker, 2014). Additionally, since this study included groups of varying sizes, MLM is appropriate because it does not require all the groups to be the same size (Field, 2013). Several studies have called for the use of multilevel modeling in CSCL research (Cress, 2008; De Wever, Van Keer, Schellens, & Valcke, 2007; Janssen, Erkens, Kirschner, & Kanselaar, 2009). The sample size required for MLM, which refers to the highest level of groups, is a minimum of 20 (Kreft & de Leeuw, 1998), but 50 is shown to be less prone to error at the group level (Hox & Maas, 2002). Thus, at least 50 groups of students (which will include the 150 students sought for the CFA) were sought for this study.

According to the statistical software G*Power, for an ANCOVA with two groups, a medium effect size of $f=.25$, power=.80, $\alpha=.05$, and one numerator degree of freedom, at least 128 participants are required. This means that at least 64 students from online sections and at least 64 students from face-to-face sections were required for that effect size. These were identified from the 150 responses needed for the CFA.

Variables

The independent variable is metacognitive awareness as indicated by the MAI. This includes the factors of knowledge of cognition and regulation of cognition. It was calculated using a 5-point Likert scale on a 52-item scale with a response of Always False corresponding to a score of 1, Sometimes False corresponding to a score of 2, Neutral corresponding to a score of 3, Sometimes True corresponding to a score of 4, and Always True corresponding to a score of 5 (see Appendix A). For the MLM, student scores were the level-one variable, and student groups created the level two variable.

The dependent variable for the MLM and the ANCOVA is social metacognitive awareness as indicated by the SMAI, a self-report instrument, which includes the factors of knowledge of social cognition and regulation of social cognition. Knowledge of social cognition and regulation of social cognition were calculated using the total score for each factor for each respondent. Each item was rated on a 5-point Likert scale, with a response of Always False corresponding to a score of 1, Sometimes False corresponding to a score of 2, Neutral corresponding to a score of 3, Sometimes True corresponding to a score of 4, and Always True corresponding to a score of 5. Knowledge of social cognition was calculated from items 3, 7, 9, 11, 12, 13, 20, 22, 25, 26, and 36 (11 total items). Regulation of social cognition was calculated from the total score on all other items (30 total items) for each individual. Individual scores for each factor represented the level 1 variable for the MLM. The overall total scores of each individual for all variables in the instrument determined the SMAI score.

The teacher or class section was not used as a level three variable for the MLM. The courses had similar assignments each week and essentially the same final project. Additionally, many sections of the course were taught by the same instructors. Thus, there was not enough difference between sections to justify this grouping, and there would not be enough top level groups for a MLM analysis. This study was interested in how social metacognition predicts student grades on a group project, not on a classroom-level intervention.

Instrumentation

The instrument was modified from the current MAI (see Appendix A) to assess social metacognition. The new instrument is the Social Metacognitive Awareness Instrument (SMAI) (see Appendix B). Questions on the modified instrument refer to the group regulation and knowledge of social cognition rather than individual metacognition. The focus of the questions also surrounds a task or project rather than general metacognitive ability. Additionally, questions that would not apply to group activity were removed. This was a total of eleven questions (numbers 3, 4, 9, 15, 17, 20, 27, 35, 41, 43, and 52). In the knowledge of cognition area, six questions were removed (3, 15, 17, 20, 27, and 35), and in the regulation of cognition area, five questions were removed (4, 9, 41, 43, and 52). These questions mainly focused on individual study habits. While Schraw & Dennison (1994) divided the instrument into eight subcomponents, the overall two factor analysis was supported by the exploratory factor analysis, while the eight-factor model was not, so the SMAI will be split into these two factors. There are eleven knowledge of social cognition items and thirty regulation of social cognition items, for a total of forty-one items in the SMAI (see Appendix A). The SMAI was be administered to students using SurveyMonkey and used a Likert scale (Figure 3). Always False corresponds with a score of 1, and Always True corresponds with a score of 5.

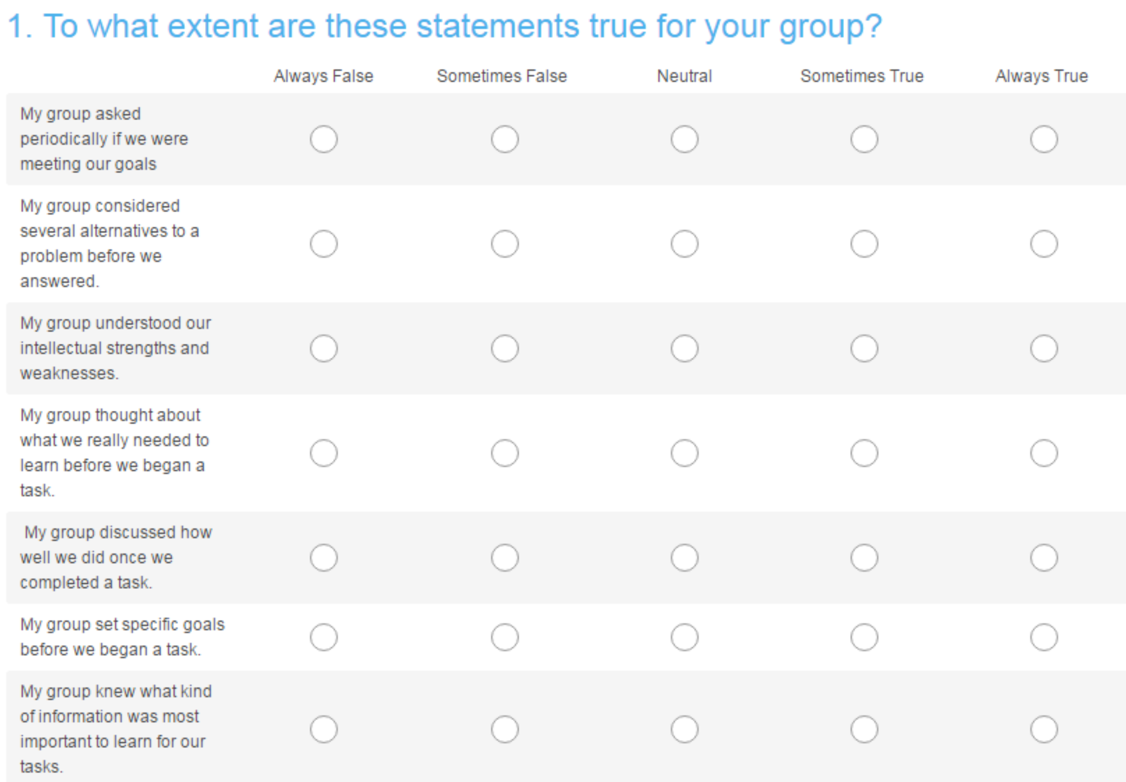

Figure 3. SurveyMonkey format for the SMAI

To compare the SMAI and the MAI, the MAI was also given using SurveyMonkey. This instrument has 52 items, and uses the same Likert scale as the SMAI, with Always False responses corresponding to 1, Sometimes False corresponding to 2, Neutral corresponding to 3, Sometimes True corresponding to 4, and Always True corresponding to 5.

Procedures

Institutional Research Board approval was acquired before recruitment began, and all ethical guidelines for using human research subjects were followed. To recruit participants, the researcher contacted instructors of the courses to ask if the researcher could invite their students to participate before the course was over in the fall of 2016. The researcher provided a link to the SurveyMonkey survey for students to complete that the instructor placed in the students'

Blackboard course site. For face-to-face sections of the course, the researcher visited the class after the final, collaborative project has been completed, explained the research study, and explained the consent procedures for the survey. Then, students were given time in class to access the survey link and complete it. For online sections of the course, students were asked to complete the survey via an emailed announcement from the researcher to the class after the final research project was completed. For students in the researcher's online class, the survey was emailed by a third party who will gave each student group a unique number so that they were anonymous. Participants were recruited until at least 150 students consented and completed the survey. The survey took about 20 minutes for students to complete the 41 social metacognitive items and the 52 metacognitive items.

The online survey contained consent information, and students clicked that they consented to the study. The data will only be seen by the researcher. Participation was voluntary and did not impact student grades or standing in the course. Students could stop their participation at any time, which withdrew their consent and did not impact their grade or their standing at the university. There were no significant risks involved in completing the survey. Instructors did not know whether students participated in the study or not, and the researcher provided each group of students not in her courses with a unique number so that they were anonymous (as stated above, students in the researcher's course were given a unique number by a third party). The students will not take future courses from the instructors or the researcher after the study.

Data Analysis

Using SPSS, data from the MAI and SMAI were screened for missing data and outliers. An item total analysis was completed to determine how deleting a question affects the reliability of the SMAI instrument. If deleting questions improved the reliability, these would have been removed. Additionally, Cronbach's alpha was used to test the quality of the scale as a whole and the subscales.

A confirmatory factor analysis was conducted to determine if the SMAI is a two-factor model. This was conducted using AMOS in SPSS to indicate the goodness-of-fit of the model. Data was screened for missing data, outliers, and normality, and issues with these were addressed. With a confirmatory factor analysis, multiple fit indices are used to determine if the model fits the data well. The comparative fit index and the TLI show goodness of fit, while the root mean square of residuals show lack of fit measures. A model that fits well will have a chi-square of $p>.05$ (Hu & Bentler, 1999) (though this methodology is not considered a very strong index), a comparative fit index (CFI) of greater than .95 (Hu & Bentler, 1999; Tabachnick & Fidell, 2013), a TLI of approaching or greater than .95 (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999), and an RMSEA (root mean square of the residuals) of $<.06$ (Hu & Bentler, 1999; Tabachnick & Fidell, 2013). The CFI and the RMSEA are the indices most often used in the literature (Tabachnick & Fidell, 2013), and all of these fit indices have been shown to be less sensitive to sample size (Fan, Thompson, & Wang, 1999; Rigdon, 1996).

A multilevel model conducted with SPSS was used to determine if knowledge of cognition and regulation of cognition on the MAI predicted total SMAI scores. While the first model was essentially a linear regression to indicate the relationship between metacognition and social metacognition, this did not take into account the fact that students were in groups and so the dependent variable would most likely have similarities among group member ratings. Therefore, a multilevel model was used to take into account the fact that students were in groups. Level 1 variables were individual scores on the MAI for knowledge of cognition and regulation of cognition. The Level 2 variable were student groups for the final project. The MLM indicated whether the individual factors of knowledge of cognition and regulation of cognition predicted social metacognitive scores, and if this relationship varies significantly among groups, revealing if group membership makes a difference in social metacognitive scores. SPSS was used to compare the -2 log likelihood of the null model with the -2 log likelihood of the random-intercept, fixed-slope model. A highly significant change as indicated by the chi-square likelihood ratio test in the random-intercept model would show that group membership does impact the relationship between metacognition and social metacognition. Random slopes were not included in the analysis because of the small group size (Clarke & Wheaton, 2007; Kenny et al., 2002; Maas & Hox, 2004).

A one-way ANCOVA was used to see if the main effect of course format (online or face-to-face) significantly impacted students' total social metacognitive scores when total individual metacognition was used as a covariate. This allowed the researcher to see if the mean scores for one group or the other were significantly higher or lower, which could reveal that more scaffolding for social metacognition is needed for that group. Before running the ANCOVA, data was screened for missing data and outliers. Tests for normality were also be conducted using the Kolmogorov-Smirnov test. Levene's Test of Equality of Variances was conducted to determine homogeneity of variance, and data were transformed if necessary. Data was tested to determine if the regression slopes are homogeneous to make sure that an ANCOVA can be conducted.

Chapter IV

Results

The purpose of this study was to investigate a measure of social metacognition within computer-supported collaborative learning to compare social metacognitive scores in online and face-to-face learning environments. To do so, this study aimed to develop and validate a social metacognitive instrument. A social metacognitive instrument, the Social Metacognitive Awareness Inventory (SMAI), was developed for the study by adopting the Metacognitive Awareness Inventory (MAI). Students in online and face-to-face computer-supported collaborative learning environments took the SMAI and MAI. The results were used to confirm whether social metacognition has two factors, to determine if metacognition predicts social metacognition, and to compare social metacognition for online and face-to-face students in computer-supported collaborative learning environments. This chapter provides findings related to the following research hypotheses:

Null Hypotheses Review

H_{01}: Social metacognition will fit the two-factor model of knowledge of social cognition and regulation of social cognition.

H_{02}: Individual metacognitive scores (knowledge of cognition and regulation of cognition) will have no relationship with social metacognitive scores.

H_{03}: Students in groups will demonstrate little agreement in their social metacognitive ratings.

H_{04}: Students in the face-to-face and online versions of the information literacy course will have similar levels of social metacognition.

For the first null hypothesis, a confirmatory factor analysis (CFA) was conducted to determine if social metacognition had two-factors, like metacognition, since the social metacognitive instrument was developed from the metacognitive instrument. For the second null hypothesis, the ungrouped multilevel model was used to indicate whether there is a significant relationship between individual scores for knowledge of cognition and regulation of cognition and the social metacognitive scores. The grouped model included group membership as a random intercept to see if this model is a better fit than the original model. If the grouping variable significantly improved the model fit that indicates group membership moderates social metacognitive scores, showing group members had similar social metacognition scores. For the fourth null hypothesis, an ANCOVA was run comparing social metacognitive scores for online and face-to-face students while moderating for metacognitive scores, indicating whether one group had significantly higher social metacognitive mean scores, when adjusted for metacognition, than the other.

Descriptive Statistics

Students completing a collaborative project in an information literacy course offered online and in person were recruited to complete the survey. A total of 371 (301 in the face-to-face course, 55 online, and 15 unspecified) students completing a collaborative project in an information literacy course offered online and face-to-face participated in the study between November of 2016 until January of 2017. Among these students, 309 (261 in the face-to-face course, 48 online) completed the questions. There were 40 incomplete survey responses, with 28 of those 40 not moving past the first page of questions. Additionally, 22 responses that had to be removed because the students answered the same for all questions, all of whom took less than five minutes to complete all 93 items. Of these, 17 were listed as outliers for the amount of time taken to complete the survey, which can be one way of identifying careless responses, though it should be paired with other methods, because response time is not the most reliable method of identifying careless responses (Meade & Craig, 2012). Individuals who answered the same for all questions were removed because of the inattentiveness they displayed toward the survey (Johnson, 2005). Researchers have suggested that even as few as 6 to 14 are too many consecutive responses in a row (Niessen, Meijer, & Tendeiro, 2016), so having all responses the same indicates that the response should not be used. This does not mean that all careless responses were definitely removed, but that measures were taken to improve the data. With the incomplete and clearly careless responses removed, this is a completion rate of 83.29%. Eighty-five groups (with two or more students) were represented, with seven online groups and 78 face-to-face groups. Data analysis was conducted with IBM SPSS version 24. Descriptive statistics for MAI and SMAI are presented in Table 3. Descriptive statistics for SMAI items are presented in Table 4.

Table 3

Mean Scores for MAI and SMAI

	N	Metacognition	SD	Social	SD
Face-to-face	261	3.985	.035	3.805	.042
Online	48	3.926	.079	3.185	.127
Total	309	3.976	.032	3.708	.043

Table 4

Mean Scores for SMAI Items

Question	Online (N=48)	SD	Face-to-face (N=261)	SD	Total mean	SD	Difference
KSC1	3.350	.180	4.020	.059	3.920	.059	0.670
KSC2	3.400	.168	4.150	.052	4.040	.053	0.750
KSC3	3.400	.178	4.130	.057	4.020	.057	0.730
KSC4	3.400	.173	4.050	.061	3.940	.059	0.650
KSC5	3.330	.194	4.150	.061	4.020	.062	0.820
KSC6	3.230	.179	3.910	.056	3.800	.057	0.680
SC7	3.000	.191	3.720	.067	3.610	.065	0.720
KSC8	3.290	.174	4.080	.056	3.950	.057	0.790
KSC9	3.190	.165	3.990	.060	3.870	.059	0.800
KSC10	3.500	.158	3.960	.054	3.890	.053	0.460
KSC11	3.790	.171	4.350	.053	4.270	.053	0.560
RSC1	3.100	.166	3.560	.070	3.490	.065	0.460
RSC2	2.980	.172	3.860	.060	3.720	.060	0.880
RSC3	3.190	.183	3.820	.067	3.720	.064	0.630
RSC4	3.020	.194	3.600	.072	3.510	.069	0.580
RSC5	3.350	.199	3.830	.070	3.750	.067	0.480
RSC6	3.100	.153	3.880	.061	3.760	.059	0.780
RSC7	3.670	.167	4.200	.056	4.120	.055	0.530
RSC8	2.980	.175	3.340	.072	3.280	.067	0.360
RSC9	2.940	.189	3.560	.071	3.460	.068	0.620
RSC10	3.210	.176	3.750	.064	3.670	.061	0.540
RSC11	3.130	.183	3.850	.063	3.740	.062	0.720
RSC12	2.580	.204	3.300	.078	3.190	.074	0.720
RSC13	3.380	.194	3.920	.067	3.830	.065	0.540
RSC14	3.150	.176	3.790	.062	3.690	.060	0.640
RSC15	3.310	.166	3.920	.062	3.830	.059	0.610
RSC16	3.150	.166	3.600	.070	3.530	.065	0.450
RSC17	2.690	.174	3.510	.069	3.390	.066	0.820
RSC18	2.920	.183	3.470	.075	3.380	.070	0.550
RSC19	1.900	.184	2.320	.084	2.250	.077	0.420
RSC20	2.540	.202	3.390	.071	3.260	.070	0.850
RSC21	3.580	.206	4.070	.058	3.990	.059	0.490
RSC22	3.170	.164	3.870	.061	3.760	.059	0.700

Table 4. (Continued)

Question	Online (N=48)	SD	Face-to-face (N=261)	SD	Total mean	SD	Difference
RSC23	3.940	.161	4.200	.053	4.160	.051	0.260
RSC24	3.630	.170	4.100	.053	4.030	.053	0.470
RSC25	3.400	.178	4.050	.062	3.950	.061	0.650
RSC26	3.730	.175	4.190	.058	4.120	.057	0.460
RSC27	3.290	.176	3.870	.057	3.780	.056	0.580
RSC28	3.060	.203	3.660	.067	3.560	.066	0.600
RSC29	2.540	.193	3.280	.076	3.160	.072	0.740
RSC30	3.020	.187	3.740	.068	3.620	.066	0.720
Total	3.183	.127	3.805	.042	3.708	.043	0.621

Reliability Statistics

Reliability statistics indicated that both SMAI and MAI are highly reliable, with a Cronbach's α of .972 for the SMAI and a Cronbach's α of .961 for the MAI. This means that both instruments have questions that consistently ask about the same construct. Item scale analysis of the SMAI showed that removing a question would not impact the scale reliability. Reliability statistics for MAI and SMAI are provided in Table 5, followed by item scale analysis for reliability in Table 6.

