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Steltenpohl, Pamela J. ***The Relationship Among Math Attitudes, Learning Strategies and Resources Used Leading to Successful Completion of Online Mathematics Courses in a Two Year Technical College***

Abstract

The purpose of this study was to investigate if math attitudes (math anxiety and math test anxiety) and self-regulated learning strategies were related to successful completion in online math courses and compare the math attitudes and strategy use in online and face-to-face courses. Students from two online and two face-to-face math courses completed an online survey that assessed math attitudes and the students' use of five self-regulated learning strategies of organization, metacognitive self-regulation, effort management, time management and help seeking and the student's use and perceived benefits of MyMathLab software resources. Descriptive statistics were generated and t-tests were conducted to compare groups of students. The results indicated that unsuccessful students (those who withdrew from the course or had a final grade below the C level) had significantly higher levels of math and test anxiety than successful students. In addition, the unsuccessful students had significantly lower strategy use for organization, metacognitive self-regulation, effort management and time management. Successful students in the online and face-to-face courses had similar math attitudes and strategy use. The results were informative for the instructors who teach the online math courses and want to improve completion rates.

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Chapter I: Introduction

There has been a growing trend in postsecondary institutions to deliver online courses to meet the students' demands for flexible schedules, provide access to college courses to students who otherwise would not have access, increase course offerings, and increase enrollments. During the 2006-07 academic year, 62% of 2-year and 4-year postsecondary institutions reported offering online distance education courses (Parsad & Lewis, 2008). There has also been a large increase in the number of students taking online courses. Allen and Seaman (2010) found that 1.6 million or 9.6% of college or university students took at least one online course in the fall of 2002. By 2008 more than 25 % of all college and university students (over 4.6 million students) took at least one online course. In the fall of 2010, 6.1 million students were taking at least one course online which equates to 31.3% of postsecondary students (Allen & Seaman, 2011).

The Wisconsin Technical College System reported "more than 45,000 students enrolled in WTCS online courses, accounting for nearly 11 % of all credit hours taken" in 2008 (Wisconsin Technical College System [WTCS], 2009, para. 5). Lakeshore Technical College (LTC) has also been part of this trend. If a course is designated online, all instruction is offered exclusively through the web, however, offline proctored testing is allowed (LTC, n.d.). During the 2004 – 05 summer, fall and spring semesters, a total of 90 online courses were offered. Five years later for the 2009-10 academic year, 204 online courses were available to students, a 127% increase in online courses over previous years (LTC, 2010a). The majority of the general education courses had online sections available to the students with the exceptions of some science and math courses.

While online courses have opened up many opportunities for students who otherwise would not have access to postsecondary courses, many online courses struggle with high attrition rates. According to Carr (2000), course completion rates and program retention are generally lower in distance education courses than in face-to-face courses. Distance education attrition rates may range from 20 – 50% and are 10 to 20% higher than face-to-face courses (Carr, 2000). Other researchers question these numbers because institutions do not use the same method to calculate retention (Howell, Laws & Lindsay, 2004).

Although there may have been discrepancies between institutions in determining successful completions, LTC has been uniformly tracking successful completion of online courses based on students receiving a C or better in the course. Those who received a W, WF, D or F were considered unsuccessful. The success rate in LTC's general education online courses has been shown to be 10% lower than the face-to-face courses (LTC, 2010c).

Mathematics is part of the general education core requirements for all associate degree programs. However, when a comparison was made of successful math course completion rates between online delivery and face-to-face delivery, the achievement gap was about 2 ½ times that of general education (LTC, 2010c).

Student attitudes toward math and poor preparation can be factors in course completion. Burns (1998) contended that upwards of two-thirds of American adults fear and loathe math. Research showed that there was a correlation between math anxiety and performance in mathematics (Dew, Galassi, & Galassi, 1984; Betz, 1978; Ma, 1999). According to the ACT Profile Report National for 2009, only 42% of high school students are ready for college level mathematics. Since the average age of a student at LTC is 31, many of the students had not needed to review math concepts since high school (LTC, 2008). As a result, 52% of new students for the 2009-2010 school year needed remediation in mathematics (LTC, 2010b). Juan, Huertas, Steegmann, Corcoles, and Serrat noted that the lack of mathematical background is one of the challenges in mathematical e-learning (2008).

Learning strategies that students employ while studying for any type of course could also affect their success in the course. In a traditional classroom, learning strategies have been shown to positively impact academic achievement (Pintrich & DeGroot, 1990; Pressley, 1986). Weinstein, Husman, & Dierking (2000) reported that "knowing about and using strategies is a major factor for discriminating between low achieving students and those who experience success" (p. 729). Any learning environment requires proactive and active learning to construct knowledge and skills, but it is especially important in online learning environments (Hu & Gramling, 2009). Proactive and active learning require students to be self regulating.

Self regulated learning involves students being motivationally, metacognitively, and behaviorally active in their learning process and in accomplishing their goals (Zimmerman, 1986). Metacognition and behavior are addressed using different types of learning strategies: metagcognitive strategies, cognitive strategies and resource management strategies. Self-regulated learning is especially important in a learning environment that requires students to work more independently than in a traditional environment. Research also has shown that learning strategies are associated with higher student achievement in online courses (Wadsworth, Husman, Duggan & Pennington, 2007; Shih, Ingebritsen, Pleasants, Flickinger, & Brown, 1998).

Online math courses have presented some challenges in the past because of the lack of support for mathematical symbolisms in online formats. There is now a wide variety of technologies and e-learning platforms for viewing mathematically rich materials and graphs (Juan et al., 2008). The mathematics online courses at LTC have all adopted textbooks with

MyMathLab, a text-specific, interactive, online teaching and learning environment, which has extensive web-accessible sites that include video lectures, multimedia clips, individualized study plans, tracked homework exercises, guided solutions, worked out examples, testing, discussion board, email, and a virtual classroom along with a complete course management system. (Pearson Publishing, n.d.)

Statement of the Problem

LTC offered five online math courses during both the fall and spring semester of the 2009-2010 school year. Since some of the math courses are often prerequisites for program courses, students receiving a grade of A, B or C were considered successful completions and those receiving a W, WF, D or F were considered unsuccessful completions. Based on a grade of C or better, the overall successful completion rate for online math students was about 25% lower than the face-to-face math courses (LTC, 2010c). The math department considered the gap of 25% unacceptable, and it sought ways to reduce unsuccessful completions.

Purpose of the Study

The purpose of the study was to identify perceived difficulties that students have in the math courses, compare the strategies and resources used by the students, and assess the perceived impact of instructional strategies in order to determine what can be done to improve the successful completion rate of online math courses at LTC. The students enrolled in the online math and face-to-face courses during the fall of 2011 answered questions via an online survey to assess difficulties, strategies, and resources used and level of course performance.

Questions to be Answered

A number of questions were addressed in this study, including:

1. What was the attitude in terms of math anxiety level of the students in the online math courses compared to the students in the face-to-face courses?
2. What strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses?
3. How did strategy use differ between successful and unsuccessful students in both the online and face-to-face math courses?
4. Which resources within MyMathLab did online and face-to-face students utilize?
5. What were the perceived benefits of these resources in both the online and face-to-face math courses?

Significance of the Study.

Although the general education instructional staff had often commented on the lack of skills students had in the online courses, there was never a study to actually determine what the student was bringing to the class and if the lack of skills was the determining factor between success and failure or if the course itself needed major modifications. The math department would like to close the gap between online and face to face course completion.

1. Finding a way to improve the student retention and pass rate in online math courses will benefit the students that need the class as a prerequisite to another course or to complete their degree. Not all program courses are offered every semester in smaller colleges. If a student is unable to pass a math course that is a prerequisite to program courses, the student may not be able to get back into the sequence of courses until the following year.

2. This study should also be of value to other technical college districts within the state that have also experienced achievement gaps between online and face-to-face courses.
3. Since governmental support is based on enrollments and retention, lowering the attrition rate in courses is particularly important.
4. Addressing the problem of unsuccessful completion of online math courses will benefit the math department and the college with potentially higher enrollment and a better reputation.
5. The retention in any course is important financially for the school. "Low student retention results in a significant loss of revenue to the institution and has the potential to impact its financial health and survival" (Shaik, n.d. p.6).
6. Students need to maintain satisfactory academic progress to continue to be eligible for financial aid.