Table 5

Reliability Statistics

Instrument	Cronbach's alpha
Social Metacognitive Awareness Inventory	.972
Metacognitive Awareness Inventory	.961

Table 6

Item Scale Analysis

Question	Scale mean if item deleted	Cronbach's alpha if item deleted
RSC1	148.540	.971
RSC2	148.310	.971
KSC1	148.120	.971
RSC3	148.310	.971
RSC4	148.520	.971
RSC5	148.280	.971
KSC2	148.000	.971
RSC6	148.270	.970
KSC3	148.020	.971
RSC7	147.920	.971
KSC4	148.090	.971
KSC5	148.010	.972
KSC6	148.230	.971
RSC8	148.750	.972
RSC9	148.570	.971
RSC10	148.370	.971
RSC11	148.290	.970
RSC12	148.840	.971
RSC13	148.200	.972
KSC7	148.420	.971
RSC14	148.340	.970
KSC8	148.080	.971
RSC15	148.210	.970
RSC16	148.500	.971
KSC9	148.170	.971
KSC10	148.150	.971
RSC17	148.650	.971
RSC18	148.650	.971
RSC19	149.780	.972
RSC20	148.780	.971
RSC21	148.040	.971
RSC22	148.270	.971
RSC23	147.870	.971

Table 6. (Continued)

Question	Scale mean if item deleted	Cronbach's alpha if item deleted
RSC24	148.010	.971
RSC25	148.080	.971
KSC11	147.770	.971
RSC26	147.920	.971
RSC27	148.250	.971
RSC28	148.470	.971
RSC29	148.870	.971
RSC30	148.410	.971

Correlations

The Pearson's correlation between social metacognition and the two factors of metacognition (knowledge of cognition and regulation of cognition), and the metacognitive score in total, are all significant at $p<.001$. The correlation between regulation of cognition and social metacognition is moderate. The correlation between knowledge of cognition and social metacognition, as well as the overall metacognition score and social metacognition, is strong. Correlations between knowledge of cognition, regulation of cognition, and metacognition are very strong, which is not surprising considering that knowledge of cognition and regulation of cognition are factors of metacognition. All correlations are positive. While the correlation between social metacognition and metacognition is strong, it is not close to 1, so they are unlikely to measure the same construct. The relationship between all continuous variables is mostly linear, as indicated by the scatterplot (Figure 1). Table 7 presents the correlations between the continuous variables.

Table 7

Continuous Variable Correlations

	Knowledge of cognition	Regulation of cognition	Metacognition
Social metacognition	.614	.505	.618
Knowledge of cognition		.890	.983
Regulation of cognition	.890		.794

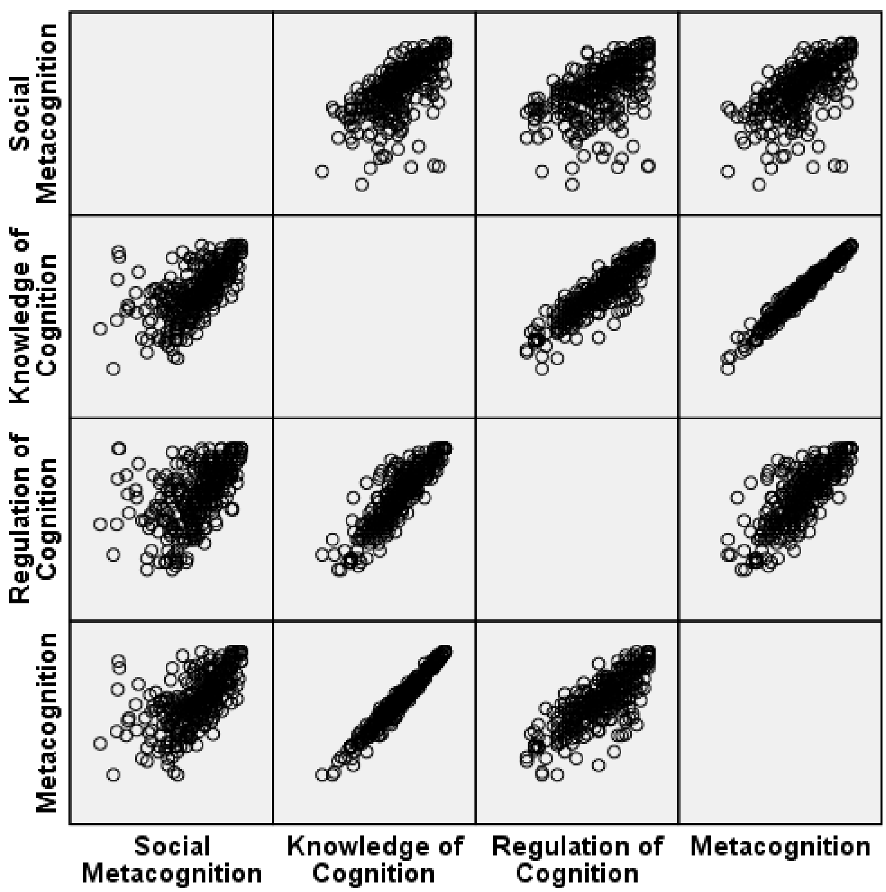

Figure 4. Scatterplot of Continuous Variable

Research Question 1: Social Metacognition as a Two-Factor Model

To test whether social metacognition represents a two-factor model, a CFA was conducted using SPSS AMOS to see if the data was a good fit for the model. Data were screened for missing data, which was removed by line. Mahalanobis's distance was used to identify multivariate outliers, with nine cases over 92.000 being removed (Figure 5). Normality measures for the scale items were not achieved with Kolmogorov-Smirnov test, and data transformations did not remedy this. While CFA is known to handle some non-normal data (Meyers, Gamst, & Guarino, 2013), the skewness and kurtosis numbers indicated relatively normal data, with skewness ranging from -.196 to -1.268 and kurtosis ranging from .089 to 1.502 (Table 8). Outliers for individual items on the SMAI were not removed because the researcher felt that these were representative of the population and a Likert scale was used, so there were not extreme differences in the scale (Hair, Black, Babin, & Anderson, 2013). Given that all the responses were from students in the information literacy course, even though scores of 1 and 2 were sometimes identified as outliers for some items, these cannot be thrown out.

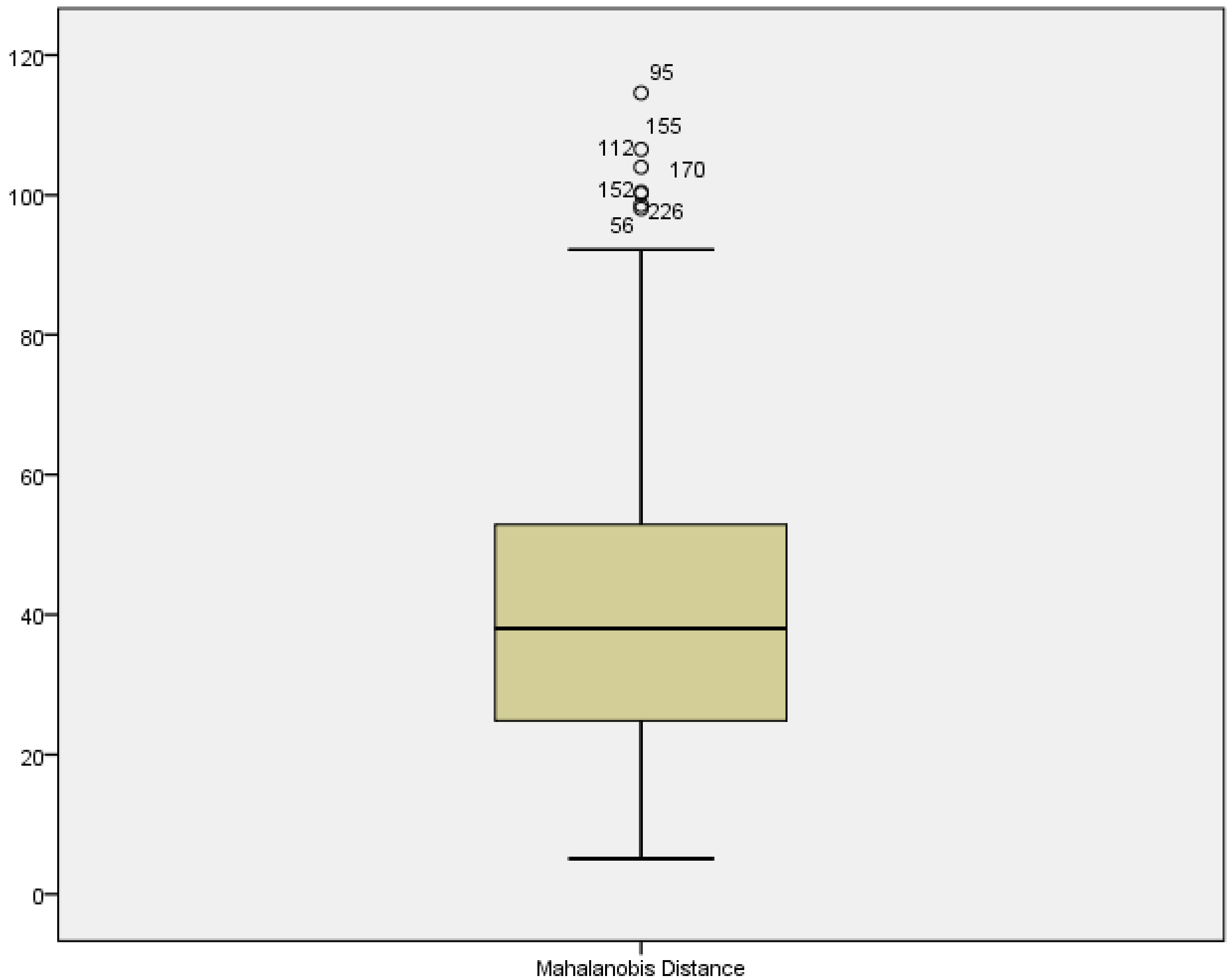

Figure 5. Mahalanobis Distance for Multivariate Analyses

Table 8

Normality Data for Scale Items

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
RSC1	-.649	.143	-.197	.284
RSC2	-.874	.143	.576	.284
KSC1	-1.004	.143	.903	.284
RSC3	-.733	.143	-.111	.284
RSC4	-.583	.143	-.404	.284
RSC5	-.890	.143	.123	.284
KSC2	-.813	.143	.254	.284
RSC6	-.753	.143	.250	.284
KSC3	-.946	.143	.468	.284
RSC7	-1.054	.143	.746	.284
KSC4	-.852	.143	.229	.284
KSC5	-.907	.143	-.115	.284
KSC6	-.627	.143	.089	.284
RSC8	-.405	.143	-.486	.284
RSC9	-.479	.143	-.537	.284
RSC10	-.805	.143	.312	.284
RSC11	-.739	.143	.141	.284
RSC12	-.196	.143	-.963	.284
RSC13	-.942	.143	.181	.284
KSC7	-.503	.143	-.399	.284
RSC14	-.803	.143	.378	.284
KSC8	-.822	.143	.408	.284
RSC15	-.775	.143	.389	.284
RSC16	-.573	.143	-.283	.284
KSC9	-.776	.143	.333	.284
KSC10	-.560	.143	-.003	.284
RSC17	-.393	.143	-.492	.284
RSC18	-.466	.143	-.626	.284
RSC19	.675	.143	-.790	.284
RSC20	-.401	.143	-.655	.284
RSC21	-1.065	.143	1.018	.284
RSC22	-.765	.143	.257	.284
RSC23	-.820	.143	.073	.284

Table 8. (Continued)

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
RSC24	-.953	.143	.986	.284
RSC25	-.938	.143	.402	.284
KSC11	-1.268	.143	1.502	.284
RSC26	-.986	.143	.597	.284
RSC27	-.445	.143	-.364	.284
RSC28	-.536	.143	-.400	.284
RSC29	-.266	.143	-.792	.284
RSC30	-.673	.143	-.150	.284

After running the CFA, standard regression weights indicated relatively high loadings for all the factors on each latent variable. The item that loaded most heavily on the factor regulation of social cognition was RSC14, with an estimated loading of .845. The item that loaded the least on the factor of regulation of social cognition was RSC19, with an estimated loading of .442. The item that loaded most heavily on the factor knowledge of social cognition was KSC3, with an estimated loading of .770. The item that loaded least on the factor knowledge of social cognition was KSC5, with an estimated loading of .483. The chi-square statistic for the model (χ^2=2199.634, df =778) was significant at $p<.05$ (Table 9), where a model with a good fit would be $p>.05$ (Hu & Bentler, 1999). The CFI was .834 (Table 10), which does not meet the requirement of a comparative fit index of greater than .95 (Hu & Bentler, 1999; Tabachnick & Fidell, 2013). The RMSEA was .078 (Table 11), which is greater than .06, which does not indicate a strong fit (Hu & Bentler, 1999; Tabachnick & Fidell, 2013). The TLI index is .85 (Table 12), whereas a good fit would be .95 (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999). These provide convincing evidence that this model is not a good fit.

Table 9

Chi-Square Statistic

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	83	2199.634	778	.000	2.827
Saturated model	861	.000	0		
Independence model	41	9372.647	820	.000	11.430

Table 10

Comparative Fit Index

Model	NFI delta1	RFI rho1	IFI delta2	TLI rho2	CFI
Default model	.765	.753	.835	.825	.834
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Table 11

Root Mean Square Error of Approximation

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.078	.074	.082	.000
Independence model	.187	.183	.190	.000

Table 12

Tucker Lewis Index (TLI)

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.766	.753	.835	.825	.834
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

To further examine the factors of social metacognition, an exploratory factor analysis was conducted on all the items for the SMAI. Eigenvalue, variance, scree plot, and residuals were used to determine the number of factors to retain. Since the scatterplot contained too much data for a visual analysis, linearity could not be established. Assumptions of normality, however, do not need to be assessed for exploratory factor analysis (Tabachnick & Fidell, 2007). Multivariate outliers had previously been removed. Additionally, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Bartlett's Test of Sphericity were run (Table 13). The KMO measure indicated that the sample size was very strong (Hutcheson & Sofroniou, 1999). Bartlett's Test of Sphericity was significant, which indicates that an exploratory factor analysis will be effective.

Table 13

KMO and Bartlett's Test

Factor Analysis Suitability Tests		Statistic
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.968
Bartlett's Test of Sphericity	Approx. Chi-Square	8918.121
	Df	820
	Sig.	.000

An exploratory factor analysis using principle component analysis, varimax rotation, Eigenvalue set at 1 was conducted. Varimax rotation was used because this orthogonal rotation minimizes the number of variables, which have a high loading on any given factor, thus simplifying the factors and the interpretation (Meyers, Gamst, & Guarino, 2013; Rennie, 1997). When conducted, the average of the communalities was greater than .6 with more than 250 respondents (M=.632), indicating the level of common variance is acceptable (Field, 2013). Five factors were identified for a cumulative percent of the variance, with the first factor accounting for 48.935% of the variance, and when rotated, accounting for 17.355%. The second factor was responsible for 5.850% of the variance, and 16.539% when rotated. A summary of factor loadings can be seen in Table 14. The scree plot indicated that there could be two factors, though there was a steep drop off between the first and second factor (Figure 3). There were 118 residuals with a p>.05, or 14%. The rotated correlation matrix revealed that variables loaded on the same factor while being categorized as questions about knowledge of social cognition and regulation of social cognition. Nearly half of the variables (n=19, 46.341%) were also cross-loaded, meaning they had a high loading on two or more factors (Matsunaga, 2010). Table 15 presents factor loadings after rotation.

Table 14

Total Variance Explained from 5 Factor Analysis

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Var.	Cumul. %	Total	% of Var.	Cumul. %	Total	% of Var.	Cumul. %
1	20.064	48.935	48.935	20.064	48.935	48.935	7.116	17.355	17.355
2	2.399	5.850	54.786	2.399	5.850	54.786	6.785	16.549	33.904
3	1.269	3.096	57.882	1.269	3.096	57.882	4.797	11.699	45.604
4	1.154	2.814	60.697	1.154	2.814	60.697	4.177	10.188	55.791
5	1.026	2.503	63.199	1.026	2.503	63.199	3.037	7.408	63.199

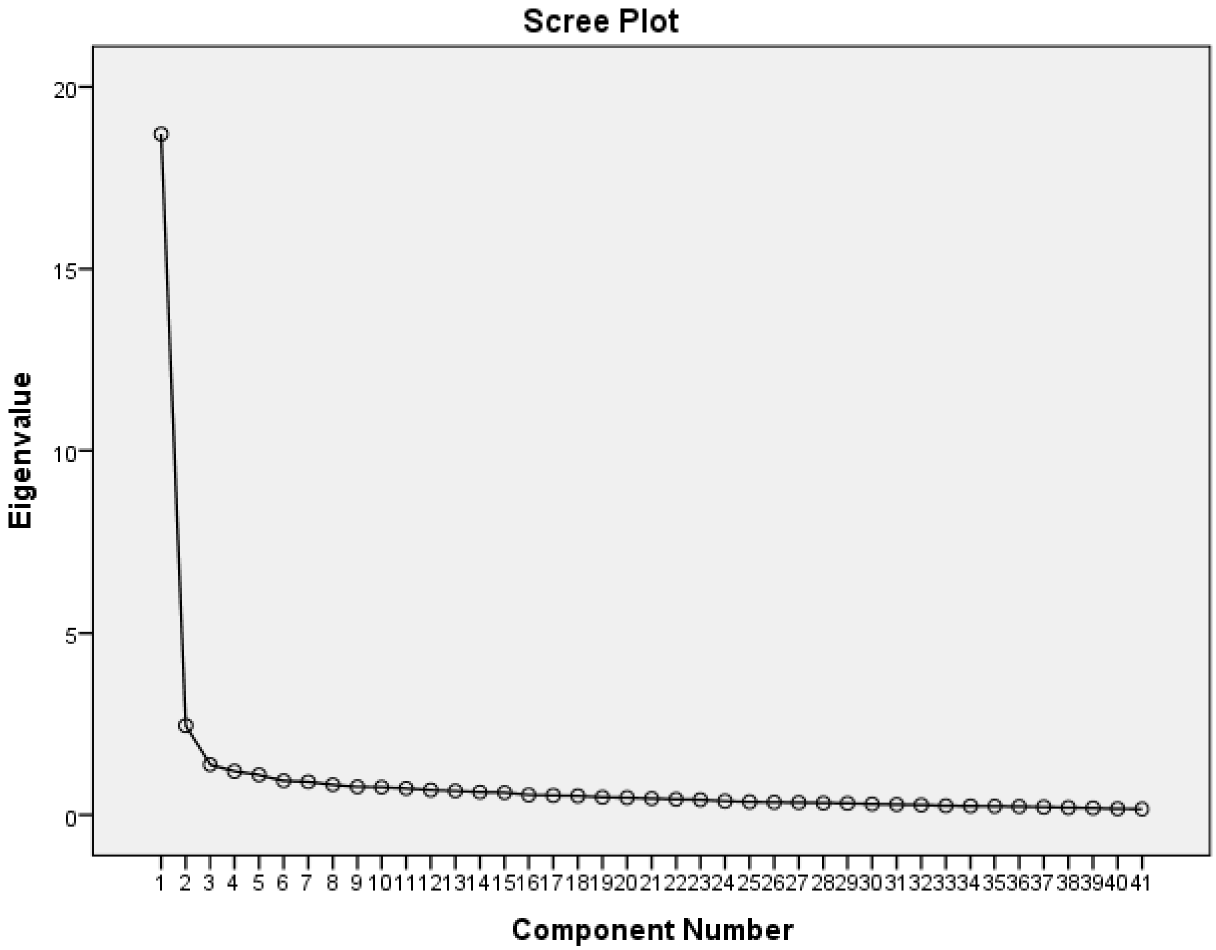

Figure 6. Scree Plot for EFA

Table 15

Factor Loadings after Rotation for 5 Factors (suppressed under .300)

Rotated component matrix[a]					
	1	2	3	4	5
RSC1	.677				
RSC2	.601		.328		
KSC1	.650		.305		
RSC3	.579	.319	.360		
RSC4	.667	.331			
RSC5	.587	.337	.314		
KSC2	.494				.519
RSC6	.604				.365
KSC3	.534			.392	.468
RSC7	.445			.480	.487
KSC4	.455			.457	.459
KSC5					.783
KSC6	.417	.314	.318		.497
RSC8	.426	.449			
RSC9	.506	.510			
RSC10	.479	.403		.331	
RSC11	.555	.346		.301	
RSC12	.374	.568			
RSC13				.761	
KSC7	.308	.475		.447	
RSC14	.454	.456	.308	.391	
KSC8	.384			.583	
RSC15	.354	.390	.327	.487	
RSC16	.307	.516		.322	
KSC9	.436	.366	.326	.380	
KSC10	.309	.320	.365	.481	
RSC17	.397	.614			
RSC18	.418	.611			
RSC19		.823			
RSC20		.733			
RSC21			.414	.555	
RSC22	.377	.301	.554		
RSC23			.649		

Table 15. (Continued)

Rotated component matrix[a]					
	1	2	3	4	5
RSC24			.639	.403	
RSC25		.340	.467		
KSC11			.649		
RSC26			.562		.367
RSC27		.436	.485		
RSC28	.312	.623	.374		
RSC29		.783			
RSC30	.392	.527	.457		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 11 iterations.

When modified to two factors, the communalities had an average of less than .6 (*M*=.548) and the residuals that were p>.05 increased (190 or 23%). The total variance for the two factors was 54.786%, implying that there were many cross-loaded items (n=20, 48.780%). Table 16 provides information about the variance from a two-factor model, followed by Table 17, which presents the factor loadings after rotation.

Table 16

Total Variance Explained by Two Factors

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Var.	Cumul. %	Total	% of Var.	Cumul. %	Total	% of Var.	Cumul. %
1	20.064	48.935	48.935	20.064	48.935	48.935	11.990	29.244	29.244
2	2.399	5.850	54.786	2.399	5.850	54.786	10.472	25.542	54.786

Table 17

Factor Loadings After Rotation for 2 Factors

Rotated component matrix[a]		
RSC1	.520	.470
RSC2	.582	.415
KSC1	.593	.419
RSC3	.602	.471
RSC4	.455	.522
RSC5	.562	.498
KSC2	.722	
RSC6	.662	.467
KSC3	.782	
RSC7	.819	
KSC4	.753	
KSC5	.528	
KSC6	.634	.402
RSC8		.555
RSC9	.388	.659
RSC10	.445	.551
RSC11	.611	.510
RSC12	.318	.666
RSC13	.363	.331
KSC7	.444	.597
RSC14	.597	.601
KSC8	.587	.416
RSC15	.611	.523
RSC16	.367	.622
KSC9	.583	.515
KSC10	.602	.448
RSC17	.381	.716
RSC18	.361	.723
RSC19		.778
RSC20		.765
RSC21	.618	.314
RSC22	.525	.453
RSC23	.637	
RSC24	.687	.348

Table 17. (Continued)

Rotated component matrix[a]		
RSC25	.538	.407
KSC11	.672	
RSC26	.548	
RSC27	.489	.461
RSC28	.391	.704
RSC29		.820
RSC30	.457	.627

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Null Hypothesis Analysis

The first null hypothesis stated that social metacognition would have two factors, knowledge of social cognition and regulation of social cognition. A CFA showed that the model had a poor fit based on chi-squared, RMSEA, and CFI. An exploratory factor analysis with varimax rotation showed that the scree plot indicated a two-factor model would be appropriate; however, the model accounted for 54.786% of the variance, which did not meet the criterion of 70% of the variance for a good model fit (Mertler & Vannatta, 2013). Additionally, many of the items were cross-loaded, and the knowledge of social cognition and regulation of social cognition items did not load onto separate factors. The five-factor model was stronger, though it still did not reach the 70% variance level. The null hypothesis for research question one was thus rejected.

Research Questions 2 and 3: Relationship Between Individual Metacognition and Social Metacognition and Group Effects

As research questions two and three build off each other, they were examined through multilevel modeling in SPSS. Data was scanned for missing values, and responses that were not in a group were removed since the grouping model was examining the effect of group membership. This left 272 responses for 85 groups. The assumption of normality was tested for the continuous dependent and independent variables. Social metacognition had four outliers of 1.5 or less, which were transformed to 1.7. Knowledge of cognition had one outlier that was transformed from 2.4 to 2.667. Regulation of cognition had no outliers. Normality tests were run, and only knowledge of cognition had a normal distribution. Data transformation did not remedy normality for regulation of cognition, but did for social metacognition, which was squared. Table 18 provides information the Kolmogoriv-Smirnov test statistics for social metacognition, social metacognition squared, knowledge of cognition, and regulation of cognition.

Table 18

Normality Tests for MLM

	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
Social metacognition	.076	272	.001
Social metacognition^2	.054	272	.057
Knowledge of cognition	.043	272	.200*
Regulation of cognition	.096	272	.000

Since multicollinearity should be checked to avoid redundant analyses (Harlow, 2014), and multilevel modeling is an analysis sensitive to multicollinearity (Field, 2013), multicollinearity was tested for the two predictor variables. They were correlated per Pearson's r (.900), which is significant at p<.001 and higher than the mid-range (-.7) that is the upper limit for a regression (Meyers, Gamst, & Guarino, 2013). Additionally, the collinearity statistics showed that these are an issue because the tolerance is less than .2 and the VIF is above 4 (Allison, 1999), though some others state that a concern only occurs when tolerance is less than .1 and VIF is above 10 (Field, 2013). Table 19 provides collinearity statistics. The condition index indicated that a component of 43.121 contributed strongly to the variance of knowledge of cognition (.94) and of regulation of cognition (.96), which indicates multicollinearity (Hair et al., 2013). Given the collinearity issues, it was decided to use the metacognitive score, which is a composite score of knowledge of cognition and regulation of cognition. For predictors with high correlations, researchers can create a single construct with variables of intercorrelations of .80 or higher (Mertler & Vannatta, 2013), and metacognition is already the single construct attributed to knowledge and regulation of cognition.

Table 19

Collinearity of Predictors

	Pearson's *r*	*P*	Tolerance	VIF
KofC * RofC	.900	.000	.190	5.275

To determine if individual metacognition predicted social metacognition, the ungrouped model included the fixed effects of metacognition as the independent variable and social metacognition as the dependent variable. This would indicate whether metacognition of a student predicts social metacognitive scores. Normality, linearity, and homogeneity of variance were all analyzed. Metacognitive scores were transformed to change two extremes of less than 2.4 to 2.4. The transformed scores passed the Kolmogor-Smirnov test for normality (Table 20).

Social metacognition was squared to have a normal distribution. Levene's test of homogeneity of variance was not significant [$F(74,197)=1.352$, $p=.052$], so the equal variance assumption was not violated. The residual plot showed a mean of zero, so the errors were normally distributed (See Figure 4). The Durbin-Watson statistic was 1.667, which is between 1.5 and 2.5, so autocorrelation was not an issue in the analysis (Field, 2013).

Table 20

Normality for Metacognition

	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
Metacognition	.047	272	.200
Social metacognition^2	.054	272	.057

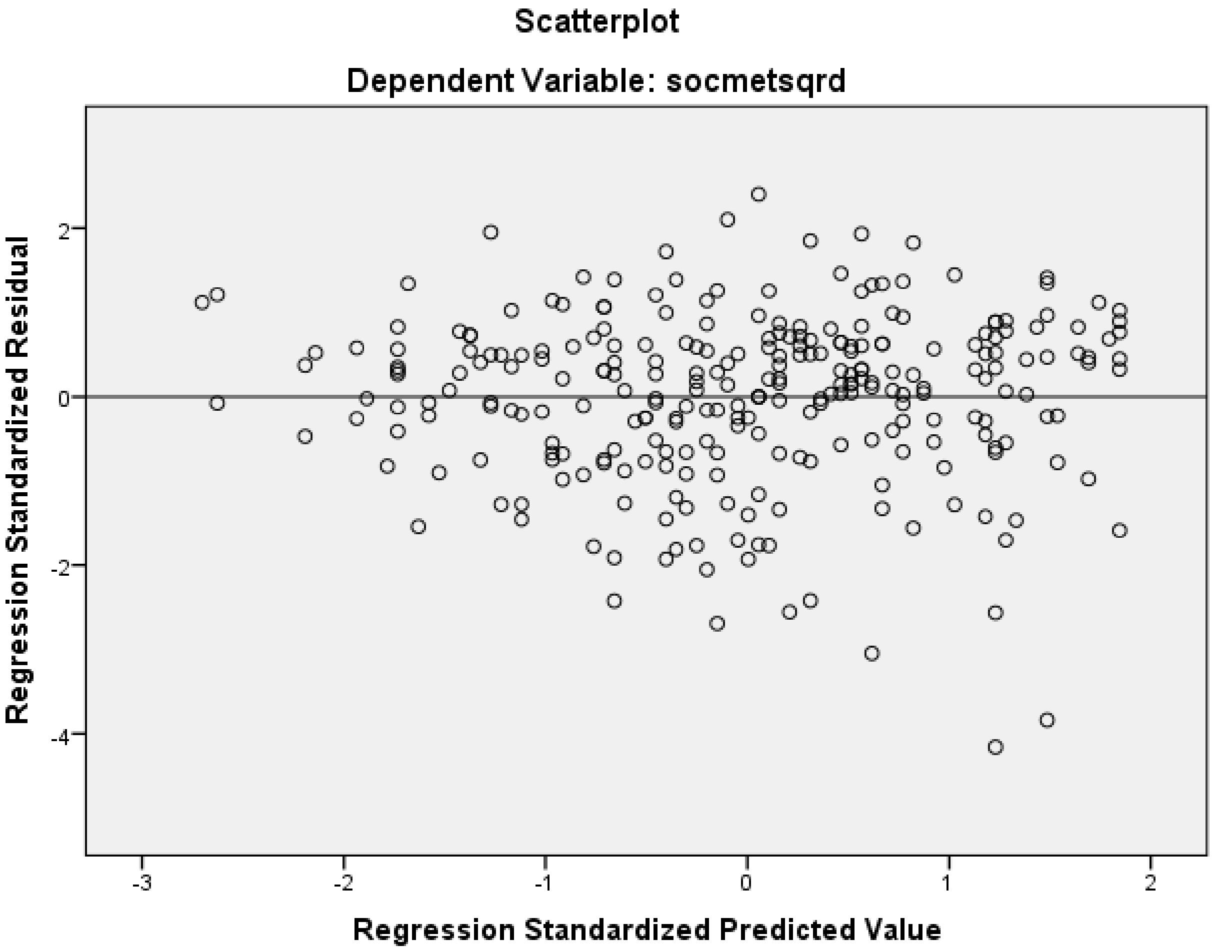

Figure 7. Residual Plot for Social Metacognition and Metacognition

Using SPSS, a null model was created using the Linear Mixed Models method, which allows a comparison between an ungrouped (null) model and the grouped model. The fixed effect was metacognition because it was the predictor variable. The dependent variable was social metacognition. There were no random effects in the null model. Table 21 presents the null model information after the analysis. The model showed that metacognitive scores significantly predicted social metacognitive scores $F(1,272) = 228.703$, $p<.001$ (Table 22). Table 23 provides estimates for the null model. The Wald z statistic is also significant for the model ($z = 11.662$, $p<.001$) (Table 24).

Table 21

Null Model Information

Goodness-of-Fit Measures	Statistic
-2 Log Likelihood	1482.435
Akaike's Information Criterion (AIC)	1488.435
Hurvich and Tsai's Criterion (AICC)	1488.525
Bozdogan's Criterion (CAIC)	1502.253
Schwarz's Bayesian Criterion (BIC)	1499.253

Table 22

Significance of Fixed Effects for Null Model

Source	Numerator df	Denominator df	*F*	Sig.
Intercept	1	272	35.603	.000
Metacognition	1	272	228.703	.000

Table 23

Estimates for Null Model

Parameter	Estimate	Std. error	df	*t*	Sig.
Intercept	-9.588	1.607	272	-5.967	.000
Metacognition	6.063	.401	272	15.123	.000

Table 24

Wald z for Null Model

Parameter	Estimate	Std. error	Wald *z*	Sig.
Residual	13.630	1.169	11.662	.000

The grouped model with the level 2 variable of group membership was conducted to see if group membership moderated the effect of individual metacognition on social metacognition. The grouped model indicated that metacognition significantly predicted social metacognitive scores in this model [$F(1,271.340) = 190.738$, $p < .001$] (Table 25). The change in -2 log likelihood between both models was calculated to determine the chi-square statistic. The first model had a -2 log likelihood of 1482.435 and the second had a -2 log likelihood of 1474.371 (Tables 21 and 27). The difference between these two is 8.064. For one degree of freedom, critical values of the chi-square distribution are 3.84 for $p = .05$ and 6.63 for $p = .01$, so the chi-square distribution for the -2 log likelihood is significant at the p<.01 level. Table 27 shows the estimates of the grouped model. Additionally, the Wald statistic with groups as the level 2 independent variables is also significant ($z = 2.368$, $p = .018$) (Table 28). This indicates that students in groups had similar social metacognitive scores.

Table 25

Significance of Fixed Effects for Groups as Level 2 Variable

Source	Numerator df	Denominator df	*F*	Sig.
Intercept	1	269.244	23.538	.000
Metacognition	1	271.340	190.738	.000

Table 26

Model Information with Groups as Level 2 Variable

Goodness-of-Fit Measures	Statistic
-2 Log Likelihood	1474.372
Akaike's Information Criterion (AIC)	1482.372
Hurvich and Tsai's Criterion (AICC)	1482.522
Bozdogan's Criterion (CAIC)	1500.795
Schwarz's Bayesian Criterion (BIC)	1496.795

Table 27

Estimates of Model with Groups as Level 2 Variable

Parameter	Estimate	Std. error	df	*t*	Sig.
Intercept	-8.020	1.653	269.244	-4.853	.000
Metacognition	5.661	.410	271.340	13.811	.000

Table 28

Wald z for Groups as Level 2 Variable

Parameter		Estimate	Std. error	Wald *z*	Sig.
Residual		11.061	1.187	9.31	.000
Intercept	Variance	2.739	1.157	2.368	.018
[subject = group number]					

Null Hypotheses Analysis

The null hypothesis for the second research question stated that knowledge of cognition and regulation of cognition do not impact social metacognitive scores. Due to multicollinearity issues, the metacognitive scores were used instead as a combination of knowledge of cognition and regulation of cognition. In both the first and second analyses, metacognition significantly predicted social metacognitive scores, so the second null hypothesis was rejected.

The null hypothesis for the third research question stated that group membership does not impact the relationship between metacognition and social metacognition. The chi-square distribution for the difference between the -2 log likelihood values was significant at the $p<.01$ level, indicating that the third null hypothesis needs to be rejected. Students had enough agreement in their ratings for their group membership to moderate the relationship between metacognition and social metacognition.

Research Question 4: Social metacognition for online and face-to-face students

To determine if social metacognition was significantly different between online and face-to-face students when accounting for metacognitive scores, an ANCOVA using SPSS was run. Social metacognition was analyzed for missing data and outliers. Outliers were analyzed for each group – online and face-to-face. The distribution for social metacognition from students online had no outliers. The social metacognitive scores for face-to-face students had seven outliers of less than or equal to 2.20. These were transformed to 2.233. Normality was explored using Kolmogorov-Smirnov test for social metacognition for online students and face-to-face students. The distribution was normal for online students and non-normal for in-person students, so the data was squared to create a normal distribution (Table 28). Levene's test showed that the test violated the assumption of equality of variance [$F(1,307) = 10.172$, $p=.002$]. Data transformation did not remedy this.

Table 29

Normality Tests for ANCOVA

		Kolmogorov-Smirnov		
		Statistic	df	Sig.
Social	Online	.095	48	.200*
Metacognition^2	In Person	.046	261	.200*

The homogeneity of regression slopes was tested to determine if an ANCOVA was appropriate. The interaction of the independent variable (whether students were enrolled in the online or face-to-face sections) and the covariate (metacognition) was not significant [$F(1, 305) = .311$, $p=.577$, partial $\eta^2 = .001$] (Table 30). As there was no interaction, an ANCOVA could be performed legitimately. Figure 8 show that the lines of metacognition and social metacognition do not intersect.