Limitations of the Study

The following limitations that may have impacted the results of the study were identified:

1. Data for the study was limited to students taking one of two online mathematics courses or the face-to-face versions of the same courses in the fall semester of 2011: Math with Business Applications or College Mathematics. These two online courses had the largest enrollments with a maximum of 20 in each course. Enrollment in the face-to-face courses had a maximum of 24 students. Because of the small population involved in the study, inferences to general population should not be made.

2. An Accuplacer Test placement score of 79 on the mathematics section was required for the courses, so the study may not be generalizable to all online math courses since some required a placement score of 100 or more.
3. Although the original Mathematics Attitudes Scales (MAS) and Motivated Strategies for Learning Questionnaire (MSLQ) had been found to be valid and reliable by the developers and subsequent users, no additional statistical measures of reliability and validity were done after the rewording of some items. Any additional questions developed by the researcher did not have any measure of statistical reliability or validity performed on them.
4. The computer/technology expertise levels of students were not evaluated before students enrolled. Students with more computer knowledge may have been more willing to experiment with the learning resources within the software.
5. The average age of students in the school was over 31 years old, so many or most students would have had many distracters (children, jobs, elderly parents) that may have been factors in successful completion of a course.
6. Work statuses of students were not examined for this study. Any combination of unemployed, part-time or full-time work status combined with part-time or full-time student status would have resulted in a wide variety of the number of hours available for working on the coursework. The study did not address the relationship of work status and student status.
7. Because of the small sample size, the study did not attempt to restrict the sample population for a specific educational background. The educational backgrounds of the students may have impacted the results of the study. Students were able to take the math

course for their program in any semester of the two-year program. A student who took the course in the last semester of a program would have had more educational experience and therefore more knowledge of the expectations of a college course compared to a student who took the online course in the first semester of a two year program. In addition, there were students enrolled in the technical college with a high school diploma or GED/HSED, while others had previously obtained an associates or a bachelors degree. In 2008, 30 % of the students had a prior degree from LTC or another institution (LTC, 2008).

Definition of Terms

The following terms will be used throughout this paper. The definitions are provided for better understanding.

Accuplacer Test is a standardized test produced by The College Board to assess academic skill in mathematics, reading and English.

Cognitive learning strategies are memory enhancing processes of rehearsal, elaboration and organization. (Bassili, 2008).

Effort Regulation refers to the student's capacity to control his or her effort and attention when confronted with distractions or uninteresting tasks (Pintrich, Smith, Garcia &McKeachie, 1991).

Elaboration involves learning strategies that require deeper processing of course material where students focus on extracting meaning, summarizing, or paraphrasing (Zusho, Pintrich, & Goppola. 2003).

Face-to-face course refers to a traditional classroom lecture delivery where the students are in the physical classroom with the instructor. A course is considered face-to-face when 0 – 29 % of content is delivered online (Allen, & Seaman, 2010).

Learning strategies are "any thoughts, behaviors, beliefs, or emotions that facilitate the acquisition, understanding, or later transfer of new knowledge and skills" (Weinstein, et al., 2000, p. 727).

Mathematics symbolism are symbols used in mathematical equations and problems, for example, π, $\sum$, $\sqrt{x}$, etc.

Metacognitive strategies involve planning, goal setting, self-monitoring of learning and self-evaluation (Zimmerman, 1990).

MYMATHLAB is an interactive, text-specific, web-based learning and teaching environment that includes multimedia tools such as video lectures, animations and multimedia textbook; online homework and assessment; multiple options for communication such as announcements, email, live chat and a virtual classroom; individual study plans, and a course management system to track usage and grades (Pearson, n.d.).

Online course is a distance education learning environment where at least 80 % of the content is delivered through the Internet (Allen, & Seaman, 2010). Communication between instructor and student can be either synchronous or asynchronous using technology tools. Since instruction and material is available on the Internet, students can access the course anytime and anywhere. Learning management system software, such as Blackboard, Angel, WebCT, MyMathLab, may be used to deliver content and manage the course.

Organization refers to strategies that require deeper processing of course material where students focus on organizing material through the use of outlines or drawing maps (Zusho, et al., 2003).

Rehearsal are superficial strategies that require surface level processing where students focus on memorizing and recall of facts (Zusho, et al., 2003).

Resource management strategies are strategies that involve help seeking, environmental management strategies and time management (Zimmerman, 1990).

Self-regulated learning is the degree to which students are motivationally, metacognitively, and behaviorally active in their learning process and in accomplishing their goals (Zimmerman, 1986).

Chapter II: Review of Literature

This chapter will address the importance of mathematics, the impact of mathematics anxiety on students, and an overview of self regulated learning strategies. It will conclude with a discussion of the relationship of self regulated learning strategies to online mathematics and a review of the software used in the mathematics courses.

Importance of Mathematics

Lack of math skills has far reaching consequences for a country. The United States has been losing its edge in mathematics, science, and innovation to other nations. It has dropped to 4th in global competitiveness (World Economic Forum, 2010). One factor attributed to the country's drop in global competitiveness is the lack of math and science skills. The World Economic Forum (2010) ranked the U.S. as 52nd in the quality of its math and science education.

President Bush signed the America Competes Act into law in 2007 with the intent of strengthening science, technology, engineering and math education (STEM). President Obama also made STEM a priority in his November 23, 2009 speech that launched the *Educate to Innovate* campaign which made STEM education a national priority in order to meet the economic challenges of a global economy (Prabhu, 2009). He said it was not only important to encourage people to seek degrees in the science, technology, engineering and mathematics, but also to increase STEM literacy for all students so they could think critically in those areas as well. According to the Senior Vice President U.S. Chamber of Commerce, Arthur Rothkopf (2010), economic strength comes from not only innovation, but also a workforce that can implement innovations which require critical analysis and problem solving. To manufacture an innovation, workers need to understand the innovation. Manufacturers will often outsource because of the lack of a skilled workforce who can critically analyze and problem-solve

(Rothkopf, 2010). One problem that seems to keep people from literacy in the STEM fields is math anxiety.

Math Anxiety

Math anxiety has been defined as an effective response that involves "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p.551). Hembree found it to be the fear of contact with any mathematics regardless of the situation (1990). The occurrence of math anxiety varies between institutions, but it is prevalent enough for many colleges to offered counseling sessions or workshops for the math anxious. Baloglu and Kocak correlated students' mathematics anxiety with their math background (2006). Students with less math background in high school reported higher levels of math anxiety (Betz, 1978; Baloglu & Kocak, 2006). Betz found that approximately 50% of the students in a developmental math course and 25% of those in a pre-calculus course showed math anxiety based on the responses on the Revised Math Anxiety Scale (1978). Another study involving math anxiety in student nurses found 45% reported high math anxiety before their first test while 45% reported a low rating (Bull, 2009, p. 75). Both pre-service elementary school teachers and student teachers reported high mathematics anxiety (Jackson, 2008). Elevated anxiety and resulting drops in performance have been studied in quantitative courses such as statistics (Pan & Tang, 2005) and finance (Sizoo, Jozkowskia, Malhotra, & Shapero, 2008). Although researchers considered statistics anxiety to be different than math anxiety, math anxiety was an antecedent and component of statistics anxiety (Hong, 1999; Pan & Tang, 2005; Zeidner, 1991).

Math anxiety has been documented at every educational level (Wigfield & Meece, 1988). Jackson & Leffingwell (1999) reported that 16 % of the respondents in their study experienced negative math encounters in 3rd and 4th grade. Hembree (1990) showed math anxiety levels increased from 6th grade through 9th or 10th grade and then leveled off in 11th grade. Students in developmental and remedial courses in college exhibited the highest math anxiety, but math anxiety declined as students took high level math courses. Studies regarding nontraditional and traditional students' levels of math anxiety have been contradictory. Baloglu and Kocak (2006) found that nontraditional students, those over 25 years old, had higher math anxiety than students in the traditional 17 – 20 year old group. Other researchers found no difference in anxiety between traditional and non-traditional students (Woodard, 2003).