Table 30

Homogeneity of Regression Slopes Test

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Corrected model	4015.533[a]	3	1338.511	104.404	.000	.507
Intercept	286.686	1	286.686	22.362	.000	.068
Online or not	1.702	1	1.702	.133	.716	.000
Metacognition	1580.568	1	1580.568	123.285	.000	.288
Online or not * metacognition	3.993	1	3.993	.311	.577	.001
Error	3910.238	305	12.820			
Total	71541.372	309				
Corrected total	7925.771	308				

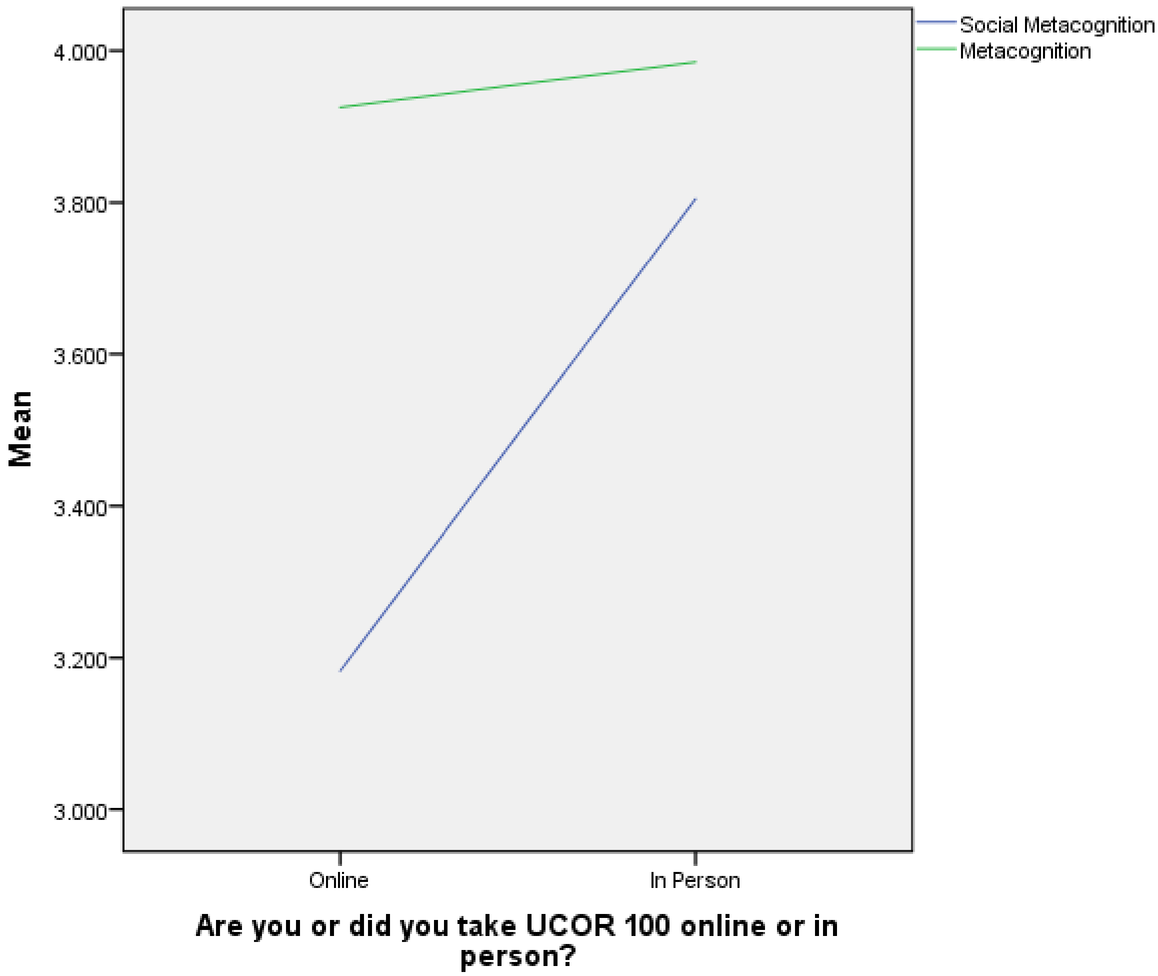

Figure 8. Line Plot of Metacognition and Social Metacognition by Course Format

A one-way ANCOVA was conducted on social metacognition. The independent variable was if students were enrolled in the information literacy course online or face-to-face. The covariate was metacognition. The covariate significantly adjusted the results (Table 31). After this adjustment, there was a significant difference in social metacognitive scores between students who took the course online and students who took the course in person [$F(1, 306) = 44.445$, $p<.001$, partial $\eta^2 = .127$] (Table 32). Students who took the course in person showed significantly higher social metacognitive scores than students who took the course online.

Table 31

Adjusted and Unadjusted Group Means for Social Metacognition by Course Format

Course Format	Adjusted *M*	Unadjusted *M*
Online	11.183	10.886
Face-to-face	14.931	14.985

Table 32

ANCOVA Summary Results

Source	SS	*df*	MS	*F*	*p*	partial η^2	Observed power[b]
Corrected Model	4011.540	2	2005.770	156.804	.000	.506	1.000
Intercept	640.889	1	640.889	50.102	.000	.141	1.000
Metacognition	3330.429	1	3330.429	260.361	.000	.460	1.000
Online or not	568.525	1	568.525	44.445	.000	.127	1.000
Error	3914.231	306	12.792				
Total	71541.372	309					
Corrected Total	7925.771	308					

Null Hypothesis Analysis

The null hypothesis for the last research question stated that students in online and face-to-face versions of the information literacy course would have similar social metacognitive scores on the SMAI. Based on the ANCOVA results, when accounting for metacognitive scores from the MAI, students in the face-to-face version of the information literacy course had significantly higher social metacognitive scores than students in the online version of the course. The null hypothesis for the last research question, thus, was rejected.

Chapter V

Conclusions

This study sought to investigate how social metacognition scores compared for students in two CSCL environments, one online and one face-to-face. To do so, the study developed an instrument, the Social Metacognitive Awareness Inventory, and used this instrument to determine if social metacognition included two factors, knowledge of social cognition and regulation of social cognition, which would be similar to the two factors of metacognition. This study also sought to determine if metacognition predicted social metacognition, and if group membership moderated social metacognitive scores.

Summary of Procedures

The Social Metacognitive Awareness Inventory (SMAI) was adopted from the Metacognitive Awareness Inventory (MAI) from Schraw and Dennison (1994). Students in an online and face-to-face version of a freshmen level, information literacy course that used computer-supported collaborative learning at a mid-sized university in the mid-Atlantic region of the United States were recruited to take the MAI and the SMAI from November of 2016 until January of 2017. All participating students had to be enrolled or recently enrolled in UCOR 100, Research and Information Skills Lab, and identified whether they were in an online or face-to-face version of the course.

The SMAI asked students about how they regulated the learning of their group and how they monitored group knowledge throughout the project. Using a five-point Likert scale, students indicated to what degree statements were true or false for their group. The same Likert scale was used for the MAI, which asked students about their own understanding of metacognitive strategies and how they use these strategies. Descriptive statistics were reported in the Results section (Chapter 4), which includes means, standard deviations, and percentages where appropriate. Data analysis included a confirmatory factor analysis, exploratory factor analysis, multilevel modeling, and an analysis of covariance (ANCOVA).

Participant Demographics

Participants were students currently enrolled or enrolled in the previous semester in a one-credit, computer-supported collaborative learning course on information literacy at a mid-Atlantic university with an enrollment of a little under 10,000 FTE students. There were 309 completed surveys, with 261 of these responses coming from students taking the face-to-face course and 48 of these responses coming from students online. This represented 85 groups, with seven of these online and 78 face-to-face. There were enough responses and groups representd for the analyses. While the desired number of online responses was 64, power analyses indicated that there were enough participants online for the ANCOVA.

Summary of Findings

This study sought to see whether a metacognitive instrument could be adapted to measure social metacognition. Social metacognition is defined as the ability to regulate and think about the cognitive activity of a group rather than an individual. Additionally, this study sought to identify if social metacognition correlated with metacognition in containing two factors: knowledge of social cognition and regulation of social cognition. Another goal of this study was to determine if a relationship existed between individual metacognition and social metacognition, and if students in a group have similar ratings of social metacognition. Finally, this study's main goal was to determine if students working in groups on the same projects in a computer supported collaborative learning (CSCL) information literacy course showed differences in social metacognitive ratings when working online or face-to-face.

Research Question 1

The first research question was "To what extent does the two-factor model of metacognition (knowledge of cognition and regulation of cognition) apply to social metacognition?" As a confirmatory factor analysis and an exploratory factor analysis both indicated that a two-factor model was not a strong fit, the conclusion is that social metacognition as measured by the SMAI does not have two factors.

Research Question 2

Research question 2 asked, "What is the relationship between individual metacognition and social metacognition?" As the correlation was not perfect, the SMAI did not measure the same construct as the MAI. Metacognition, however, was strongly correlated with social metacognition, and individual metacognitive scores predicted social metacognitive scores. Thus, a student with a high level of metacognition as indicated by the MAI is more likely to have a high level of social metacognitive awareness as indicated by the SMAI.

Research Question 3

The third research question was "To what extent do students in groups in a CSCL environment in higher education agree on their ratings of social metacognition?" Multilevel modeling indicated that accounting for group membership improved the model where individual metacognitive scores predicted social metacognitive scores. Students in groups had enough agreement in their metacognitive scores that this moderated the relationship between individual metacognition and social metacognition.

Research Question 4

The final research question asked, "How does social metacognition for students in an online information literacy course compare to the social metacognition of students taking a face-to-face information literacy course?" When accounting for individual metacognitive scores, students online had significantly lower social metacognitive scores than students who completed the project in a CSCL but in-person environment. Descriptive statistics showed that online students had a lower mean than face-to-face students for every item on the SMAI.

Findings Related to the Literature

Social constructivist approaches to education create a collaborative, problem-solving community in education environments (Wells, 2000). Students scaffold learning for each other when working collaboratively (Powell & Kalina, 2009), and students learn more when working together (Pai, Sears, & Maeda, 2015). CSCL engenders collaboration with technological interventions that can allow students to work together in different ways. Metacognition, an individual's ability to think about their own thinking while learning, plays an important role in successful CSCL environments (Saab, 2012; Volet, Vauras, Khosa, & Iiskala, 2013). Since social metacognition refers to a group's ability to regulate their learning, social metacognition is also a requirement of a CSCL environment. This study sought to contribute to the nascent research on social metacognition using a social metacognitive instrument to determine the relationship between metacognition and social metacognition and to compare social metacognitive scores between students working in groups online and face to face. The current section will relate the findings from this study to the relevant literature.

Measuring Social Metacognition

Assessing social metacognition, like assessing metacognition, remains difficult. Due to metacognition's link to student learning (Hattie, Biggs, & Purdie, 1996; Slavin & Lake, 2009; Wang, Haertel, & Walberg, 1990), having a measurement of metacognition can provide a useful way to indicate whether particular interventions improve metacognitive skills and what metacognitive skills link to particular types of learning. Similarly, having a method of measuring social metacognition can show the link between the regulation of group learning and successful group learning outcomes. Without a consistent and useable measurement, though, conclusions regarding metacognition, social metacognition, and learning will not be easily transferable to situations outside a particular research study.

In measuring metacognition, several research studies use coding of online discussions, think aloud protocols, and interviews (Akyol & Garrison, 2011; Lajoie & Lu, 2012; Meijer, Veenman, & van Hout-Wolters, 2006; Papanikolaou & Boubouka, 2010; Winne, 2010). Coding has also been used in several studies measuring social metacognition in CSCL environments (Duffy et al., 2015; Hurme, Palonen, & Järvelä, 2006; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013). The use of coding of logfiles to measure metacognition or social metacognition presumes that metacognitive and social metacognitive activity will be apparent in online interactions (Veenman, 2011), but it is clear that self-regulatory activities are not always explicit (Ibabe & Jauregizar, 2010). Group regulation, even in CSCL environments, could take place offline or in a space where an instructor or researcher has no access, like a Facebook group, a Google Doc chat, or text messages among group members.

Metacognitive self-report instruments have many of the same limitations of other self-report instrument, with social desirability bias being the most significant of these (DeVellis, 2003). Self-report instruments run the risk of students not understanding of scale items, or students who do not know how to connect their strategies to the scale items (Pintrich et al., 2000). They do, however, provide an easy method for researchers and instructors alike to measure metacognition. High scores on the Metacognitive Awareness Inventory (Schraw & Dennison, 1994) have been positively linked, at least to some extent, to student success in college (Hammann & Stevens, 1998; Lehmann, Hähnlein, & Ifenthaler, 2014; Sperling et al., 2004; Tok, Özgan, & DÖġ, 2010; Young & Fry, 2008). As the MAI could be given in a variety of learning environments and has high internal validity and some degree of construct validity, this study adapted it to measure social metacognition with the SMAI. Since some researchers have pointed out that self-report instruments may be more accurate after a particular project (Schellings et al., 2013; Winne, 2010), the SMAI was modified to ask students about group work on a specific project or activity.

The SMAI answers the call from researchers for a social metacognition self-report instrument (Panadero et al., 2015). The internal validity of the SMAI was very high in this study. While construct validity could not be established, multilevel modeling did indicate that group members had similar ratings of social metacognition. Correlations also revealed that the SMAI and MAI were strongly but not perfectly correlated, so this study is in line with previous studies indicating that social metacognition is a unique construct from metacognition (Iiskala, Vaurus, & Lehtinen, 2004; Iiskala, Vauras, Lehtinen, & Salonen, 2011).

Multiple studies have shown that metacognition has two factors: knowledge of cognition and regulation of cognition (Schraw & Dennison, 1994; Scott & Levy, 2013). Researchers theorize that social metacognition requires awareness, knowledge, and monitoring of group cognition (Chiu, 2008; Siegel, 2011). The results from this study, however, do not support a two-factor model for social metacognition as measured by the SMAI. Factor analysis did not produce a satisfactory model of social metacognition based on the instrument. Further research is required to determine if social metacognition has multiple factors and what, if any, other items on a social metacognitive instrument might identify other factors of social metacognition.

Relationship between Metacognition and Social Metacognition

As stated above, this study supported the theory that metacognition and social metacognition are unique constructs. Researchers have hypothesized that collaborative work requires students to make their metacognitive processes explicit, which can scaffold metacognitive work for other group members and improve social metacognition overall for the group (Chiu & Kuo, 2009; Lipponen, 2002). While this study did not directly measure if group members improved social metacognitive awareness for the others in their group, similar social metacognitive ratings could indicate that those students with high metacognitive abilities were able to improve the social metacognitive abilities of everyone in the group. This study did show a positive correlation between individual metacognition and social metacognition, indicating that individuals with high levels of metacognition are more likely to have higher levels of social metacognition. This aligns with the findings of other studies that have indicated that individuals with high levels metacognition can predict higher levels of socially-shared regulation (Panadero et al., 2015; Zion, Adler, & Mevarech, 2015).

Taking measures to scaffold individual metacognitive skills could have a postivie impact on social metacognition, as metacognitive scaffolding has shown to improve individual metacognition (Chalmers & Nason, 2005; Molenaar, van Boxtel, & Sleegers, 2010). The findings of this study support this idea and show that metacognitive scaffolding could have a positive impact on social metacognition. Scaffolding social metacognition itself can have a positive impact on social metacognitive performance in students (Saab, van Joolingen, & Hout-Wolters, 2012). The instrument developed in this study could help to reveal what social metacognitive scaffolding improves social metacognition.

Comparing Online and Face-to-Face Students

Previous studies have shown that the performance of online and face-to-face students is very similar (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011; Means, Toyama, Murphy, & Baki, 2013). The current study examined social metacognition of students who had completed a collaborative assignment in a CSCL information literacy course. The assignment asked students to go through the research process together, reflect on their search strategy, and evaluate the sources they used. Since students often do not think much about their research process or how to evaluate sources (Hofer, 2004), this assignment made students consider their metacognitive strategies related to research. While students online and in the in-person version of the course completed the same assignment, students in the face-to-face version of the course had significantly higher levels of social metacognition than students who took the course online. This seems to indicate that students perceived that the interactions they had with each other in the face-to-face course allowed them to regulate the group's learning more effectively than they did online. Student-student interaction has been shown to benefit online learning (Bernard et al., 2009), but the challenge remains to encourage effective student-student interaction when students do not meet in person. Both versions of the course were in CSCL environments, but working mostly (if not entirely) virtually in the CSCL environment appears to have left students with the perception that they were not able to work as effectively together. This supports the literature stating that collaborative learning online does not inherently create an effective group experience (Chang & Hannafin, 2015; Hämäläinen, 2012). There are studies that reveal that online group learning can be as effective in increasing learning as face-to-face collaborative learning (Solimeno, Mebane, Tomai, & Francescato, 2008; Wolfson, Cavanagh, & Kraiger, 2014), but appropriate tools and structuring is necessary for an effective experience (Aragon, 2003; Figueira & Leal, 2013; Saab, van Joolingen, & van Hout-Wolters, 2012). Since social metacognition has not seen much comparison in face-to-face and online environments in the literature, this study provides another way to evaluate online and face-to-face group learning experiences.

While metacognitive strategies have been encouraged more frequently in information literacy instruction (Mackey & Jacobson, 2014), this study shows that the same collaborative research assignment did not generate similar social metacognitive scores for different CSCL learning environments. It is worth noting, though, that individual metacognitive scores for the online and face-to-face students were similar. This could imply that either students had similar overall levels of metacognition, or perhaps that the research assignment did equally impact individual metacognition in online and face-to-face students. There is, however, not enough information from this study to determine this.

Application of Findings

The findings of this study further support the research indicating that social metacognition is distinct from metacognition, and therefore social metacognition should be considered its own construct (Iiskala, Vaurus, & Lehtinen, 2004; Iiskala, Vauras, Lehtinen, & Salonen, 2011). This study provides an instrument based on an established metacognitive measure that can be used to study student perceptions of social metacognition. As a self-report instrument, it can be given to many students at once without the time required of think-aloud protocols and discussion board coding, and may also be given to students taking a course online or in person. This instrument can be used to determine if certain interventions, like scaffolding, improve social metacognition, or if any of the following impact social metacognitive scores: collaborative or cooperative groups, particular group projects, different combinations of students (heterogeneous or homogeneous groups, for example), and group size. The instrument could also be used to examine how group performance relates to social metacognition.