Math Anxiety and Test Anxiety

Both test anxiety and math anxiety can be important factors for predicting success in academics. Test anxiety has often been associated with math anxiety. In many of the surveys to determine math anxiety, there are questions regarding math test anxiety. Hembree (1990) found that math anxiety correlated directly to general anxiety and test anxiety. Other studies have concluded similar findings (Dew, Galassi, & Galassi, 1984; Haynes, Mullins and Stein, 2004; Kazelskis, et al, 2000; Zettle & Raines, 2000). Hembree also found that math and test anxiety affected performance in parallel ways. Some have suggested that math anxiety was actually test anxiety. However, Hembree (1990) concluded that mathematics anxiety is not restricted to just assessment, but rather a "general fear of contact with mathematics, including classes, homework and tests" (p. 45). A meta-analysis by Ma (1999) confirmed that mathematics anxiety was not just assessment anxiety. Ma found that math achievement improved if math anxiety was addressed and reduced. Baloglu and Kocak (2006) divided math anxiety into three constructs: math test anxiety, numerical task anxiety and math course anxiety. They found that postsecondary female students showed significantly higher math test anxiety while males showed significantly higher numerical task anxiety. Cates and Rhymer found math anxiety was related to performance more in terms of mathematics fluency than error rates. Students with higher math anxiety did not have more errors; however, they were less fluent (2003). The lack of fluency may be the reason some students are anxious about time limits on tests.

Math Anxiety and Performance

High levels of math anxiety have been negatively correlated with performance at all educational levels (Betz, 1978; Ma, 1999). Ashcraft and Kirk (2001) found that math anxiety correlated with lower grades in math courses. In a study that integrated 151 studies relating to math anxiety, Humbree (1990) found that math anxiety inversely correlated with achievement in math across all grade levels from 5th grade through postsecondary. Those students with high math anxiety consistently showed lower math performance. The lower performance could be partially attributed to avoidance of mathematics and mathematics based courses in high school or college. Dew, Galassi, and Galassi (1984) found math anxiety had only a minimal relationship to math avoidance and a modest relationship to performance.

Consequences of Mathematics Anxiety

Mathematics anxiety has been often used as an explanation for students' poor performances in courses and the reason for avoiding math courses altogether (Ashcraft & Kirk, 2001; Ruben, 1998). Students with high math anxiety tended to take fewer math courses in high school and also were less likely to take math courses in college (Hembree, 1990). Although females have been found to exhibit higher math anxiety (Betz, 1978), males with high math anxiety in middle school and high school were less likely to take additional math courses than females with high mathematics anxiety (Hembree, 1990). Research revealed some of the highest math anxiety levels occurred in students who were elementary education majors while the lowest in math and science majors (Hembree, 1990). Jackson (2008) reported 81% of student teachers surveyed indicated having negative affective or physical reactions to mathematics. Preservice teachers with high math anxiety had much lower confidence in their ability to teach math to elementary students (Brady & Bowd, 2005; Bursal & Paznokas, 2006). Such findings bring into question whether math anxious teachers are able to teach math affectively to students or if teachers transfer their attitudes to students. Elementary teachers' attitudes toward mathematics was correlated with their students' achievement. (Beilock, Gunderson, Ramirez, & Levine, 2010). Bursal and Paznokas (2006) also found poor attitudes toward mathematics affected the teacher's ability to teach science.

In addition to affecting course and career selection, math anxiety could also affect adults later in life. Donnelle, Hoffman-Goetz and Arocha (2007) found math anxiety was a contributing factor in low health literacy in the senior population since there is a great deal of health context numeracy required for people to make informed choices relating to their health. Anxiety toward mathematics generalized to any quantitative subject such as statistics and finance could also limit educational, and therefore, career opportunities. Math anxiety towards statistics may prevent individuals from continuing their education, completing graduate school or doing research work in social sciences (Onwuegbuzie & Wilson, 2000; Zeidner, 1991).

Math Anxiety and Working Memory

It is not uncommon for students in math classes to understand the math processes while doing their homework but forget everything when tested. Researchers have looked at the underlying cognitive psychology that may explain the relationship of math anxiety and decreased performance. Working memory has the task of focusing attention on the relevant information for a task during periods of distractions from internal or external sources or competing information

(Engle, Tuholski, Laughlin, & Conway,1999). Ashcroft and Kirk (2001) found that math anxiety taxed working memory capacity. For a math anxious individual, working memory resources were consumed with the anxiety related thoughts and worries which reduced the working memory available for processing math-related tasks. Since math-related tasks rely heavily on working memory, the result was a decrease in performance that could not be attributed to math competence or intelligence.

Self-Regulated Learning

Self-regulated learning has been researched for over three decades in an effort to understand how students exercise control over their own learning and explain how successful students adapt their behaviors and way of thinking to improve their learning. According to Zimmerman (2001), self-regulated learning did not address intelligence or performance skills, but rather the self-directed cognitive processes that allowed learners to alter mental abilities into task specific academic skills. Three common components emerged in definitions of self-regulated learning regardless of theoretical orientation. One component was the student needed to have an awareness of the self-regulated processes and their potential to improve learning. Another common aspect was self-monitoring has to be part of the learning process. Lastly, students needed an understanding of how and why processes, strategies or responses were chosen. If a student did not use self-regulation strategies, Zimmerman concluded the student did not feel the strategies would work, the student did not believe he or she was capable of using the strategy, or the student was not motivated to work toward the learning goal (2001). Therefore, self-regulated learners could be defined as “metacognitively, motivationally and behaviorally” in charge of what they learn (Zimmerman, 1986). The student’s ability to develop his or her own thoughts, feelings and actions in order to reach personal learning goals and achieve academically is based on the processes, strategies and responses that are chosen by the learner (Zimmerman, 2001). Self-regulated learners are able to initiate and manage their own efforts to obtain knowledge and skills (Zimmerman, 1989). Learner who are self-regulated integrate metacognitive processes into learning through planning, setting goals, organizing and transforming learning materials, self-monitoring and self-evaluating throughout the learning endeavors which will allow the student to adapt or change the cognitive strategies and behaviors he or she is using or will use in future learning situation. It is cyclical because the adjustments or behavior changes made as the result of the self-reflective feedback are then put through the same metacognitive processes. Motivation is the next prerequisite for self-regulated learning. Motivation plays a role in learning in terms of intrinsic interest in the task, self-efficacy for doing the task and personal responsibility for achieving or not achieving a goal. Lastly, behavioral processes are integrated into learning through selecting, structuring and creating environments to enhance learning. Self-regulated learners will seek out help, additional information and optimal locations; self-instruct; and reinforce learning in pursuit of academic goals (Zimmerman, 1990).

Boekaerts defined self-regulated learning as a “series of reciprocally related cognitive and affective processes that operate together on different components of the information processing system” (1999, p. 447). Three key components of SRL were identified by Boekaerts (1999): regulation of processing modes, regulation of the learning process and regulation of self. Regulation of processing modes is the ability to select, combine and coordinate cognitive learning strategies effectively. The second component, regulation of the learning process, involves the student’s ability to use metacognitive knowledge and skills to direct his or her learning processes. Finally, regulation of self incorporates self-chosen goals and resources into the learning process.

Garcia and Pintrich (1994) merged the cognitive and motivational models of learning, *skill* and *will*, to better describe academic learning. The motivational model explained why students made certain choices, enlisted effort and persisted in pursuing an academic task. The cognitive model described how students mastered tasks using their cognitive resources, such as prior knowledge, and cognitive and regulatory learning strategies. In the classroom, both motivational and cognitive factors will influence learning. Therefore, self-regulated learning involves cognitive strategies, metacognitive strategies, resource management and motivation (Garcia & Pintrich, 1995). Research has shown that self-regulated learning components are an important part of academic success (Barnard-Brak, Lan, & Paton, 2010; Garavalia & Gredler, 2002; Lindner & Harris, 1993; Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1990).

Self-Regulated Learning Strategies

Learning strategies are “any thoughts, behaviors, beliefs or emotions that facilitate the acquisition, understanding, or later transfer of new knowledge and skills” (Weinstein, Husman, Dierking, 2000). Weinstein and Mayer (1986) developed a taxonomy of self-regulated learning strategies that was divided into three groups: cognitive strategies, metacognitive strategies and time and resource management strategies. Cognitive strategies are goal-directed, deliberately manipulated, domain specific and effortful. Cognitive strategies include rehearsal strategies, elaboration strategies and organizational strategies (Weinstein & Meyer, 1991). Rehearsal strategies are considered surface level processing strategies which include copying, underlining or repeating, and memorizing information. Rehearsal strategies help to draw attention to important material and transfer the material to working memory for later use (Weinstein & Mayer, 1983). Elaboration strategies involve activities such as paraphrasing, summarizing or describing how new information relates to previous knowledge. The goal of elaboration is to make information meaningful and integrate the new knowledge into the existing knowledge base (Weinstein, Husman,& Dierking, 2000). Elaboration involves more thought processes than repeating or copying the material and is therefore considered a deeper processing strategy. The third type of cognitive strategy, organizational strategies, also requires deeper thought processes. Organizational strategies include organizing material with outlines and mapping activities or sorting information according to characteristics in order to find interrelationships between new and existing knowledge (Weinstein, Husman, & Dierking, 2000).