As the study supports previous research that metacognition may predict social metacognition (Panadero et al., 2015; Zion, Adler, & Mevarech, 2015), the findings of this study are a futher indication of the need to develop students' metacognitive awareness and skills. If students understand how to approach their own learning and how to identify what they know and do not know, they may be more prone to be able to transfer these skills to a group setting. Metacognitive ability should be scaffolded for individual students, not only because of the positive effects it has on individual learning, but because it also may strengthen the ability of students to learn well as a group. Though some research shows that students learn more in a group (Lipponen, Hakkarainen, & Paavola, 2004; Zhao & Chan, 2014), it cannot be assumed that all students will automatically perform well in a group setting.

One important finding of this study is that social metacognition for online students was not as high as in-person students in a CSCL environment. More effort may be needed on the part of the instructor or instructional designer to scaffold social metacognition for collaborative work that takes place mostly or entirely online. Scaffolds can be relatively simple, like providing examples for students how to complete a task or posing questions to students to have them explain their thinking as they complete a task (Molenaar, Boxtel, & Sleegers, 2010). This may also include collaboration scripts that establish for students how they can regulate the group's learning, like asking them to use a planning tool where groups set learning goals together, and capitalize on the intellectual strengths of different members of the group, like asking students to share what role they believe they are best suited for in group work (e.g., leader, communicator, note-taker, etc.). Particular tools and strategies may increase social metacognition online that are not as necessary in a face-to-face environment. Scripting software that prompt students to reflect on their metacognitive activities throughout online collaboration can scaffold both metacognitive and social metacognitive activities, as can online planning tools that ask students to consider the steps necessary to complete a task (Järvelä, Kirschner, Hadwin, Järvenoja, Malmberg, Miller, & Laru, 2016). Technological advancements that allow students to collaborate synchronously may closer approximate a face-to-face course, and so this may create more social metacognitive awareness.

Additionally, since metacognition was shown in this study to be a predictor of social metacognition, scaffolding of individual metacognitive strategies could improve social metacognition. This study did not distinguish between the performance of students in a group project online or face to face, but the differences in social metacognitive scores shows that more metacognitive scaffolding for individuals online could improve social metacognitive outcomes. This scaffolding, along with resources for effective collaboration, may be more necessary for online students in higher education.

Future Research

Further research into social metacognition will allow instructors and researchers to understand its role in collaborative activities. The predictive validity of the SMAI should be examined by linking SMAI scores to group performance on an assignment. This will indicate whether high levels of social metacognition for a group predict better performance on a group assignment. Triangulating the SMAI with other methods of assessing social metacognition, like think-aloud protocols, interviews, and discussion board coding, could indicate the strength of the construct validity of the SMAI.

The factors of social metacognition, if they are distinguishable, were not indicated by this study. Model respecification could be used to modify the SMAI to examine factor loadings or error variances to indicate if measures should be dropped or if factor loadings are incorrect. If this is not successful, the SMAI may be modified to remove questions that are similar, and an exploratory factor analysis could then be run to identify the distinct factors of social metacognition as measured by the instrument. Determining the factors of social metacognition may allow researchers to determine which factor(s) are most predictive of student performance, satisfaction, and group cohesion.

Additionally, future research could be done to re-specify the MAI as well. Since the inventory is 52 items, this is a very lengthy. While Sperling, Howard, Miller, and Murphy (2002) did develop the Jr. MAI, which is much shorter than the MAI, the internal consistency was not as strong as the MAI. Decisions about what to include was determined by looking at which items loaded most heavily on knowledge and regulation of cognition, and decisions about how to reword the indicators was determined by the researchers based on assumptions about the comprehension of elementary and middle-school students. Performing a model re-specification using a CFA could create a more reliable, parsimonious instrument.

Social metacognitive scores for upper-level undergraduates, graduates, and other levels of education should be explored to see if age and experience make a difference in social metacognitive awareness. Older adults have been shown to perform better in groups than individually in an online environment (Wolfson, Cavanagh, & Kraiger 2014), so future studies could use the SMAI to determine if older adults have higher levels of social metacognition in CSCL environments than younger adults.

Because the online course had been offered at the institution for a limited amount of time, comparing the social metacognitive awareness of students enrolled in more well-established online learning programs with students in face-to-face courses could reveal different results. These programs that have a more established online program that use a variety of new technologies and have rigorous standards for their online courses may show higher social metacognitive awareness scores than the students included in this study. Online courses with higher social metacognition could be seen as a model for others to emulate.

Greater consistency in instruction may change the results. While this study used students who took the same course and completed the same assignment, future research could include less variance in instructors. While students in this study did complete similar scaffolding assignments to prepare them for the final assignment, perhaps future research could be done in more standardized, experimental setting so that the learning process was entirely consistent.

The SMAI should be used to indicate how particular technological and pedagogical interventions impact social metacognitive awareness in both online and face-to-face courses. The CSCL environment allows for various tools and strategies that can increase student interaction, like cloud-based, real-time editing software, collaboration scripts, and synchronous meeting rooms. The online course used in this study was asynchronous, so a comparison of social metacognitive scores for students who worked online synchronously and asynchronously could be revealing. Using the SMAI to determine which strategies better prepare students to regulate group learning can allow instructors to make evidence-based decisions in their pedagogical approaches to collaborative learning.

Finally, a replication study could provide interesting data as well. This could be done with an information literacy course offered online and face-to-face, or some other type of course that is offered online and face-to-face. This would allow researchers to see if the results and conclusions made in this study are upheld in other areas.

Limitations

While this study provides a measure for social metacognitive awareness and indicates that high levels of social metacognition may be more difficult to achieve for online students than in-person students, there are limitations to this study. Because of the unequal group sizes, intracorrelation coefficient scores, which would have indicated the level of agreement among group members in their social metacognitive ratings, were not able to be determined. The multilevel model indicated that accounting for group membership did significantly improve the model, so group members did have similarities in their ratings.

The homogeneity of variance assumption for the ANCOVA was violated. Additionally, the group sizes for the ANCOVA were uneven, with more than five times the responses from students who took the course in-person ($n=261$) versus those who took the course online ($n=48$). This could indicate that the null hypothesis was falsely rejected, but given the significance level of $p<.001$, this is unlikely.

As there were 11 sections of the information literacy course face-to-face and twelve sections online, along with 10 different instructors, there may have been differences in the way that instructors prepared students to work in groups or in how they scaffolded metacognitive tasks. This means there may have been variables other than whether the student took the course online or face-to-face that impacted social metacognition. Additionally, a few of the online instructors had not had experience teaching in an online environment, and the online course had undergone some significant changes, so it may not be representative of more well-established online learning with more experienced instructors.

Delimitations

Within any study, there are delimitations set by the researcher. The students identified as participants for the study were taking a first-year information literacy course at a single institution. While the students came from a variety of disciplines, they may have had similar characteristics because of being in a freshmen-level class at the same institution. This must be considered when generalizing the results of the study.

Furthermore, this study used a self-report instrument to measure social metacognitive awareness. As previously discussed, self-report instruments are susceptible to student comprehension errors and desirability bias. The researcher decided to use a self-report instrument because of its potential usefulness and ease of use for other researchers and instructors. Think-aloud protocols and interviews may also lend themselves to student comprehension issues, cognitive overload, and desirability bias. They are also time-consuming for teachers and researchers. Computer logs and traces cannot capture all the face-to-face collaboration that occurs in a face-to-face CSCL environment. Thus, a self-report instrument was determined to be the most appropriate. The SMAI was modified from a reliable and valid instrument, the MAI, but the researcher did not conduct pilot testing for the instrument. Regardless, the instrument was found to be reliable, and the item scale analysis did not indicate that an item needed to be removed to improve the instrument. Additionally, the instruments did not use an item to verify that students were paying attention, so some responses may have been the result of inattentiveness.

Summary

The intersection of technology and social constructivist theories has created CSCL environments that allow students to collaborate and co-create knowledge. In CSCL environments online and face-to-face, students must be able to not only regulate their own learning through metacognition, but also regulate the learning of the group through social metacognition. This study created an instrument to measure social metacognitive awareness of students after they had completed a collaborative assignment. The results of the study showed that individual metacognition predicted social metacognition, and that group membership moderated social metacognitive scores. In a comparison of social metacognitive awareness of students online and face-to-face, students working on a project in a CSCL environment face-to-face had higher social metacognitive ratings than students working on the same project in a CSCL environment online.

The instrument developed in this study, the SMAI, can be used by other researchers and instructors to better understand the role of social metacognition in collaborative learning. By finding interventions in both the technology and pedagogical strategies that increase social metacognition, researchers can make recommendations for how we can improve collaborative learning both in the traditional classroom and online. The CSCL environment provides many exciting opportunities for education, but care should be taken to ensure that instructors are not assuming that effective group work will occur naturally without instructional design and facilitation, especially for those students who may never be able to meet physically with their peers. If CSCL is to be successful in the online environment, instructors must approximate the social presence and sense of community of face-to-face collaborative learning. Further research will determine how much social metacognition plays a role in collaborative learning, and this dissertation represents an important step in that determination.

REFERENCES

Abdolhosseini, A., Keikhavani, S., & Hasel, K. M. (2011). The effect of instructing cognitive and metacognitive strategies on the academic progress of Ilam Medical University Students. *Psychology Research*, *1*. Retrieved from ERIC database. (ED447152)

Abrami, P. C., Bernard, R. M., Bures, E. M., Borokhovski, E., & Tamim, R. M. (2011). Interaction in distance education and online learning: Using evidence and theory to improve practice. *Journal of Computing in Higher Education, 23*, 82-103. doi:10.1007/s12528-011-9043-x

Adams, R. (2013). Blogging in context: reviewing the academic library blogosphere. *The Electronic Library*, *31*, 664-677. doi:10.1108/el-05-2012-0054

Aharony, N. (2009). The use of a wiki as an instructional tool: A qualitative investigation. *Journal of Web Librarianship*, *3*, 35-53. doi:10.1080/19322900802660334

Akin, A., Abaci, R., & Cetin, B. (2007). The validity and reliability of the Turkish version of the Metacognitive Awareness Inventory. *Educational Sciences: Theory & Practice, 7*, 671-678. Retrieved from http://www.estp.com.tr/

Akyol, Z., & Garrison, D. R. (2011). Assessing metacognition in an online community of inquiry. *Internet and Higher Education*, *14*(3), 183–190. doi:10.1016/j.iheduc.2011.01.005

Aleven, V., Roll, I., Mclaren, B. M., & Koedinger, K. R. (2010). Automated, unobtrusive, action-by-action assessment of self-regulation during learning with an intelligent tutoring system. *Educational Psychologist*, *45*, 224-233. doi:10.1080/00461520.2010.517740

Alismail, H. A. (2015). Integrate digital storytelling in education. *Journal of Education and Practice, 6*(9), 126-129. Retrieved from ERIC database. (EJ1082416)

Allen, I. E., & Seaman, J. (2013). *Changing course: Ten years of tracking online education in the United States*. Babson Park, MA: Babson Survey Research Group and Quahog Research Group. Retrieved from http://www.onlinelearningsurvey.com/reports/changingcourse.pdf

Allison, P. D. (1999). *Multiple Regression: A Primer*. Thousand Oaks, CA: Pine Forge Press.

Amory, A., Naicker, K., Vincent, J., & Adams, C. (1999). The use of computer games as an educational tool: identification of appropriate game types and game elements. *British Journal of Educational Technology*, *30*, 311-321. doi:10.1111/1467-8535.00121

Aragon, S. R. (2003). Creating social presence in online environments. *New Directions for Adult & Continuing Education*, *2003*, 57-68.

Artino, A. R., Jr. (2008). Promoting academic motivation and self-regulation: Practical guidelines for online instructors. *TechTrends, 52*, 37-45. doi:10.1007/s11528-008-0153-x

Arvaja, M., Salovaara, H., Häkkinen, P., & Järvelä, S. (2007). Combining individual and group-level perspectives for studying collaborative knowledge construction in context. *Learning and Instruction, 17*(4), 448-459. doi:10.1016/j.learninstruc.2007.04.003

Association of College & Research Libraries. (2000). *Information literacy competency standards for higher education*. Retrieved from http://www.ala.org/acrl/standards/informationliteracycompetency

Association of College & Research Libraries. (2015). *Framework for information literacy for higher education*. Retrieved from http://www.ala.org/acrl/standards/ilframework

Azevedo, R. (2005). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educational Psychologist*, *40*, 199–209. doi:10.1207/s15326985ep4004_2

Azevedo, R., Landis, R., Feyzi-Behnagh, R., Duffy, M., Trevors, G., Harley, J., ... Yeasin, M. (2012). The effectiveness of pedagogical agents' prompting and feedback in facilitating co-adapted learning with MetaTutor. In *Intelligent tutoring systems* (pp. 212-221). Berlin: Springer.

Azevedo, R., Moos, D. C., Johnson, A. M., & Chauncey, A. D. (2010). Measuring cognitive and metacognitive regulatory processes during hypermedia learning: Issues and challenges. *Educational Psychologist*, *45*, 210-223. doi:10.1080/00461520.2010.515934

Bacow, L. S., Bowen, W. G., Guthrie, K. M., Lack, K. A., & Long, M. P. (2012). *Barriers to adoption of online learning systems in US higher education*. New York, NY: Ithaka S+ R. doi:10.18665/sr.22432

Bannert, M., Hildebrand, M., & Mengelkamp, C. (2009). Effects of a metacognitive support device in learning environments. *Computers in Human Behavior*, *25*, 829-835. doi:10.1016/j.chb.2008.07.002

Barbour, M. K. (2013). The landscape of K-12 online learning: Examining what is known. In M. G. Moore (Eds.), *Handbook of distance education* (3rd ed., pp. 574–593). New York, NY: Routledge.

Barkley, E. F., Cross, K. P., & Major, C. H. (2014). *Collaborative learning techniques: A handbook for college faculty*. New York, NY: John Wiley & Sons.

Barr, R. B., & Tagg, J. (1995). From teaching to learning—A new paradigm for undergraduate education. (Cover story). *Change, 27*(6), 12. Retrieved from http://www.tandfonline.com/toc/vchn20/current

Bartels, J. M., & Magun-Jackson, S. (2009). Approach–avoidance motivation and metacognitive self-regulation: The role of need for achievement and fear of failure. *Learning and Individual Differences, 19*(4), 459-463. doi:10.1016/j.lindif.2009.03.008

Becker-Beck, U., Wintermantel, M., & Borg, A. (2005). Principles of regulating interaction in teams practicing face-to-face communication versus teams practicing computer-mediated communication. *Small Group Research*, *36*, 499-536. doi:10.1177/1046496405277182

Bembenutty, H. (2007). Self-regulation of learning and academic delay of gratification: gender and ethnic differences among college students. *Journal of Advanced Academics, 18*, 586-616. Retrieved from http://journals.sagepub.com/home/joa

Bentler, P. M., & Chou, C. P. (1987). Practical issues in structural modeling. *Sociological Methods & Research*, *16*, 78-117. doi:10.1177/0049124187016001004

Bernard, R. M., Abrami, P. C., Borokhovski, E., Wade, C. A., Tamim, R. M., Surkes, M. A., & Bethel, E. C. (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, *79*, 1243-1289. doi:10.3102/0034654309333844

Bigum, C. (2012). Schools and computers: Tales of a digital romance. In L. Rowan & C. Bigum (Eds), *Transformative Approaches to New Technologies and Student Diversity in Futures Oriented Classrooms* (pp. 15-28). New York, NY: Springer.

Blaschke, L. M., Porto, S., & Kurtz, G. (2010). Assessing the added value of web 2.0 tools for e-learning: The MDE experience. *Proceedings of the European Distance and E-learning Network (EDEN) Research Workshop*, *Budapest, Hungary*, *6*, 80-98. Retrieved from http://www.eden-online.org/

Bouffard, T., Boisvert, J., Vezeau, C., & Larouche, C. (1995). The impact of goal orientation on self-regulation and performance among college students. *British Journal of Educational Psychology, 65*, 317-329. doi:10.1111/j.2044-8279.1995.tb01152.x

Brodahl, C., Hadjerrouit, S., & Hansen, N. K. (2011). Collaborative writing with Web 2.0 technologies: education students' perceptions. *Journal of Information Technology Education: Innovations in Practice*, *10*, 73–103. Retrieved from https://www.informingscience.org/Journals/JITEIIP/Overview

Broadbent, J., & Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review. *The Internet and Higher Education, 27*, 1-13. doi:10.1016/j.iheduc.2015.04.007

Brown, S., Bennett, C., Henson, B., & Valk, A. (2014, September). SPEC Kit 342: Next-gen learning spaces. *Association of Research Libraries*. Retrieved from http://publications.arl.org/Next-Gen-Learning-Spaces-SPEC-Kit-342/

Buraphadeja, V., & Kumnuanta, J. (2011). Enhancing the sense of community and learning experience using self-paced instruction and peer tutoring in a computer-laboratory course. *Australasian Journal of Educational Technology*, *27*(8), 1338-1355. doi:10.14742/ajet.897

Cacciamani, S., Cesareni, D., Martini, F., Ferrini, T., & Fujita, N. (2012). Influence of participation, facilitator styles, and metacognitive reflection on knowledge building in online university courses. *Computers & Education*, *58*(3), 874-884. doi:10.1016/j.compedu.2011.10.019

Cassell, K. A., & Hiremath, U. (2011). *Reference and information services in the twenty-first century* (Rev. ed.). New York, NY: Neal-Schuman.

Cavanaugh, C., Gillan, K. J., Kromrey, J., Hess, M., & Blomeyer, R. (2004). *The effects of distance education on k-12 student outcomes: A meta-analysis*. Naperville, IL: Learning Point Associates.

Chace, J. F. (2014). Collaborative projects increase student learning outcome performance in nonmajors environmental science course. *Journal of College Science Teaching, 43*(6), 58-63. doi:10.2505/4/jcst14_043_06_58

Chalmers, C., & Nason, R. (2005). Group metacognition in a computer-supported collaborative learning environment. In C. K. Looi & H. David (Eds.), *Towards sustainable and scalable educational innovations informed by the learning sciences* (pp. 35–41). Amsterdam: IOS Press.