Another group of self-regulated learning strategies is metacognitive strategies which involve setting goals, planning, self-monitoring, self-testing and self-evaluating throughout the learning process (Zimmerman, 1990). Metacognition often has been casually referred to as *thinking about thinking*. Schraw and Moshmann (1995) defined the two components of metacognition: metacognitive knowledge and regulation of cognition. Metacognitive knowledge refers to the what, how, why and when aspects of cognition. Regulation of cognition includes selecting strategies, monitoring comprehension and performance, and evaluating learning and strategy use. Metacognition has been linked to increased academic performance (Ibe, 2009; Zulkiply, Kabit, & Ghani, 2009). Legg and Locker (2009) found that metacognition had a moderating effect on math anxiety.

Finally, resource management involves students monitoring their time, environment and effort to support learning. Time management includes scheduling an appropriate amount of time for study as well as planning tasks to be accomplished within a designated time period. Environment management requires students to plan and structure their environment to have an appropriate distraction-free, well-organized location for studying (Pintrich, Smith, Garcia, & McKeachie, 1991). Zimmerman and Martinez-Pons (1988) concluded that “self-regulated learners select, structure, and even create social and physical environments" (p. 284) to improve learning. Social environment can include help seeking from peers or others. Effort regulation is also an important part of achievement. Students need to be able to control the amount of effort required to accomplish a goal and be able to stay focused on the task when distractions compete for the student's attention. Tedious or complex tasks also require students to be able to regulate effort to complete the tasks (Pintrich, Smith, Garcia, & McKeachie, 1991).

Early research showed that motivation was also a key element in self-regulated learning and achievement (Garcia & Pintrich, 1993; Zimmerman & MartinezPons, 1988; Linnenbrick & Pintrich, 2002). More recent research also documented the importance of motivation in learning (Zusho, Pintrich & Coppola, 2003; Artino & Stephens, 2009). Motivational aspects of self-regulated learning include intrinsic and extrinsic goal orientations, self-efficacy, task value to the student, and affective components such as test anxiety (Pintrich, Smith, Garcia, & McKeachie, 1991). Goal orientation refers to a student's awareness of the reasons why he or she is engaging in an academic task. Intrinsic goal orientation would include reasons such as the task is a challenge, the student is curious about the topic or the student wants to master the task. Extrinsic goal orientation means the student is doing the task for external reasons such as grades, rewards, or competition. Self-efficacy includes judgments on one's ability to accomplish a task as well as the confidence one has in one's skills to achieve the task. Task value is a personal assessment of a task's importance, usefulness or interest (Pintrich, Smith, Garcia, & McKeachie, 1991).

Self-Regulated Learning and Achievement

According to the ACT Profile Report 2009, only 42% of high school students were ready for college level mathematics. These students possibly did not have the necessary self-regulatory learning strategies to be successful. Ley and Young found that college students enrolled in developmental courses utilized fewer different strategies and less frequently utilized strategies than students who were not enrolled in developmental courses (1998). Other researchers have determined that student's use of learning strategies increased with academic level (Zimmerman & Martinez-Pons, 1990). Zimmerman and Martinez-Pons found that gifted students made more use of self regulated learning strategies to regulate processes, behavior and their environment than regular students (1990).

Research has documented that strategy use is related to achievement. Lynch (2010) found elaboration, effort regulation, critical thinking, metacognitive strategies and time and study environments management were significantly correlated to performance. Ruban, McCoach, & Nora (2002) established that cognitive, motivational and self-regulatory strategies were predictive of post-secondary academic success. However, the research by Ruban et al. (2002) showed the use of compensatory supports was negatively related to GPA's for non-learning disabled students, so the more compensatory supports that were used, the lower the reported GPA. This contrasted with learning disabled students' use of compensatory supports. Learning disabled students' use of compensatory support was positively correlated with GPA's. Compensatory supports could include listening or recording devices, text to speech readers, graphic organizer software and other assistive technologies.

Having self-regulating learning skills have been shown to improve students' chances of success (Garavalia & Gredler, 2002; Azevedo & Cromley, 2004; Camahalan, 2006), so improving students' ability to self regulate their learning should be important. Bail, Zhang and Tachiyama (2008) found evidence that a course in the use of self-regulated learning strategies could have a significant impact on future academic performance and resulted in higher graduation rates for underprepared college students. Embedding prompts into online content to encourage self-regulated learning practices also increased students' use of strategies (Yang, 2006).

Self-Regulated Learning Strategies and Mathematics

Students who excel in one subject area because of self-regulated learning skills may not excel in other subjects, such as mathematics. Researchers have differed on whether self-regulated learning strategies are transferable to different domains or subject areas or if they are context specific. Weinstein and Meyer (1991) reported cognitive learning strategies to be situational specific. However, Bail, Zhang and Tachiyama (2008) found evidence that a course in self-regulated learning had significant influence on the academic success of underprepared post-secondary students even four semesters after taking the course and the students had a higher graduation rate compared to students who did not receive the self-regulated learning course. Rotgans and Schmidt (2009) determined that the cognitive portions of self-regulated learning did not appear to be subject specific, but motivational aspects such as self-efficacy judgments and task-value beliefs did consistently vary by subject.

Self-regulated learning strategies are especially applicable in mathematics since mathematics involves the intentional use of computational and problem-solving routines. Pape and Smith (2002) reported self-regulation in mathematics involves comprehending the text of the problem, analyzing relationships between components within the problem, choosing a procedure or algorithm to solve the problem, monitoring the progress toward the solution with the chosen algorithm and adapting or replacing the algorithm as needed, and then checking the solution in relation to the problem. Each of the steps involves planning, monitoring and reflection (Pape and Smith, 2002) which are all components of self-regulation. Therefore, students need to know how, when and where to use self-regulation strategies in mathematics. For students to become good problem solvers, teachers need to train students in the use of goal-setting strategies, monitoring strategies and higher order cognitive strategies (Pressley, 1986). Research in learning strategies showed that learning strategies can be taught with a resulting increase in achievement (Azevedo & Cromley, 2004; Camahalan, 2006; Pape, & Smith, 2002; Moseki & Schulze, 2010). Montague, Enders and Dietz (2011) found that cognitive strategy instructions improved problem solving in middle school mathematics students across ability groups, including those with learning disabilities. Students in online or face-to-face mathematics courses that included self-regulation scaffolding, or learning aids, to encourage self-regulation or training in self-regulation strategies outperformed students in comparable courses without the scaffolding or training (Kramarski, & Gutman, 2006; Mevarech, & Kramarski, 1997; Yang, 2006).

Correlations between learning strategies and learning outcomes in mathematics have been documented. Bembenutty and Zimmerman (2003) gave direct training in self-regulation to at risk technical college math students and subsequently determined students' motivational beliefs and self-regulation impacted homework completion and course outcomes in mathematics. Glogger et al. (2012) found that the quantity and quality of cognitive learning strategies assessed using journaling predicted learning outcomes. The quantity of elaboration strategies and the quality of organizational strategies were especially relevant to predicting outcomes. High achieving students showed high levels of both quantity and quality of cognitive and metacognitive strategies compared to low achieving students. Lower achieving students tended to avoid the use of learning strategies or used mostly rehearsal strategies (Glogger et al., 2012). Rehearsal strategies are considered to be only surface level learning (Pintrich, 2004) and are commonly part of the beginning steps to constructing a subject knowledge base (Weinstein & Meyer, 1991).