Chan, C. K. K. (2012). Co-regulation of learning in computer-supported collaborative learning environments: a discussion. *Metacognition and Learning, 7*, 63-73. doi:10.1007/s11409-012-9086-z

Chang, M. M. (2010). Effects of self-monitoring on web-based language learner's performance and motivation. *CALICO Journal*, *27*, 298-310. doi:10.11139/cj.27.2.298-310

Chang, Y. & Hannafin, M. J. (2015). The uses (and misuses) of collaborative distance education technologies: Implications for the debate on transience in technology. *Quarterly Review of Distance Education, 16*, 77-92,148-149. Retrieved from http://www.infoagepub.com/quarterly-review-of-distance-education.html

Chen, G., Chiu, M. M., & Wang, Z. (2012). Social metacognition and the creation of correct, new ideas: A statistical discourse analysis of online mathematics discussions. *Computers in Human Behavior, 28*, 868-880. doi:http://dx.doi.org/10.1016/j.chb.2011.12.006

Chiu, M. M. (2008). Flowing toward correct contributions during group problem solving. *Journal of the Learning Sciences*, *17*, 415-463. doi:10.1080/10508400802224830

Chiu, M. M., & Kuo, S. W. (2009). From metacognition to social metacognition: Similarities, differences, and learning. *Journal of Education Research*, *3*, 321-338. Retrieved from http://www.tandfonline.com/loi/vjer20

Clarke, P., & Wheaton, B. (2007). Addressing data sparseness in contextual population research using cluster analysis to create synthetic neighborhoods. *Sociological Methods & Research*, *35*, 311-351. doi:10.1177/0049124106292362

Conrad, D. (2009). Cognitive, instructional, and social presence as factors in learners' negotiation of planned absences from online study. *The International Review of Research in Open and Distributed Learning*, *10*(3). Retrieved from http://www.irrodl.org/index.php/irrodl

Cooper, M. M., & Sandi-Urena, S. (2009). Design and validation of an instrument to assess metacognitive skillfulness in chemistry problem solving. *Journal of Chemical Education*, *86*, 240-245. doi:10.1021/ed086p240

Coutinho, S. (2008). Self-efficacy, metacognition, and performance. *North American Journal of Psychology, 10*, 165-172. Retrieved from http://najp.us/

Cress, U. (2008). The need for considering multilevel analysis in CSCL research—an appeal for the use of more advanced statistical methods. *International Journal of Computer-Supported Collaborative Learning*, *3*, 69-84. doi:10.1007/s11412-007-9032-2

Cromley, J., & Azevedo, R. (2006). Self-report of reading comprehension strategies: What are we measuring? *Metacognition and Learning, 1*, 229-247. doi:10.1007/s11409-006-9002-5

Crook, A. E., & Beier, M. E. (2010). When training with a partner is inferior to training alone: the importance of dyad type and interaction quality. *Journal of Experimental Psychology Applied, 16*, 335-348. doi:10.1037/a0021913

Cuban, L. (2001). *Oversold and underused: Computers in schools 1980-2000.* Cambridge, MA: Harvard University.

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education, 15*, 3-8. doi:10.1016/j.iheduc.2011.06.002

Dabbagh, N., & Kitsantas, A. (2004). Supporting self-regulation in student-centered Web-based learning environments. *International Journal on E-Learning*, *3*, 40–47. Retrieved from https://www.aace.org/pubs/ijel/

de Jong, N., Verstegen, D. L., Tan, F. S., & O'Connor, S. J. (2013). A comparison of classroom and online asynchronous problem-based learning for students undertaking statistics training as part of a public health master's degree. *Advances in Health Sciences Education*, *18*, 245-264. doi:10.1007/s10459-012-9368-x

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2007). Applying multilevel modelling to content analysis data: Methodological issues in the study of role assignment in asynchronous discussion groups. *Learning and Instruction*, *17*(4), 436-447. doi:10.1016/j.learninstruc.2007.04.001

Derry, S. (1993). *The effects of collaborative interaction and computer tool use on the problem-solving processes of lower-ability students*. Retrieved from ERIC database. (ED374776)

Desoete, A. (2008). Multi-method assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition and Learning, 3*, 189-206. doi:10.1007/s11409-008-9026-0

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2nd ed.). Newbury Park, CA: Sage Publications

Dewey, J. (1938). *Experience and education.* New York, NY: Simon and Schuster.

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

Dinsmore, D. L., Alexander, P. A., & Loughlin, S. M. (2008). Focusing the conceptual lens on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review*, *20*, 391-409. doi:10.1007/s10648-008-9083-6

Diekema, A. R., Holliday, W., & Leary, H. (2011). Re-framing information literacy: Problem-based learning as informed learning. *Library & Information Science Research, 33*, 261-268. doi:10.1016/j.lisr.2011.02.002

Doran, M. S., & Klein, J. D. (1996, February). *The effects of learning structures on student achievement and attitude using a computer simulation*. Paper presented at the National Convention of the Association for Educational Communications and Technology, Indianapolis, IN. Retrieved from ERIC database. (ED397788)

Duffy, M. C., Azevedo, R., Sun, N.Z., Griscom, S. E., Stead, V., Crelinsten, L., . . . Lachapelle, K. (2015). Team regulation in a simulated medical emergency: An in-depth analysis of cognitive, metacognitive, and affective processes. *Instructional Science, 43*, 401-426. doi:10.1007/s11251-014-9333-6

Dunlosky, J., & Metcalfe, J. (2009). *Metacognition*. London: Sage Publications.

Eagan, K., Stolzenberg, E. B., Lozano, J. B., Aragon, M. C., Suchard, M. R., & Hurtado, S. *Undergraduate teaching faculty: The 2013–2014 HERI Faculty Survey*. Los Angeles, CA: Higher Education Research Institute, UCLA.

The Economist Intelligence Unit. (2008). *The future of higher education: How technology will shape learning*. Retrieved from http://graphics.eiu.com/upload/The%20Future%20of%20Universities.pdf

Elshout-Mohr, M., Meijer, J., van Daalen-Kapteijns, M. M., & Meeus, W. (2004, June-July). *Joint research into the AILI (Awareness of Independent Learning Inventory)* [Abstract]. Paper presented at the first EARLI-SIG on Metacognition. Amsterdam: University of Amsterdam. Retrieved from https://www.narcis.nl/publication/RecordID/oai:dare.uva.nl:publications%2Fb2d11041-1076-4018-952c-ca3a199e66eb

Everson, H.T., Tobias, S., & Laitusis, V. (1997, March). *Do metacognitive skills and learning strategies transfer across domains?* Paper presented at the Annual Convention of the American Educational Research Association. Chicago, IL. Retrieved from ERIC database. (ED410262)

Fan, X., Thompson, B., & Wang, L. (1999). Effects of sample size, estimation method, and model specification on structural equation modeling fit indexes. *Structural Equation Modeling, 6*, 56−83.

Farkas, M. (2012). Participatory technologies, pedagogy 2.0 and information literacy. *Library Hi Tech*, *30*, 82-94. doi:10.1108/07378831211213229

Field, A. (2013). *Discovering statistics using SPSS* (4th ed.). London, England: Sage.

Figueira, A., & Leal, H. (2013, October). *An Online Tool to Manage and Assess Collaborative Group Work.* Paper presented at the European Conference on eLearning, Sophia Antipolis, France.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34,* 906-911. Retrieved from http://www.apa.org/pubs/journals/amp/

Flewitt, R., Messer, D., & Kucirkova, N. (2015). New directions for early literacy in a digital age: The iPad. *Journal of Early Childhood Literacy, 15*, 289-310. doi:10.1177/1468798414533560

Francescato, D., Porcelli, R., Mebane, M., Cuddetta, M., Klobas, J., & Renzi, P. (2006). Evaluation of the efficacy of collaborative learning in face-to-face and computer-supported university contexts. *Computers in Human Behavior, 22*, 163-176. doi:10.1016/j.chb.2005.03.001

Garrison, D. R. (2009). Implications of online learning for the conceptual development and practice of distance education. *International Journal of E-Learning and Distance Education, 23*(2), 93-104. Retrieved from http://www.ijede.ca

Ginder, S., & Stearns, C. (2014). *Enrollment in distance education course, by state: Fall 2012*. Washington, DC: US Department of Education, National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2014/2014023.pdf

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education, 7*(1). doi:10.21061/jte.v7i1.a.2

Goos, M., Galbraith, P., & Renshaw, P. (2002). Socially mediated metacognition: Creating collaborative zones of proximal development in small group problem solving. *Educational Studies in Mathematics, 49*, 193-223. doi:10.2307/3483075

Graham, M., Milanowski, A. & Miller, J. (2012). *Measuring and promoting inter-rater agreement of teacher and principal performance ratings*. Washington, DC: Center for Educator Compensation Reform.

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in US public schools: 2009* (NCES 2010-040). Retrieved from the National Center for Education Statistics website: https://nces.ed.gov/pubs2010/2010040.pdf

Gunawardena, C. N. (1995). Social presence theory and implications for interaction and collaborative learning in computer conferences. *International Journal of Educational Telecommunications, 1*, 147-166. Retrieved from https://www.learntechlib.org/j/IJET

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2009). *Multivariate data analysis* (7rd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Hämäläinen, R. (2012). Methodological reflections: designing and understanding computer-supported collaborative learning. *Teaching in Higher Education, 17*, 603-614. doi:10.1080/13562517.2012.658556

Hammann, L. A., & Stevens, R. J. (1998, April). *Metacognitive awareness assessment in self-regulated learning and performance measures in an introductory educational psychology course*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.

Hart, C. (2012). Factors associated with student persistence in an online program of study: A review of the literature. *Journal of Interactive Online Learning*, *11*, 19-42. Retrieved from www.ncolr.org/jiol

Harting, K., & Erthal, M. J. (2005). History of distance learning. *Information Technology, Learning, and Performance Journal, 23*(1), 35-44. Retrieved from https://www.learntechlib.org/j/ISSN-1535-1556

Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, *66*, 99-136. doi:10.3102/00346543066002099

Hofer, B. K. (2004). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist*, *39*, 43-55. doi:10.1207/s15326985ep3901_5

Honebein, P., Duffy, T., & Fishman, B. (1993). Constructivism and the design of learning environments: Context and authentic activities for learning. In T. Duffy, J. Lowyck, D. Jonassen & T. Welsh (Eds.), *Designing Environments for Constructive Learning* (Vol. 105, pp. 87-108). Berlin, Heidelberg: Springer.

Hooper, D., Coughlan, J., Mullen, M. (2008). Structural Equation Modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods*, *6*, 53-60. doi:10.1016/j.paid.2006.09.018

Houtman, E. (2015). "Mind-blowing": Fostering self-regulated learning in information literacy instruction. *Communications in Information Literacy, 9*, 6-18. Retrieved from www.comminfolit.org

Howard, B. C., McGee, S., Shia, R., & Hong, N. S. (2000, April). *Metacognitive self-regulation and problem-solving: expanding the theory base through factor analysis*. Paper presented at the American Educational Research Association, New Orleans, LA.

Howard, B. C., McGee, S., Shia, R., & Hong, N. S. (2001, April). *The influence of metacognitive self-regulation and ability levels on problem solving*. Paper presented to the American Educational Research Association, Seattle, WA.

Hox, J. J., & Maas, C. J. M. (2002). Sample sizes for multilevel modeling. In J. Blasius, J. J. Hox, E. de Leeuw, & P. Schmidt (Eds.), *Social science methodology in the new millennium: Proceedings of the Fifth International Conference on Logic and Methodology* (2nd ed., pp. 0-19). Opladen, Germany: Leske + Budrich.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55. doi:10.1080/10705519909540118

Hurme, T.R., Palonen, T., & Järvelä, S. (2006). Metacognition in joint discussions: an analysis of the patterns of interaction and the metacognitive content of the networked discussions in mathematics. *Metacognition and Learning, 1*, 181-200. doi:10.1007/s11409-006-9792-5

Hutcheson, G. D., & Sofroniou, N. (1999). *The multivariate social scientist: Introductory statistics using generalized linear models*. London: Sage.

Ibabe, I., & Jauregizar, J. (2010). Online self-assessment with feedback and metacognitive knowledge. *Higher Education, 59*, 243-258. doi:10.1007/s10734-009-9245-6

Iiskala, T., Vauras, M., & Lehtinen, E. (2004). Socially-shared metacognition in peer learning? *Hellenic Journal of Psychology, 1*, 147-178. Retrieved from http://www.pseve.org/journal.asp

Iiskala, T., Vauras, M., Lehtinen, E., & Salonen, P. (2011). Socially shared metacognition of dyads of pupils in collaborative mathematical problem-solving processes. *Learning and Instruction, 21*(3), 379-393. doi:10.1016/j.learninstruc.2010.05.002

Imazeki, J. (2014). Bring-your-own-device: Turning cell phones into forces for good. *Journal of Economic Education, 45*, 240-250. doi:10.1080/00220485.2014.917898

Inan, B. (2013). The relationship between self-regulated learning strategies and academic achievement in a Turkish EFL Setting. *Educational Research and Reviews*, *8*, 1544-1550. Retrieved from http://www.academicjournals.org/journal/ERR

Israel, S. E., Bauserman, K. L., & Block, C. C. (2005). Metacognitive assessment strategies. *Thinking Classroom, 6*(2), 21-28. Retrieved from http://www.rwctic.org/thinking-classroom

Jacobse, A., & Harskamp, E. (2012). Towards efficient measurement of metacognition in mathematical problem solving. *Metacognition and Learning, 7*, 133-149. doi:10.1007/s11409-012-9088-x

Jaggars, S. S., & Bailey, T. (2010). Effectiveness of fully online courses for college students: Response to a Department of Education meta-analysis. New York, NY: Community College Research Center, Teachers College, Columbia University. Retrieved from http://ccrc.tc.columbia.edu/

Janssen, J., Erkens, G., Kirschner, P. A., & Kanselaar, G. (2011). Multilevel analysis in CSCL research. In S. Puntambeka, E. Sadhana, & C. Hmelo-Silver (Eds.), *Analyzing Interactions in CSCL*: Methods, approaches, and issues. (pp. 187-205). New York, NY: Springer US.

Janssen, J., Erkens, G., Kirschner, P. A., & Kanselaar, G. (2012). Task-related and social regulation during online collaborative learning. *Metacognition and Learning, 7*, 25-43. doi:10.1007/s11409-010-9061-5

Järvelä, S., Järvenoja, H., Malmberg, J., & Hadwin, A. F. (2013). Exploring socially shared regulation in the context of collaboration. *Journal of Cognitive Education and Psychology*, *12*, 267-286. doi:10.1891/1945-8959.12.3.267

Järvelä, S., & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL. *Educational Psychologist*, *48*, 25-39. 10.1080/00461520.2012.748006

Järvelä, S., Häkkinen, P., Arvaja, M., & Leinonen, P. (2004). Instructional support in CSCL. In *What we know about CSCL* (pp. 115-139). Netherlands: Springer.

Järvelä, S., Kirschner, P. A., Hadwin, A., Järvenoja, H., Malmberg, J., Miller, M., & Laru, J. (2016). Socially shared regulation of learning in CSCL: Understanding and prompting individual-and group-level shared regulatory activities. *International Journal of Computer-Supported Collaborative Learning*, *11*, 263-280. doi:10.1007/s11412-016-9238-2

Järvenoja, H., Volet, S., & Järvelä, S. (2013). Regulation of emotions in socially challenging learning situations: An instrument to measure the adaptive and social nature of the regulation process. *Educational Psychology*, *33*, 31-58. doi:10.1080/01443410.2012.742334

Jaschik, S., & Lederman, D. (2014). *The 2014 Inside Higher Ed survey of faculty attitudes on technology.* Washington, D.C.: Gallup and Inside Higher Ed.

Johnson, J. A. (2005). Ascertaining the validity of individual protocols from web-based personality inventories. *Journal of Research in Personality*, *39*, 103-129. doi:10.1016/j.jrp.2004.09.009

Johnson, R. D., Gueutal, H., & Falbe, C. M. (2009). Technology, trainees, metacognitive activity and e-learning effectiveness. *Journal of Managerial Psychology*, *24*, 545-566. doi:10.1108/02683940910974125

Johnson, T. E., Archibald, T. N., & Tenenbaum, G. (2010). Individual and team annotation effects on students' reading comprehension, critical thinking, and meta-cognitive skills. *Computers in Human Behavior, 26*, 1496-1507. doi:10.1016/j.chb.2010.05.014

Jonassen, D. H. (1994). Thinking technology: Toward a constructivist design model. *Educational Technology, 34*(4), 34-37.

Jones, M. E., Antonenko, P. D., & Greenwood, C. M. (2012). The impact of collaborative and individualized student response system strategies on learner motivation, metacognition, and knowledge transfer. *Journal of Computer Assisted Learning, 28*, 477-487. doi:10.1111/j.1365-2729.2011.00470.x

Jost, J. T., Kruglanski, A. W., & Nelson, T. O. (1998). Social metacognition: An expansionist review. *Personality & Social Psychology Review, 2*, 137-154. doi:/10.1207/s15327957pspr0202_6

Joung, S., & Keller, J. M. (2004). The effects of high-structure cooperative versus low-structure collaborative design of decision change, critical thinking, and interaction pattern during online debates. Presented at the Association for Educational Communications and Technology (AECT) 2004 Annual International Convention, Orlando, FL. Retrieved from ERIC database. (ED485151)

Kaplan, A. (2008). Clarifying metacognition, self-regulation, and self-regulated learning: What's the purpose? *Educational Psychology Review*, *20*, 477-484. doi:10.1007/s10648-008-9087-2

Kelemen, W. L., Frost, P. J., & Weaver, C. A. (2000). Individual differences in metacognition: Evidence against a general metacognitive ability. *Memory & Cognition, 28*, 92-107. doi:10.3758/bf03211579

Kenny, D. A., Mannetti, L., Pierro, A., Livi, S., & Kashy, D. A. (2002). The statistical analysis of data from small groups. *Journal of Personality and Social Psychology*, *83*, 126-137. Retrieved from http://www.apa.org/pubs/journals/psp/

Khosa, D., & Volet, S. (2014). Productive group engagement in cognitive activity and metacognitive regulation during collaborative learning: can it explain differences in students' conceptual understanding? *Metacognition and Learning, 9*, 287-307. doi:10.1007/s11409-014-9117-z

Kirschner, P. A., Kirschner, F., & Janssen, J. (2014). The collaboration principle in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 547-575). New York, NY: Cambridge University Press.