Otts (2010) studied self-regulated learning, math attitudes (perceived usefulness of math and math anxiety) and achievement in developmental math courses students and found that self-regulated learning was predictive of achievement in mathematics. Collectively, math attitudes were predictive of self-regulated learning strategy use and accounted for 12% of the variance in self-regulated learning. Students who had positive math attitudes were more likely to use self-regulated learning strategies. Separately, perceived usefulness in math was predictive of strategy use. Although math anxiety was related to metacognitive self-regulation, environment management, effort regulation, study skills (rehearsal, elaboration and organization) and help seeking, it was not predictive of self-regulated strategy usage.

Online Learning and Self-Regulated Learning Strategies

Self-regulated learning is also an important component of online learning. Online learning places more of the responsibility for learning on the student. Schunk and Zimmerman (1998) emphasized the importance of self-regulation in distance learning. "Self regulation seems critical due to the high degree of student independence deriving from the instructor's physical absence" (Schunk & Zimmerman, 1998, p. 231). Kauffman (2004) similarly noted self-regulation was especially important in online learning where students may need to perform complex tasks with little support from other students or an instructor. The amount of information readily available, the distractibility potential of online resources, and the non-linear nature of the online information can complicate the learning process of students and magnify the need for self-regulating behaviors.

Self-regulated learning strategies have been shown to be used by students during online learning. In a qualitative study of twelve students, Hu and Grambing (2009) established that online students used metacognitive, cognitive and resource management strategies. Students working in hypermedia environments, which allowed students to follow links on the screen to access additional information, showed greater understanding of material when they used self-regulating behaviors (Greene & Azevedo, 2007).

Clayton, Blumberg and Auld (2010) studied whether students' preferences for an online learning environment or a traditional learning environment were influenced by motivational beliefs and learning strategies. The students they surveyed differed significantly in terms of achievement goals, self-efficacy and learning strategies. Self-efficacy and achievement goals are both considered motivational constructs. Achievement goals are the reasons students engage in learning. Achievement goals have been divided into mastery goals and performance goals. Mastery goals are associated with a student's desire to increase his or her knowledge base or understanding of concepts while performance goals are related to a student's desire to outperform others or to avoid a task (Ames, 1992). Students who chose online environments had greater self-efficacy in their ability to succeed in online learning. Those in traditional courses were mastery goal directed. In terms of learning strategies, effort regulation was shown to make the largest difference in environment preference with those who preferred a traditional environment showing significantly more interest in expending effort (Clayton, Blumberg and Auld, 2010).

Online learning environments often allow students more control over context since students are able to access additional information just by clicking on links within the text of the page. Paechter, Maier and Macher (2010) studied the relationship of various factors in online learning to learning achievement and course satisfaction and found self-regulated learning opportunities contributed to learning achievement. Paechter, et al's (2010) conclusion agreed with the earlier research of Young (1996) who found that strategy use and achievement was higher for students in computer-based instruction where the student had control over the instructional sequence and content compared to students in computer-based instruction with a program-controlled linear instructional sequence. To be able to effectively control the context of the learning environment, students need to engage in self-regulating behavior. Besides needing to set goals, choose strategies, assess chosen strategies in terms of goal attainment and evaluate their understanding of the material, students also have to use metacognitive strategies to monitor their learning and then adjust goals, strategies and effort accordingly within the changing context available with hypermedia (Azevedo, 2005). However, changing learning contexts frequently by clicking on new links indicated a lack of goal-directed behavior and frequent context changing was associated with less understanding of the complex topics being studied compared to students who were better able to monitor the need to use the hyperlinks provided (Greene & Azevedo, 2007).

In a study involving self-regulated learning, achievement, course satisfaction and technology self-efficacy for students enrolled in 163 online courses, Puzziferro (2008) reported higher achieving students were more apt to plan and manage time, study environments and effort then low achievers. The study also revealed a relationship between course satisfaction and self-regulated learning strategies. Students who scored higher in rehearsal, elaboration, metacognitive self-regulation and time and study environment strategies had greater course satisfaction.

Other researchers have linked motivational components of self-regulated learning and use of self-regulated learning strategies in online learning. Task value and self-efficacy had a significant relationship with elaboration, critical thinking and metacognitive self-regulation in online learning (Artino and Stephens, n.d.). One would also expect time management and help seeking to be important components of online learning; however, Lynch and Dembo (2004) reported self-efficacy for learning had a significant correlation with performance in a blended graduate level course, but other self-regulating strategies such as intrinsic goal orientation, help-seeking, time and study environment did not. However, Lynch and Dembo (2004) noted the course studied was a blended course, so the need for help seeking and time and study environment management was reduced because of regular classroom meetings.

Achievement in online learning has also shown a relationship to self-regulated learning components. In a study looking at student entry characteristics, students' use of self-regulated learning strategies, and academic achievement of 170 graduate students in online courses, Colorado (2006) determined that there were significant relationships between entry GPA and metacognitive regulation, time and study environment and effort regulation. However, the same study showed that there was no relationship between any of the cognitive, metacognitive, or resource management learning strategies and academic performance. However, the academic level of the graduate students and the resulting lack of variance in final grades were possible explanations for the lack of relationships between self-regulated learning and performance.

Others have found correlations between self-regulating learning strategies and academic achievement in online learning. Success in an online course was significantly and positively correlated to intrinsic goal orientation, task value, self-efficacy, cognitive strategy use and self-regulation in a study by Yukselturk and Bulut (2007) with self-regulation accounting for 16.4% of the variance in students' programming success. Looking at self-regulating learning profiles of online students, Barnard-Brak, Lan and Paton (2010) found statistically significant differences in academic achievement based on the profiles of the students. Super or competent self-regulators had the highest achievement while non-self-regulators or minimal self-regulators had the lowest academic achievement. Wang (2010) also found that self-regulated learning correlated with both course satisfaction and achievement.

The number of postsecondary students taking at least one online course has been increasing an average of 18.3% annually since 2002 from 1.6 million students in Fall 2002 to 6.1 million students in Fall 2010 (Allen & Seaman, 2011). Even in courses that have a face-to-face delivery method, students are expected to use Internet resources. Self-regulated learning is particularly applicable to college students because the nature of the courses offer students more alternatives and control over environments, time, study approaches and learning (Pintrich & Garcia, 1994). Online learning gives more of the responsibility of learning to the students so self-regulated learning strategies are especially relevant (Schunk & Zimmerman, 1998).

Cognitive and metacognitive learning strategies have been found to be improve learning in online courses. Yukselturk & Bulut found self-regulation was the dominant variable in student success (2007). Sankaran and Bui (2001) established that students with similar learning strategies performed comparably in courses regardless whether the course is face-to-face or online. Unfortunately, not all postsecondary students have been given the instruction or opportunity to develop self-regulating behaviors to be successful. For example, Peverly, Brobst, Graham and Shaw reported the college students they studied lacked metacognitive strategy skills based on an inability to judge how well prepared they were for a test or how well they did on a test (2003). However, students can be taught the strategies and how to use them and strategy instruction was shown to improve academic success (Pintrich & Garcia, 1994). Therefore, an initial step to improving students' success in the mathematics courses would be to determine which strategies are used by students.

MyMathLab Learning Environment

MyMathLab online software was used as part of the course requirements for the courses used for the present study. MyMathLab was marketed as a multimedia online learning environment that is textbook specific for the student and a course-management system for an instructor. Included in the MyMathLab access for students were interactive tutorial exercises with feedback, algorithmically generated homework and quizzes, an E-textbook, multimedia learning aids and a personalized study plan generator. The student could view specific grades for assignments or tests as well as overall grades. The instructor had the ability to manage homework, tests, and grades from offline and online work. The instructor could add links to course documents, videos, or other online resources. MyMathLab had communication tools for synchronous and asynchronous communication with email, a discussion board and a chat room for student-student or student-teacher interaction (Pearson, n.d.).

Studies have found that students who exercised control over the learning context coupled with self-regulating learning processes had higher achievement (Paechter, et al., 2010; Young, 1996; Greene & Azevedo, 2007). MyMathLab provided many resources for students to control their learning context. There was a multimedia library housing video lectures for every section in the textbook, videos or animations of specific example problems in the textbook, and a multimedia e-textbook. Students who used the multimedia textbook could go directly to individual chapters using a link. Embedded in the e-textbook were links to the lecture and example videos. Students also could monitor progress using the sample pretest and posttest under the *Study Plan* link. After taking the pretest, a personalized study plan would be generated based on performance. The study plan linked the student to specific problems to practice in the areas they needed further study. The students could then take a posttest to determine mastery. Again the study plan would be updated based on performance.