Kitsantas, A., & Dabbagh, N. (2011). The role of Web 2.0 technologies in self-regulated learning. *New Directions for Teaching and Learning, 2011*(126), 99-106. doi:10.1002/tl.448

Kizilcec, R. F., & Halawa, S. (2015, March). Attrition and achievement gaps in online learning. *Proceedings of the Second (2015) ACM Conference on Learning @ Scale*, New York, USA, 57-66. Retrieved from http://dl.acm.org/

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guilford

Kollar, I., Fischer, F., & Hesse, F. W. (2006). Collaboration scripts – A conceptual analysis. *Educational Psychology Review*, *18*, 159-185. doi:10.1007/s10648-006-9007-2

Kreft, I. G., Kreft, I., & de Leeuw, J. (1998). *Introducing multilevel modeling*. Thousand Oaks, CA: Sage.

Künsting, J., Kempf, J., & Wirth, J. (2013). Enhancing scientific discovery learning through metacognitive support. *Contemporary Educational Psychology, 38*(4), 349-360. http://dx.doi.org/10.1016/j.cedpsych.2013.07.001

Kwon, K., Hong, R.-Y., & Laffey, J. M. (2013). The educational impact of metacognitive group coordination in computer-supported collaborative learning. *Computers in Human Behavior, 29*, 1271-1281. doi:10.1016/j.chb.2013.01.003

Lajoie, S. P., & Lu, J. (2012). Supporting collaboration with technology: does shared cognition lead to co-regulation in medicine? *Metacognition and Learning*, *7*, 45-62. doi:10.1007/s11409-011-9077-5

Lamb, A., & Johnson, L. (2009). The digital dog ate my notes: Tools and strategies for 21st century research projects. *Teacher Librarian*, *37*(2), 77-81. Retrieved from http://teacherlibrarian.com/

Lawley, D.N., Maxwell, A.E. (1971). *Factor analysis as a statistical method*. London: Butterworth and Co.

Lee, Y., Choi, J., & Kim, T. (2013). Discriminating factors between completers of and dropouts from online learning courses. *British Journal of Educational Technology*, *44*, 328-337. doi:10.1111/j.1467-8535.2012.01306.x

Lehmann, T., Hähnlein, I., & Ifenthaler, D. (2014). Cognitive, metacognitive and motivational perspectives on preflection in self-regulated online learning. *Computers in Human Behavior, 32*, 313-323. doi:http://dx.doi.org/10.1016/j.chb.2013.07.051

Liao, H.-A. (2014). Examining the role of collaborative learning in a public speaking course. *College Teaching, 62*, 47-54. doi:10.1080/87567555.2013.855891

Lipponen, L. (2002, January). Exploring foundations for computer-supported collaborative learning. *Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL community*, Fraunhofer, Germany, 72-81. Retrieved from http://dl.acm.org

Lipponen, L., Hakkarainen, K., & Paavola, S. (2004). Practices and orientations of CSCL. In J.-W. Strijbos, P. A. Kirschner, & R. L. Martens (Eds.), *What we know about CSCL* (pp. 31-50). Dordrecht: Springer Netherlands.

Livingstone, I., & Shepherd, I. (1997). Using the Internet. *Journal of Geography in Higher Education*, *21*, 435-443. doi:10.1080/03098269786291

Livingston, J. A. (2003). *Metacognition: An overview*. Retrieved from ERIC database. (ED474273)

Lou, Y., Abrami, P. C., & d'Apollonia, S. (2001). Small group and individual learning with technology: a meta-analysis. *Review of Educational Research*, *71*, 449–521. doi:10.3102/00346543071003449

Maas, C. J., & Hox, J. J. (2004). Robustness issues in multilevel regression analysis. *Statistica Neerlandica*, *58*, 127-137. doi:10.1046/j.0039-0402.2003.00252.x

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*, 84-99.

Mackey, T. P., & Jacobson, T. E. (2014). *Metaliteracy: Reinventing information literacy to empower learners.* Chicago, IL: American Library Association.

Mackey, T. P., & Jacobson, T. E. (2010). Reframing information literacy as a metaliteracy. *College & Research Libraries*, *72*, 62-78. doi:10.5860/crl-76r1

Madden, A.D., Ford, N., Gorrell, G., Eaglestone, B., & Holdridge, P. (2012). Metacognition and web credibility. *The Electronic Library*, *30*, 671–689. http://doi.org/10.1108/02640471211275710

Marsh, H. W., & Hau, K.-T. (1999). Confirmatory factor analysis: Strategies for small sample size. In R. H. Hoyle (Ed.), *Statistical strategies for small sample research*. Thousand Oaks, CA: Sage Publications.

Meade, A. W., & Craig, S. B. (2012). Identifying careless responses in survey data. *Psychological methods*, *17*, 437-455. doi:10.1037/e518362013-127

Means, B., Toyama, Y., Murphy, R. F., & Baki, M. (2013). The effectiveness of online and blended learning: a meta-analysis of the empirical literature. *Teachers College Record*, *115*(3). Retrieved from http://www.tcrecord.org/

Meijer, J., Veenman, M. V. J., & van Hout-Wolters, B. H. A. M. (2006). Metacognitive activities in text-studying and problem-solving: development of a taxonomy. *Educational Research and Evaluation*, *12*, 209–237. doi:10.1080/13803610500479991

Mertler, C. A, & Vannatta, R. A. (2013). Advanced and multivariate statistical methods: Practical application and interpretation (3rd ed.). Los Angeles, CA: Pyrczak.

Meyer, J.H.F. and Land, R. (2003).Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practicing. In C. Rust (Ed.), *Improving student learning – Ten years on*. Oxford: OCSLD.

Meyers, L. S., Gamst, G. C., & Guarino, A. J. (2013). *Performing data analysis using IBM SPSS*. Hoboken, NJ: John Wiley & Sons.

Michalsky, T., Zion, M., & Mevarech, Z. R. (2007). Developing students' metacognitive awareness in asynchronous learning networks in comparison to face-to-face discussion groups. *Journal of Educational Computing Research*, *36*(4), 395-424. doi:10.2190/320v-8h4w-1123-44r6

Miller, A. L. (2012). Investigating social desirability bias in student self-report surveys. *Educational Research Quarterly, 36*(1), 30-47. Retrieved from http://erquarterly.org/

Misanchuk, M., & Anderson, T. (2001, April). Building community in an online learning environment: Communication, cooperation and collaboration. Presented at the Teaching, Learning, and Technology Conference, Middle Tennessee State University. Retrieved from ERIC database. (ED463725)

Mokhtari, K., & Reichard, C. A. (2002). Assessing students' metacognitive awareness of reading strategies. *Journal of Educational Psychology, 94*, 249-259. doi:10.1037/0022-0663.94.2.249

Molenaar, I., Van Boxtel, C. A., & Sleegers, P. J. (2010). The effects of scaffolding metacognitive activities in small groups. *Computers in Human Behavior*, *26*, 1727-1738. doi:10.1016/j.chb.2010.06.022

Molinari, G., Sangin, M., Dillenbourg, P., & Nüssli, M.A. (2009). Knowledge interdependence with the partner, accuracy of mutual knowledge model and computer-supported collaborative learning. *European Journal of Psychology of Education - EJPE (Instituto Superior de Psicologia Aplicada), 24*, 129-144. doi:10.1007/bf03173006

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education*, *3*(2), 1-6.

Moore, M. G. (1993). Theory of transactional distance. *Theoretical principles of distance education*, *1*, 22-38.

Nickel, C. E. (2010). *The effects of cooperative and collaborative strategies on student achievement and satisfaction in blended and online learning environments* (Doctoral dissertation, Old Dominion University, Ann Arbor). Retrieved from ProQuest Dissertations and Theses. (UMI No. 3416872)

Niess, M., & Gillow-Wiles, H. (2013). Developing asynchronous online courses: Key instructional strategies in a social metacognitive constructivist learning trajectory. *Journal of Distance Education (Online)*, *27*(1). Retrieved from http://ijede.ca/index.php/jde

Niessen, A. S. M., Meijer, R. R., & Tendeiro, J. N. (2016). Detecting careless respondents in web-based questionnaires: Which method to use? *Journal of Research in Personality, 63*, 1-11. doi:10.1016/j.jrp.2016.04.010

Nietfeld, J. L., Cao, L., & Osborne, J. W. (2005). Metacognitive monitoring accuracy and student performance in the postsecondary classroom. *Journal of Experimental Education*, *74*, 7-28. Retrieved from http://www.tandfonline.com/loi/vjxe20

Northrup, P. (2002). Online learners' preferences for interaction. *Quarterly Review of Distance Education*, *3*(2), 219-226. Retrieved from ERIC database. (EJ654234)

O'Dwyer, L. M., & Parker, C. E. (2014). A primer for analyzing nested data: Multilevel modeling in SPSS using an example from a REL study. REL 2015-046. *Regional*

Educational Laboratory Northeast & Islands. Retrieved from https://ies.ed.gov/ncee/edlabs/regions/northeast/pdf/REL_2015046.pdf

Oja, M. (2011). Student satisfaction and student performance. *Journal of Applied Research in the Community College, 19*(1), 50-56. Retrieved from http://www.montezumapublishing.com/jarcc1/aboutus.aspx

Omori, J. S., Wong, V. S., & Nishimura, S. (2013). Medical school hotline: Enhancing problem-based learning with technology: the introduction of iPads into the John A. Burns School of Medicine Curriculum. *Hawai'i Journal of Medicine & Public Health, 72*, 362-364. Retrieved from http://www.hjmph.org/

Pai, H. H., Sears, D. A., & Maeda, Y. (2015). Effects of small-group learning on transfer: A meta-analysis. *Educational Psychology Review, 27*, 79-102. doi:http://dx.doi.org/10.1007/s10648-014-9260-8

Palincsar, A. S. (2005). Social constructivist perspectives on teaching and learning. In H. Daniels (Ed.), *An introduction to Vygotsky* (2nd ed., pp. 285-314). New York, NY: Routledge.

Panadero, E., Kirschner, P. A., Järvelä, S., Malmberg, J., & Järvenoja, H. (2015). How individual self-regulation affects group regulation and performance: A shared regulation intervention. *Small Group Research, 46*, 431-454. doi:10.1177/1046496415591219

Panitz, T. (1999). *Collaborative versus cooperative learning: Comparing the two definitions helps understand the nature of interactive learning*. Retrieved from ERIC database. (ED448443)

Papanikolaou, K., & Boubouka, M. (2010). Promoting collaboration in a project-based e-learning context. *Journal of Research on Technology in Education*, *43*, 135-155. doi:10.1080/15391523.2010.10782566

Pattanpichet, F. (2011). The effects of using collaborative learning to enhance students' English speaking achievement. *Journal of College Teaching & Learning, 8*(11), 1-10. doi:10.19030/tlc.v8i11.6502

Pear, J. J., & Crone-Todd, D. E. (2002). A social constructivist approach to computer-mediated instruction. *Computers & Education, 38*(1-3), 221-231. doi:10.1016/S0360-1315(01)00070-7

Pellas, N. (2014). The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs: Evidence from the virtual world of Second Life. *Computers in Human Behavior, 35*, 157-170. doi:10.1016/j.chb.2014.02.048

Piaget, J. (1968). *On the development of memory and identity* (Vol. 2). Worcester, MA: Clark University Press.

Picciano, A., Seaman, J. & Allen, I.E. (2010). Educational transformation through online learning: To be or not to be. *Journal of Asynchronous Learning Networks (JALN), 14*(4). Retrieved from http://sloanconsortium.org/publications/olj_main

Picciano, A. G., Seaman, J., Shea, P., & Swan, K. (2012). Examining the extent and nature of online learning in American K-12 Education: The research initiatives of the Alfred P. Sloan Foundation. *The Internet and Higher Education, 15*, 127-135. doi:1016/j.iheduc.2011.07.004

Pifarre, M., & Cobos, R. (2010). Promoting metacognitive skills through peer scaffolding in a CSCL environment. *International Journal of Computer-Supported Collaborative Learning*, *5*, 237-253. doi:10.1007/s11412-010-9084-6

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*, 667-686. doi:10.1037/0022-0663.95.4.667

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33. doi:10.1037//0022-0663.82.1.33

Pintrich, P. R., Smith, D. A., García, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801-813. doi:10.1177/0013164493053003024

Pintrich, P. R., Smith, D. A., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. Ann Arbor, MI: Regents of the University of Michigan

Pintrich, P. R., Wolters, C. A., & Baxter, G. P. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. C. Impara (Eds.), *Issues in the Measurement of Metacognition* (pp. 43-97). Lincoln, NE: Buros Institute of Mental Measurements.

Poitras, E., Lajoie, S., & Hong, Y. J. (2012). The design of technology-rich learning environments as metacognitive tools in history education. *Instructional Science*, *40*, 1033-1061. doi:10.1007/s11251-011-9194-1

Powell, K. C., & Kalina, C. J. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education, 130*, 241-250. Retrieved from ERIC database. (EJ871658)

Puzziferro, M. (2008). Online technologies self-efficacy and self-regulated learning as predictors of final grade and satisfaction in college-level online courses. *The American Journal of Distance Education*, *22*, 72-89. doi:10.1080/08923640802039024

Radovan, M. (2011). The relation between distance students' motivation, their use of learning strategies, and academic success. *Turkish Online Journal of Educational Technology - TOJET, 10*(1), 216-222. Retrieved from http://www.tojet.net/

Rahimirad, M., & Shams, M. R. (2014). The effect of activating metacognitive strategies on the listening performance and metacognitive awareness of EFL Students. *International Journal of Listening, 28*, 162-176. doi:10.1080/10904018.2014.902315

Rakes, G. C., & Dunn, K. E. (2010). The impact of online graduate students' motivation and self-regulation on academic procrastination. *Journal of Interactive Online Learning*, *9*, 78-93. Retrieved from www.ncolr.org/jiol

Rampp, L. C., & Guffey, J. S. (1999). *The impact of metacognition training on academic self-efficacy of selected underachieving college students*. Retrieved from ERIC database. (ED432607)

Ravenscroft, A. (2011). Dialogue and connectivism: A new approach to understanding and promoting dialogue-rich networked learning. *The International Review of Research in Open and Distributed Learning*, *12*(3), 139-160. doi:10.19173/irrodl.v12i3.934

Reiser, R. A. (2001). A history of instructional design and technology: Part I: A history of instructional media. *Educational Technology Research and Development, 49*, 53-64. doi:10.1007/bf02504506

Reisetter, M., LaPointe, L., & Korcuska, J. (2007). The impact of altered realties: Implications of online delivery for learners' interactions, expectations, and learning skills. *International Journal on E-learning*, *6*, 55-80. Retrieved from https://www.aace.org/pubs/ijel/

Rennie, K.M. (1997, January). *Exploratory and confirmatory rotation strategies in exploratory factor analysis*. Paper presented at the Annual Meeting of the Southwest Educational Research Association. Austin, TX. Retrieved from ERIC database. (ED406446)

Rigdon, E. E. (1996). CFI versus RMSEA: A comparison of two fit indexes for structural equation modeling. *Structural Equation Modeling, 3*, 369−369.

Rogat, T. K., & Linnenbrink-Garcia, L. (2011). Socially shared regulation in collaborative groups: An analysis of the interplay between quality of social regulation and group processes. *Cognition and Instruction, 29*, 375-415. doi:10.1080/07370008.2011.607930

Roll, I., Aleven, V., McLaren, B. M., & Koedinger, K. R. (2007). Designing for metacognition--applying cognitive tutor principles to the tutoring of help seeking. *Metacognition and Learning, 2*, 125-140. doi:http://dx.doi.org/10.1007/s11409-007-9010-0

Romainville, M. (1994). Awareness of cognitive strategies: The relationship between university students' metacognition. *Studies in Higher Education, 19*, 359-366. doi:10.1080/03075079412331381930

Rovai, A. P. (2004). A constructivist approach to online college learning. *The Internet and Higher Education, 7*, 79-93. doi:http://dx.doi.org/10.1016/j.iheduc.2003.10.002

Saab, N. (2012). Team regulation, regulation of social activities or co-regulation: Different labels for effective regulation of learning in CSCL. *Metacognition and Learning, 7*, 1-6. doi:10.1007/s11409-011-9085-5

Saab, N., van Joolingen, W., & van Hout-Wolters, B. (2012). Support of the collaborative inquiry learning process: influence of support on task and team regulation. *Metacognition and Learning*, *7*, 7-23. doi:10.1007/s11409-011-9068-6

Schellings, G. M., van Hout-Wolters, B. A. M., Veenman, M. J., & Meijer, J. (2013). Assessing metacognitive activities: the in-depth comparison of a task-specific questionnaire with think-aloud protocols. *European Journal of Psychology of Education, 28*, 963-990. doi:10.1007/s10212-012-0149-y

Schraw, G. (1994). The effect of metacognitive knowledge on local and global monitoring. *Contemporary Educational Psychology*, *19*, 143-154. doi:10.1006/ceps.1994.1013

Schraw, G. (2001). Promoting general metacognitive awareness. In H. J. Harmon (Ed.), *Metacognition in learning and instruction* (pp. 3-16). Dordrecht, Netherlands: Kluwer.

Schraw, G. & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, *19*, 460-475. doi:10.1006/ceps.1994.1033

Schunk, D. (2008). Metacognition, self-regulation, and self-regulated learning: research recommendations. *Educational Psychology Review, 20*, 463-467. doi:10.1007/s10648-008-9086-3

Scott, B. M., & Berman, A. F. (2013). Examining the domain-specificity of metacognition using academic domains and task-specific individual differences. *Australian Journal of Educational & Developmental Psychology*, *13*, 28–43. Retrieved from https://www.newcastle.edu.au/about-uon/governance-and-leadership/faculties-and-schools/faculty-of-education-and-arts/school-of-education/school-research/ajedp/previous-issues

Scott, B. M., & Levy, M. G. (2013). Metacognition: Examining the components of a fuzzy concept. *Revistas - Educational Research eJournal*, *2*, 120-131. doi:10.5838/erej.2013.22.04

Sharma, M. D., & Bewes, J. (2011). Self-monitoring: Confidence, academic achievement and gender differences in physics. *Journal of Learning Design*, *4*(3), 1-13. doi:10.5204/jld.v4i3.76

Shea, N., Boldt, A., Bang, D., Yeung, N., Heyes, C., & Frith, C. D. (2014). Supra-personal cognitive control and metacognition. *Trends in Cognitive Sciences*, *18*, 186-193. doi:10.1016/j.tics.2014.01.006

Shea, P., & Bidjerano, T. (2010). Learning presence: Towards a theory of self-efficacy, self-regulation, and the development of a communities of inquiry in online and blended learning environments. *Computers & Education, 55*(4), 1721-1731. doi:http://dx.doi.org/10.1016/j.compedu.2010.07.017

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. New York, NY: John Wiley.