Additional resources were provided with each homework problem. When a problem was shown, the student would also see the following links next to the problem: *Help Me Solve This*, *View an Example*, *Video*, *Animation*, *Textbook,* and *Ask My Instructor*. *Help Me Solve This* provided the students with interactive scaffolding to solve the problem. The program would explain the step and the students would have to input the necessary parts in the space provided and would then be provided with feedback and the next step. *View an Example* was the solution to a similar problem using the same scaffolding steps used in the *Help Me Solve* This link. *Video* and *Animation* linked the student to the video or animation of the related sample problem in the textbook if available. Clicking on *Textbook* linked the student to the page in the textbook that explained the concept in the problem. The final resource, *Ask My Instructor* link, would send an email to the instructor with a link to the actual problem. The student could include questions or other information in the email message. The link to the actual problem was important since the numbers within the problem would change if the student did not get the correct answer after three attempts.

Mathematics software packages, such as MyMathLab, have been shown to increase success in math courses. Carol Twigg, president of the The National Center for Academic Transformation (NCAT), reported students' completion rate in developmental courses increased an average of 51% at colleges with redesigned mathematics courses that included mathematics software packages. The completion rate in college level mathematics courses increased an average of 25% (2011).

Summary

Mathematics is important to the continued economic growth of the country. The more technological society becomes, the more important it is to have a math literate population. Many factors can influence a student's achievement in a mathematics course, especially with adults who may have other responsibilities requiring their time and attention. Past research has shown that mathematics anxiety and mathematics test anxiety are related and both can impact achievement in a course.

Research has also concluded that self-regulated learning strategy use also contributes to academic achievement. It is therefore important to determine if students' attitudes toward mathematics are contributing factors to lack of success in a course or if students need additional instruction and guidance in the use of learning strategies that have been shown to be used by successful students and have been shown to moderate the affects of math anxiety. Math anxiety and test anxiety, although related, have been shown to be different constructs (Ma, 1999). Both can affect the achievement of a student (Humbree, 1990). Self-regulated learning explains how students exercise control over their own learning and how successful students adapt their beliefs and behaviors to improve their learning. Self-regulated learning involves cognitive strategies, metacognitive strategies, resource management and motivational strategies (Garcia & Pintrich, 1995). Self-regulated learning strategies have been correlated with achievement (Barnard-Brak, Lan, & Paton, 2010; Garavalia & Gredler, 2002; Lindner & Harris, 1993; Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1990), with mathematics (Glogger et al., 2012; Otts, 2010), and with online learning (Paechter, et al, 2010; Yukselturk & Bulut, 2007).

This researcher will study student's self-reported math attitudes in terms of math anxiety and math test anxiety, self-regulated learning strategies and online resources use to determine if online course completion can be improved.

Chapter III: Methodology

The purpose of this study was to provide information to the instructors of online mathematics courses at Lakeshore Technical College regarding the math attitudes of students measured in terms of math and test anxiety, the learning strategies used by students, and the online resources accessed by math students and the perceived benefits of the resources in order to determine if any relationships exists between the three components - attitudes, learning strategies, and resources - and successful completion of the course in order to enhance online learning experiences and improve course success. This information would be important to improving the math performance of students in both an online learning environment and the classroom. Specifically, the questions to be answered in the study include:

1. What was the attitude in terms of math anxiety level of the students in the online math courses compared to the students in the face-to-face courses?
2. What strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses?
3. How did strategy use differ between successful and unsuccessful students in both the online and face-to-face math courses?
4. Which resources within MyMathLab did online and face-to-face students utilize?
5. What were the perceived benefits of these resources in both the online and face-to-face math courses?

Included in this chapter is a description of the subjects involved in the study, the instruments used to collect the data, and the statistical analyses done on the data. This chapter will conclude with a discussion of the limitations of the methodology.

Subject Selection and Description

Math with Business Applications and *College Mathematics* online courses were chosen for this study because these two courses historically had the largest number of students enrolled and both courses were available in a face-to-face and online delivery. The face-to-face versions of these classes that were taught by the same instructors as the online courses that were chosen for comparison purposes. A total of four sections were surveyed. The four sections consisted of one online and one face-to-face *Math with Business Applications* courses and one online and one face-to-face *College Mathematics* courses. Although a few other math courses were available online, few students choose to take those courses in the online format. The online and face-to-face *Math with Business Applications* courses were both taught by this researcher. The online and face-to-face *College Mathematics* courses had the same instructor. In addition, both the *Math with Business Application* and the *College Mathematics* courses required the same entrance test minimum score as a prerequisite.

The subjects involved with this study were volunteers who were enrolled in the targeted online and face-to-face *Math with Business Applications* and *College Mathematics* courses at the college in the fall of 2011. The total enrollment in the courses that were used in the study was 86 students. Both courses had been taught previous semesters by the same instructors and used the publisher online software, *MyMathLab*, which provided students with access to resources such as a digital textbook (most students also purchased a hard copy of the textbook), publisher-produced section videos and tutorials, algorithmically generated homework and quizzes, and access to grades.

All 86 students in the two online courses and two face-to-face courses were invited to participate in the study. Since the survey was accessed online, an implied consent form was used. The purpose of an implied consent form was explained to the students verbally in the face-to-face courses and by email for the students in the online courses. The implied consent form included relevant information about the nature of study, confidentiality assurances and the opportunity to stop if desired. Because the study was concerned with successful completion of the course, the students were provided with their test averages and course grades before the survey was given. The students were then asked to self-report both their test average and course grades within the survey. Students who had dropped out of the courses either officially or unofficially during the semester were also invited to fill out the survey. As an incentive, all students who completed the survey were entered into a drawing for a $50 gas card.

Instrumentation

The survey for this research consisted of 55 questions comprised of questions created by the researcher and questions in published validated surveys. The first part of the survey measured math attitudes. The Math Attitudes section was composed of questions from two surveys. Math anxiety was measured by five questions modeled after six of the ten math anxiety questions in the math anxiety scale of the Fennema-Sherman Mathematics Attitudes Scale (MAS) (Fennema & Sherman, 1976). The Math Anxiety scale was one of nine Likert-style scales that composed the MAS to measure attitudes. The other questions that were not included from the MAS math anxiety scale dealt with math test anxiety. The math test anxiety questions from the MAS were replaced with the test anxiety questions from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991). For the current study, a 7-point Likert scale was used to be consistent with the rest of the questions with "1" representing the response "Not at all true of me" and "7" representing ""Very true of me."

Learning strategies usage and math test anxiety were determined using some sections of the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991). Permission to use the MSLQ was obtained from the University of Michigan. The MSLQ Strategies section originally consisted of fifty questions involving cognitive, metacognitive, and resource management strategies. These three areas of strategies were divided into nine different subscales: rehearsal, elaboration, organization, critical thinking, metacognitive self regulation, time and study environment, effort regulation, peer learning and help seeking. According to Garcia and Pintrich (1995), the fifteen MSLQ scales could be used together or individually. Pintrich, et al (1991) found that the Cronbach's alpha ranged from 0.52 to 0.93 thereby showing reliability. They also found that the MSLQ scale scores were significantly correlated with final course grades which demonstrated predictive validity. A meta-analytic study by Crede and Phillips (2011) who looked at sixty-seven independent studies that used the MSLQ found that the MSLQ was a reasonable reliable measure of constructs with some of the scales showing a meaningful relationship with academic performance. Rotgans & Schmidt (2009) reported that the MSLQ's underlying structure was consistent across different subject domains; however, some of the self-regulated learning variables were influenced by domain. Because strategy use may differ for individual students based on context, the authors did not provide norms for the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991).

The following MSLQ learning strategy scales were chosen to be part of the current research: Organization, Metacognitive Self-regulation, Effort Regulation, Help Seeking and Time Management. These areas would seem to be especially important to online learning. In addition, Crede and Phillips' (2011) showed that organization, metacognive self-regulation, effort regulation and time and environment management showed significant correlation with grades. Help Seeking was included not only because it may be more difficult for online students to access support services, but also because the college had been putting additional resources into providing tutoring and study group services for students. Some of the MSLQ questions were slightly re-worded by the researcher to reflect a mathematics course. The current study chose 30 out of the 50 learning strategy questions on the MSLQ. One additional help seeking question composed by the researcher was added regarding tutoring services, and one additional time management question was added. Both of these questions were evaluated separately from the MSLQ data. The students responded to all strategy questions by using a 7-point Likert scale with 1 representing the response “Not at all true of me” and 7 representing “Very true of me.”