Siegel, M. A. (2011). Filling in the distance between us: Group metacognition during problem solving in a secondary education course. *Journal of Science Education and Technology, 21*, 325-341. doi:10.1007/s10956-011-9326-z

Sitzmann, T. (2012). A theoretical model and analysis of the effect of self-regulation on attrition from voluntary online training. *Learning and Individual Differences*, *22*(1), 46–54. doi:10.1016/j.lindif.2011.11.004

Slavin, R. E., & Lake, C. (2009). *Effective educational programs: Meta-findings from the best evidence encyclopedia*. Retrieved from ERIC database. (ED524709)

Smith, K. A. (1996). Cooperative learning: Making "groupwork" work. *New Directions for Teaching and Learning*, *1996*(67), 71-82. doi:10.1002/tl.37219966709

Smith, G. G., Sorensen, C., Gump, A., Heindel, A. J., Caris, M., & Martinez, C. D. (2011). Overcoming student resistance to group work: Online versus face-to-face. *Internet and Higher Education*, *14*, 121-128. doi:10.1016/j.iheduc.2010.09.005

Snyder, M. M., & Dringus, L. P. (2014). An exploration of metacognition in asynchronous student-led discussions: A qualitative inquiry. *Online Learning: Official Journal of the Online Learning Consortium*, *18*(2). doi:10.24059/olj.v18i2.418

Solimeno, A., Mebane, M. E., Tomai, M., & Francescato, D. (2008). The influence of students and teachers characteristics on the efficacy of face-to-face and computer supported collaborative learning. *Computers & Education, 51*, 109-128. doi:10.1016/j.compedu.2007.04.003

Sperling, R. A., Howard, B. C., Miller, L. A., & Murphy, C. (2002). Measures of children's knowledge and regulation of cognition. *Contemporary Educational Psychology, 27*, 51-79. doi:10.1006/ceps.2001.1091

Sperling, R. A., Howard, B. C., Staley, R., & DuBois, N. (2004). Metacognition and self-regulated learning constructs. *Educational Research and Evaluation, 10*, 117-139. doi:10.1076/edre.10.2.117.27905

Stacey, E. (2007). Collaborative learning in an online environment. *International Journal of E-Learning & Distance Education, 14*(2), 14-33. Retrieved from http://www.ijede.ca/index.php/jde/article/viewArticle/154/379

Stahl, G. (2010). Guiding group cognition in CSCL. *International Journal of Computer-Supported Collaborative Learning, 5*, 255-258. doi:10.1007/s11412-010-9091-7

Stahl, G., Kosschmann, T., & Suthers, D (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 409-426). Cambridge, UK: Cambridge University Press.

Stankov, L., & Kleitman, S. (2014). Whither metacognition. *Learning and Individual Differences, 29*, 120-122. doi:10.1016/j.lindif.2013.06.001

Tabachnick, B.G., & Fidell, L.S. (2013). *Using multivariate statistics* (6th ed.). Boston, MA: Pearson.

Tempelaar, D. T., Wosnitza, M., Volet, S., Rienties, B., Giesbers, B., & Gijselaers, W. H. (2013). The role of self-and social directed goals in a problem-based, collaborative learning context. *Higher Education*, *66*, 253-267. doi:10.1007/s10734-012-9602-8

Thomas, I. D. (1985). *Uses of the computer in teaching the composing process*. 1985 Annual Report of the NCTE Committee on Instructional Technology. Retrieved from ERIC database. (ED265571)

Tok, H., Özgan, H., & DÖġ, B. (2010). Assessing metacognitive awareness and learning strategies as positive predictors for success in a distance learning class. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 7*(14), 123-134. Retrieved from http://sbed.mku.edu.tr/

Tosun, C., & Taşkesenligil, Y. (2011). The effect of problem based learning on student motivation towards chemistry classes and on learning strategies. *Journal of Turkish Science Education, 9*(1), 104-125. Retrieved from http://www.tused.org/internet/tused/default13.asp

Tu, C.-H., & McIsaac, M. (2002). The relationship of social presence and interaction in online classes. *The American Journal of Distance Education, 16*, 131-150. doi:10.1207/s15389286ajde1603_2

U.S. Department of Education, National Center for Education Statistics. (2016). *Digest of Education Statistics, 2014* (NCES 2016-006), Table 311.15. Retrieved from https://nces.ed.gov/fastfacts/display.asp?id=80

U.S. Department of Education (2011). Learning at a distance: Undergraduate enrollment in distance education courses and degree programs. *Statistics in Brief*, 2011. (NCES 2012-154). Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012154

Uzun, A. M., Unal, E., & Yamac, A. (2013). Service teachers and academic achievements in online distance education: The roles of online self-regulation and attitudes. *Turkish Online Journal of Distance Education, 14*(2), 131-140. Retrieved from http://tojde.anadolu.edu.tr/

Valentine, M. J. (2003). The role of satisfaction in the retention and performance of university students. *Masters Abstracts International*, *41*(05), 1251. (UMI No. 1413000)

Vandergrift, L., Goh, C. C. M., Mareschal, C. J., & Tafaghodtari, M. H. (2006). The Metacognitive Awareness Listening Questionnaire: Development and validation. *Language Learning, 56*, 431-462. doi:10.1111/j.1467-9922.2006.00373.x

Veenman, M. V. J. (2011). Alternative assessment of strategy use with self-report instruments: a discussion. *Metacognition and Learning, 6*, 205-211. doi:10.1007/s11409-011-9080-x

Veenman, M. V. J., Bavelaar, L., De Wolf, L., & Van Haaren, M. G. P. (2014). The on-line assessment of metacognitive skills in a computerized learning environment. *Learning and Individual Differences, 29*, 123-130. doi:10.1016/j.lindif.2013.01.003

Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and learning*, *1*, 3-14. doi:10.1007/s11409-006-6893-0

Volet, S., & Mansfield, C. (2006). Group work at university: significance of personal goals in the regulation strategies of students with positive and negative appraisals. *Higher Education Research and Development, 25*, 341-356. doi:10.1080/07294360600947301

Volet, S., Vauras, M., Khosa, D., & Iiskala, T. (2013). Metacognitive regulation in collaborative learning. In S.Volet & M. Vauras (Eds.)*, Interpersonal regulation of learning and motivation: Methodological advances* (pp. 67–101). London: Routledge.

Vrugt, A., & Oort, F. J. (2008). Metacognition, achievement goals, study strategies and academic achievement: pathways to achievement. *Metacognition and Learning*, *3*, 123-146. doi:10.1007/s11409-008-9022-4

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Cambridge, MA: Harvard University Press.

Wang, M. C., Haertel, G. D., & Walberg, H. J. (1990). What influences learning? A content analysis of review literature. *Journal of Educational Research*, *84*, 30–43.

Watson, J., Pape, L., Murin, A., Gemin, B., & Vashaw, L. (2014). Keeping pace with K-12 digital learning: An annual review of policy and practice. *Evergreen Education Group.* Retrieved from http://www.kpk12.com/wp-content/uploads/EEG_KP2014-fnl-lr.pdf

Wells, G. (2000). Dialogic inquiry in education: Building on the legacy of Vygotsky. In C. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literary research* (pp. 51-85). New York, NY: Cambridge University Press.

Willis, B. (1993). *Distance education: A practical guide*. Englewood Cliffs, NJ: Educational Technology.

Wilson, J. (1997, November). *Beyond the basics: Assessing students' metacognition*. Paper presented at The Hong Kong Educational Research Conference, Hong Kong.

Winne, P. H. (2010). Improving measurements of self-regulated learning. *Educational Psychologist*, *45*, 267-276. doi:10.1080/00461520.2010.517150

Winters, F., Greene, J., & Costich, C. (2008). Self-regulation of learning within computer-based learning environments: A critical analysis. *Educational Psychology Review, 20*, 429-444. doi:10.1007/s10648-008-9080-9

Witek, D., & Grettano, T. (2014). Teaching metaliteracy: a new paradigm in action. *Reference Services Review*, *42*, 188–208. http://doi.org/10.1108/RSR-07-2013-0035

Wolf, E. J., Harrington, K. M., Clark, S. L., & Miller, M. W. (2013). Sample size requirements for structural equation models: An evaluation of power, bias, and solution propriety. *Educational and Psychological Measurement*, *76*, 913–934. http://doi.org/10.1177/0013164413495237

Wolfson, N. E., Cavanagh, T. M., & Kraiger, K. (2014). Older adults and technology-based instruction: Optimizing learning outcomes and transfer. *Academy of Management Learning & Education*, *13*, 26-44. doi:10.5465/amle.2012.0056

Worthington, R. L., & Whittaker, T. A. (2006). Scale development research a content analysis and recommendations for best practices. *The Counseling Psychologist*, *34*, 806-838. doi:10.1177/0011000006288127

Wolters, C. A. (2003). Understanding procrastination from a self-regulated learning perspective. *Journal of Educational Psychology, 95*, 179-187. doi:10.1037/0022-0663.95.1.179

Woo, Y., & Reeves, T. C. (2007). Meaningful interaction in web-based learning: A social constructivist interpretation. *The Internet and Higher Education, 10*, 15-25. doi:http://dx.doi.org/10.1016/j.iheduc.2006.10.005

Xu, D., & Jaggars, S. S. (2013). The impact of online learning on students' course outcomes: Evidence from a large community and technical college system. *Economics of Education Review*, *37*, 46-57. doi:10.1016/j.econedurev.2013.08.001

York, R. O. (2008). Comparing three modes of instruction in a graduate social work program. *Journal of Social Work Education*, *44*, 157-172. doi:10.5175/jswe.2008.200700031

Young, A., & Fry, J. (2012). Metacognitive awareness and academic achievement in college students. *Journal of the Scholarship of Teaching and Learning, 8*(2), 1-10. Retrieved from http://josotl.indiana.edu/

Zhao, K., Chan, C. K., & K. (2014). Fostering collective and individual learning through knowledge building. *International Journal of Computer-Supported Collaborative Learning, 9*, 63-95. doi:http://dx.doi.org/10.1007/s11412-013-9188-x

Zimmerman, B. J. (1995). Self-regulation involves more than metacognition: A social cognitive perspective. *Educational Psychologist, 30*, 217-221. doi:10.1207/s15326985ep3004_8

Zion, M., Adler, I., & Mevarech, Z. (2015). The effect of individual and social metacognitive support on students' metacognitive performances in an online discussion. *Journal of Educational Computing Research, 52*, 50-87. doi:10.1177/0735633114568855

Appendix A

MAI (Schraw & Dennison, 1994)

Metacognitive scales

KNOWLEDGE OF COGNITION

1. Declarative knowledge: knowledge about learning and one's cognitive skills and abilities

2. Procedural knowledge: knowledge about how to use strategies

3. Conditional knowledge: knowledge about when and why to use strategies

REGULATION OF COGNITION

1. Planning: planning, goal setting, and allocating resources

2. a) Organizing: implementing strategies and heuristics that help one manage information

   b) Information management: organizing, elaborating, summarizing, and selectively focusing on important information

3. Monitoring: on-line assessment of one's learning or strategy use

4. Debugging: strategies used to correct performance errors or assumptions about the task or strategy use

5. Evaluation: post-hoc analysis of performance and strategy effectiveness

Questions by category

DK. Items 5, 10, 12, 16, 17, 20, 32, 46 (8)

PK. Items 3, 14, 27, 33 (4)

CK. Items 15, 18, 26, 29, 35 (5)

PLAN. Items 4, 6, 8, 22, 23, 42, 45 (7)

STRAT. Items 9, 13, 30, 31, 37, 39, 41, 43, 47, 48 (10)

MONITOR. Items 1, 2, 11, 21, 28, 34, 49 (7)

DEBUG. Items 25, 40, 44, 51, 52 (5)

EVALUATE. Items 7, 19, 24, 36, 38, 50 (6)

Metacognitive assessment inventory

We would like you to respond to the questions in this packet by indicating how true or false each statement is about you. If a statement is always true, write the number 5 in the blank provided to the right of each statement. Your responses are scored anonymously, so please answer as truthfully as you can.

Always False	Sometimes False	Neutral	Sometimes True	Always True
1	2	3	4	5

__ 1. I ask myself periodically if I am meeting my goals.

__ 2. I consider several alternatives to a problem before I answer.

__ 3. I try to use strategies that have worked in the past.

__ 4. I pace myself while learning in order to have enough time.

__ 5. I understand my intellectual strengths and weaknesses.

__ 6. I think about what I really need to learn before I begin a task.

__ 7. I know how well I did once I finish a test.

__ 8. I set specific goals before I begin a task.

__ 9. I slow down when I encounter important information.

__ 10. I know what kind of information is most important to learn.

__ 11. I ask myself if I have considered all options when solving a problem.

__ 12. I am good at organizing information.

__ 13. I consciously focus my attention on important information.

__ 14. I have a specific purpose for each strategy I use.

__ 15. I learn best when I know something about the topic.

__ 16. I know what the teacher expects me to learn.

__ 17. I am good at remembering information.

__ 18. I use different learning strategies depending on the situation.

__ 19. I ask myself if there was an easier way to do things after I finish a task.

__ 20. I have control over how well I learn.

__ 21. I periodically review to help me understand important relationships.

__ 22. I ask myself questions about the material before I begin.

__ 23. I think of several ways to solve a problem and choose the best one.

__ 24. I summarize what I've learned after I finish.

__ 25. I ask others for help when I don't understand something.

__ 26. I can motivate myself to learn when I need to.

__ 27. I am aware of what strategies I use when I study.

__ 28. I find myself analyzing the usefulness of strategies while I study.

__ 29. I use my intellectual strengths to compensate for my weaknesses.

__ 30. I focus on the meaning and significance of new information.

__ 31. I create my own examples to make information more meaningful.

__ 32. I am a good judge of how well I understand something.

__ 33. I find myself using helpful learning strategies automatically.

__ 34. I find myself pausing regularly to check my comprehension.

__ 35. I know when each strategy I use will be most effective.

__ 36. I ask myself how well I accomplished my goals once I'm finished.

__ 37. I draw pictures or diagrams to help me understand while learning.

__ 38. I ask myself if I have considered all options after I solve a problem.

__ 39. I try to translate new information into my own words.

__ 40. I change strategies when I fail to understand.

__ 41. I use the organizational structure of the text to help me learn.

__ 42. I read instructions carefully before I begin a task.

__ 43. I ask myself if what I'm reading is related to what I already know.

__ 44. I re-evaluate my assumptions when I get confused.

__ 45. I organize my time to best accomplish my goals.

__ 46. I learn more when I am interested in the topic.

__ 47. I try to break studying down into smaller steps.

__ 48. I focus on overall meaning rather than specifics.

__ 49. I ask myself questions about how well I am doing while I am learning something new.

__ 50. I ask myself if I learned as much as I could have once I finish a task.

__ 51. I stop and go back over new information that is not clear.

__ 52. I stop and reread when I get confused.

Appendix B

Social Metacognitive Awareness Inventory

Indicate whether or not the following statements are true for the work you did with your group in this course. If the statement is always false for your group, select Always False. If it is always true, select Always True. Please answer as honestly as you can since these will not impact your grade.

To what extent are these statements true for your group?

Always False	Sometimes False	Neutral	Sometimes True	Always True
1	2	3	4	5

__ 1. My group asked periodically if we were meeting our goals.

__ 2. My group considered several alternatives to a problem before we answered.

__ 3. My group understood our intellectual strengths and weaknesses.

__ 4. My group thought about what we really needed to learn before we began a task.

__ 5. My group discussed how well we did once we completed a task.

__ 6. My group set specific goals before we began a task.

__ 7. My group knew what kind of information was most important to learn for our tasks.

__ 8. My group made sure we considered all options when solving a problem.

__ 9. My group was good at organizing information.

__ 10. My group focused our attention on important information.

__ 11. My group had a specific purpose for each strategy we used.

__ 12. My group knew what the instructor expected us to learn.

__ 13. My group used different learning strategies depending on the situation.

__ 14. My group asked if there was an easier way to do things after we finished a task.

__ 15. My group periodically reviewed information together to help ourselves understand important relationships.

__ 16. My group asked questions about the material before we began on the task.

__ 17. My group considered several ways to solve a problem and chose the best one.

__ 18. My group summarized what we learned after we finished.

__ 19. My group asked others for help when we didn't understand something.

__ 20. My group motivated each other to learn when we needed to.

__ 21. My group analyzed the usefulness of strategies while we problem solved.

__ 22. My group used each member's intellectual strengths to compensate for others' weaknesses.

__ 23. My group focused on the meaning and significance of new information.

__ 24. My group created our own examples to make information more meaningful.

__ 25. My group was a good judge of how well we understood something.

__ 26. My group used helpful learning strategies automatically.

__ 27. My group paused regularly to check our comprehension.

__ 28. My group asked how well we accomplished our goals once we finished.

__ 29. My group drew pictures or diagrams to help each other understand while learning.

__ 30. My group asked if we had considered all options after we solved a problem.

__ 31. My group tried to translate new information into our own words.

__ 32. My group changed strategies when we failed to understand.

__ 33. My group read instructions carefully before we began a task.

__ 34. My group re-evaluated our assumptions when we became confused.

__ 35. My group organized our time to best accomplish our goals.

__ 36. My group learned more when we were interested in the topic.

__ 37. My group broke down the project or task into smaller steps.

__ 38. My group focused on overall meaning rather than specifics.

__ 39. My group asked questions about how well we were doing on the task.

__ 40. My group asked if we learned as much as we could have once we finished a task.

__ 41. My group stopped and went back over new information that was not clear.