The third part of the survey was composed of researcher developed questions relating to usage of resources within the online MyMathLab software. This resource section was answered using a 5-point Likert scale with 1 representing “never used” and 5 representing “Used extensively with every chapter.” Another question asked respondents to rate the perceived benefit of each resource on a scale from 1 – not beneficial to 5 – very beneficial. The final question about MyMathLab was a multiple choice question with an open-ended option regarding what additional resources would help the student in the online environment, for example, videos of the face-to-face lectures, or a weekly live chat where students could ask questions.

The survey concluded with multiple choice demographic questions regarding course title, delivery method, student status, number of years since a math course, number of college semesters completed, and number of previous online courses. Students were also asked to self-report their course average. If students withdrew from their course, an open-ended question was asked regarding what factors contributed to the decision to withdraw.

Students had been updated on current course grade averages. As a pilot, this survey was distributed to one other math course taught by the researcher for clarity and for approximate time required to complete the survey. It was also reviewed by four college math instructors for intended content validity regarding mathematics anxiety. Based on the feedback, minor revisions were made to the wording of some questions.

Data Collection Procedures

The survey was given to the students in the fifteenth and sixteenth weeks of the sixteen week semester. The survey was distributed online using Qualtrics Survey Software. The online students were sent directions as a text message in email. Students in the face-to-face courses were given instructions by a non-instructional staff member and were provided the opportunity to complete the survey during class time. The researcher gave the staff member directions on how to conduct the survey and a script to use. The script included the same information provided in the implied consent form and a brief explanation on how to access the survey. All students accessed the survey through a link that the researcher had emailed to them. An additional email was sent the following week to encourage students to complete the survey.

Data analysis

All statistical analyses on the data were done using Statistical Package for the Social Services (SPSS 19) at the University of Wisconsin - Stout. To evaluate the negatively worded items on the MSLQ, the items were reversed coded (Pintrich, et al, 1991). The questions in the attitudes section were also recoded to have 7 represent high anxiety and 1 represent low anxiety in individuals. Descriptive statistics and independent samples *t*-tests were used to analyze the data. Because of the small sample size for this study, no additional inferential statistics were generated and the results of the study were not used to generalize beyond local population.

Limitations of study

The limitations of the study included the following.

1. Data for the study was limited to students taking one of two online mathematics courses or the face-to-face versions of the same courses in the fall semester of 2011: Math with Business Applications or College Mathematics. These two online courses had the largest enrollments with a maximum of 20 in each course. Enrollment in the face-to-face courses had a maximum of 24 students. Because of the small population involved in the study, inferences to general population should not be made.
2. An Accuplacer Test placement score of 79 on the mathematics section was required for the courses, so the study may not be generalizable to all online math courses since some required a placement score of 100 or more.
3. Although the original MAS and MSLQ had been found to be valid and reliable by the developers and subsequent users, no additional statistical measure of reliability and validity were done after the rewording of some items. Any additional questions developed by the researcher did not have any measure of statistical reliability or validity performed on them.
4. The computer/technology expertise levels of students were not evaluated before students enrolled. Students with more computer knowledge may have been more willing to experiment with the resources within software.
5. The average age of students in the school was over 31, so many or most students would have had many distracters (children, jobs, elderly parents) that may have been factors in successful completion of a course.
6. Work statuses of students were not examined for this study. Any combination of unemployed, part-time or full-time work status combined with

part-time or full-time student status would have resulted in a wide variety of the number of hours available for working on the coursework. The study did not address the relationship of work status and student status.

7. Because of the small sample size, the study did not attempt to restrict the sample population for a specific educational background. The educational backgrounds of the students may have impacted the results of the study. Students were able to take the math course for their program in any semester of the 2 year program. A student who took the course in the last semester of a program would have had more educational experience and therefore more knowledge of the expectations of a college course compared to a student who took the online course in the first semester of a two year program. In addition, there were students enrolled in the technical college with a high school diploma or GED/HSED, while others had previously obtained an associates or a bachelors degree. In 2008, 30% of the students had a prior degree from LTC or another institution (LTC, 2008).

Chapter IV Results

The purpose of the study was to identify perceived difficulties that students have in their mathematics courses, compare the strategies and resources used by the students, and assess the perceived impact of instructional strategies in order to determine what can be done to improve the successful completion rate of online math courses at LTC. The study compared the math attitudes, self-regulated learning strategies and software resource use of students in two online and two face-to-face mathematics courses. This chapter will include the demographics of the participants, and the descriptive statistics of the data collected and the inferential statistical analysis done on the data to address the following questions:

1. What was the attitude in terms of math anxiety level of the students in the online math courses compared to the students in the face-to-face courses?
2. What strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses?
3. How did strategy use differ between successful and unsuccessful students in both the online and face-to-face math courses?
4. Which resources within MyMathLab did online and face-to-face students utilize?
5. What were the perceived benefits of these resources in both the online and face-to-face math courses?

Demographics

The survey was offered to a total of 86 students who enrolled in an online and a face-to-face version of two mathematics courses: College Mathematics and Math with Business Applications. The survey was sent to the students via campus email and 63 began the survey. Of the 63 attempts, 56 participants' responses were included in the analysis. The other seven participants were excluded because the first two sections of the survey were not complete. Of the 56 included surveys, six did not report a course average, so those responses were excluded from any analysis regarding course completion.

Table 1 summarizes the demographics of the participants. The majority of participants had full-time student status (83.9%). Only 42.9% of the participants were traditional-aged students (18 – 24) while 32.1% were 40 years old or more. About one-third of the participants were within the first year of college and one-fourth of the participants had over four semesters completed. Of the 56 participants, 12 participants or 21.1% reported grades below a C grade and three of those students reported withdrawing. The students who participated were mostly students who were successful in the course with 12%, 10% and 28.6% reporting a C, B or A grade respectively. The high number of successful students compared to unsuccessful students in the courses may have skewed the results in favor of the successful students. The mix of participants was fairly evenly divided between those enrolled in College Mathematics (48.2%) and those in Math with Business Applications (53.6%) and between online course (46.6%) and the face-to-face course (53.6%). Of the 26 students reporting online course delivery, only 7.7% did not have previous experience with online courses while 50% of the participants had 4 or more previous online courses. Finally, about 50% of the students did not have a math course within the last 6 years and 40% had their last math course over 10 years ago.

Table 1

Demographic Information of Study Participants

Demographic Category		Frequency	% of total
Student Enrollment Status			
	Full-Time	47	83.9%
	Part-Time	9	16.1%
Age			
	18-24	24	42.9%
	25-29	6	10.7%
	30-39	8	14.3%
	Over 40	18	32.1%
Total Semesters Completed			
	0	12	21.4%
	1	5	8.9%
	2	11	19.6%
	3	7	12.5%
	4	7	12.5%
	Over 4	14	25.0%
Student's Grade in Course			
	withdrew	3	5.4%
	Below 70	2	3.6%
	70-77	7	12.5%
	78-85	12	21.1%
	86-92	10	17.9%
	93-100	16	28.6%
	missing	6	10.7%
Course			
	College Math	27	48.2%
	Math w/ Bus. App.	29	51.8%
Course Delivery Method			
	Online	26	46.4%
	F2F	30	53.6%
Number of Previous Online Courses taken by online students (*N* = 26)			
	none	2	7.7%
	1 course	6	23.1%
	2 courses	3	11.5%
	3 courses	2	7.7%
	4 or more	13	50.0%

Table 1
Notes: F2F = face-to-face course. *N = 56* unless otherwise specified

Table 1 continued

Demographic Information of Study Participants

Demographic Category		Frequency	% of total
Years since last math course			
	Less than 1 year	13	22.8%
	1-5 years	16	28.1%
	6-10 years	4	7.0%
	More than 10 years	23	40.4%

Table 1
Notes: F2F = face-to-face course. $N = 56$ unless otherwise specified

Math Attitudes

Descriptive statistics for math attitudes, math anxiety and math test anxiety are provided in Table 2. The first 11 statements in the study survey dealt with math attitudes. Overall math attitude was measured as a combination of the math anxiety statements and the math test anxiety statements. All of the statements were evaluated on a 7 point Likert scale (1 = not at all true of me to 7 = very true of me). The numerical values of positively worded statements were reversed (items 1, 3, and 6) so 7 represented high anxiety. Means of math anxiety and math test anxiety were also calculated separately and compared within groups of participants. The means for both the online and face-to-face student groups as well as successful online and successful face-to-face student groups were slightly below the midpoint of the response scale indicating both groups reported some anxiety. The numbers of successful and unsuccessful online participants were 21 and 3 respectively. The number of successful face-to-face participants compared to unsuccessful face-to-face participants was 17 to 9. When unsuccessful students from the entire sample were compared to the successful students, the math attitude, math anxiety, and math test anxiety means of all the unsuccessful students from either delivery method were above the midpoint while the means of the same three constructs were below the midpoint of the scale for the successful students from either delivery method.

To answer the first question in the study, *What was the attitude in terms of math anxiety level of the students in the online math courses compared to the students in the face-to-face courses?*, an independent samples *t* test was done using math anxiety, test anxiety, and overall math attitudes as the dependent variables for each of the student groups. The *t* test on the means showed no significant differences between online and face-to-face students or successful online and successful face-to-face students. The *t* test comparing the means of total unsuccessful students to total successful students showed a statistically significant difference between unsuccessful students and successful students for math attitude [$t(48)= 3.042$, $p = .005$], math anxiety [$t(48) = 2.622$, $p = .013$], and math test anxiety [$t(48) =2.367$, $p = .022$].

Table 2

Math Attitudes of Participants Based on Delivery Method and Successful/Unsuccessful Course Completion

		Math Attitude		Math Anxiety		Test Anxiety	
Group	*n*	*M(S.D.)*	*t*(sig)	*M(S.D.)*	*t*(sig)	*M(S.D.)*	*t*(sig)
All Online	26	3.48(1.36)	-.893(.376)	3.25(1.52)	-1.532(.131)	3.67(1.37)	-.269(.789)
All F2F	30	3.82(1.49)		3.88(1.53)		3.77(1.54)	
Successful Online	21	3.52(1.30)	.565(.576)	3.30(1.45)	-.142(.888)	3.69(1.35)	1.146(.259)
Successful F2F	17	3.25(1.58)		3.38(1.66)		3.15(1.57)	
Unsuccessful All	12	4.41(.83)	3.042(.005)*	4.28(0.91)	2.622(.013)*	4.51(.96)	2.367(.022)*
Successful All	38	3.40(1.42)		3.34(1.53)		3.45(1.46)	

Table 2 Notes: * $p < .05$ *two-tailed.* Math attitudes were measured on a 7-point Likert response scale with 4 as the midpoint.

Self-Regulated Learning Strategies

Descriptive statistics for the five learning strategy scales used in this study are provided in Table 3. The strategy section of the survey consisted of statements 12 through 42. All of the statements were evaluated on a 7 point Likert scale (1 = not at all true of me to 7 = very true of me). The numerical values of negatively worded statements were reversed so a value of 7 indicated the student had the attributes related to the strategy The mean was calculated for each of the five strategies for student groups and compared. Online students had a slightly higher mean on the organization, metacognitive self-regulation, time management and effort regulation scales than face-to-face students. Face-to-face students had a higher mean on organization and help seeking than online students. The mean was only slightly higher for organization, but the difference for help seeking was more pronounced. The mean values increased in every area when only successful online and successful face-to-face students were addressed. Metacognitive regulation was the only mean that was higher for successful online students compared to successful face-to-face. Successful face-to-face students had higher means for the other four areas. The most pronounced differences in means, shown in Table 3, were between all unsuccessful students and all successful students. Successful students reported higher usage on in four out of the five categories. Only help seeking was higher for the unsuccessful students.

To answer the second research question, *What strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses?,* an independent samples *t* test was used to determine the relationship between each of the strategies and student groups. The *t* values and two-tailed significance are shown on Table 4. There are statistically significant differences for help seeking for both the all online students versus all face-to-face students [t(54) = -4.309 p =.000] and the successful online versus successful face-to-face students [t(36) = -2.497, p = .017]. Online students used fewer help seeking strategies than face-to-face students.

Table 3

Mean and Standard Deviation of Self-Regulated Learning Strategy Usage

Student Group	N	Org	Meta	Time	Effort	Help
		M(S.D.)	*M*(S.D.)	*M*(S.D.)	*M*(S.D.)	*M*(S.D.)
All Online	26	4.04(1.37)	4.44(1.11)	5.12(1.18)	5.73(1.14)	2.91(1.09)
All F2F	30	4.28(1.39)	4.10(.89)	5.03(1.39)	5.20(1.34)	4.31(1.30)
Successful Online	21	4.33(1.35)	4.60(1.13)	5.32(1.10)	5.88(1.12)	3.01(1.11)
Successful F2F	17	4.57(1.44)	4.47(.90)	5.72(1.05)	5.90(.96)	4.07(1.51)
All Unsuccessful	12	3.48(1.20)	3.67(.68)	4.37(1.23)	4.42(1.21)	4.17(1.46)
All successful	38	4.44(1.38)	4.54(1.02)	5.50(1.08)	5.89(1.04)	3.49(1.39)

Table 3

Notes: Abbreviations for strategies Org = organization, Meta = metacognitive self-regulation, Time = Time Management, Effort = Effort regulation, Help = Help Seeking.

The third research question, *How did strategy use differ between successful and unsuccessful students in both the online and face-to-face math courses?*, was not answered directly since there were too few unsuccessful students who completed the survey to compare unsuccessful and successful students within a delivery method. However, an independent samples *t* test was used to determine the relationship between each of the strategies and the total unsuccessful and total successful students. The analysis, as shown in Table 4, showed significant differences in organization [$t(48) = -2.167$, $p = .035$], metacognitive self-regulation [$t(48) = -2.765$, $p = .008$], time management [$t(48) = -3.056$, $p = .004$] and effort regulation [$t(48) = -4.109$, $p = .000$]. Unsuccessful students showed using significantly fewer strategies than the successful students except in help seeking. Although unsuccessful students used more help seeking strategies, it was not a significant difference.

Although online tutoring through the publisher of the software had an additional fee after an initial free 30 minutes, none of the online students made use of the option. The discussion board was not a requirement of face-to-face courses, but there was an open prompt for students to ask questions where either students or the teacher could respond. The face-to-face students did not use that option. The discussion board was used by the majority of online students, but the requirements for using the discussion board for class may have been different for the two classes surveyed.

Table 4

T values and two-tailed significance of self-regulated learning strategy use.

Student Group	**N**	**Org** *t*(sig)	**Meta** *t*(sig)	**Time** *t*(sig)	**Effort** *t*(sig)	**Help** *t*(sig)
All Online	26	-.640(.525)	1.270(.210)	.255(.800)	1.583(.119)	-4.309(.000)*
All F2F	30					
Successful Online	21	-.528(.600)	.370(.714)	-1.117(.271)	-.047(.963)	-2.497(.017)*
Successful F2F	17					
All Unsuccessful	12	-2.167(.035)*	-2.765(.008)*	-3.056(.004)*	-4.109(.000)*	1.48(.151)
All successful	38					

Table 4

Notes: *p < .05 two-tailed. Abbreviations for strategies Org = organization, Meta = metacognitive self-regulation, Time = Time Management, Effort = Effort regulation, Help = Help Seeking.

Online resources

The fourth research question, *Which resources within MyMathLab did online and face-to-face students utilize?*, is summarized in Table 5. MyMathLab software resources were measured by students self-reporting their usage as 1 = never, 2 = rarely, 3 = occasionally, 4 = often, and 5 = extensively. Table 5 summarizes the percent of the reporting population that reported extremely low 1 or 2 values for usage compared to the percent reporting 3- occasional, and then those with high usage at 4 or 5. In general, face-to-face students made greater use of the resources than online students. The digital textbook may have low usage because most students buy the physical textbook with online access. The majority of online students did not make use of video lectures, example problem videos, ask your instructor link, online tutoring or the sample tests. No online students used the "Ask Your Instructor" link that will send an email to the instructor with the actual problem included an area for students to ask specific questions. One additional question in the survey relating to resources was not included in Table 5. Item 45 on the survey asked what additional resources the online students would like to have available. Students were able to choose all or none of the options as well as type in additional suggestions. Of the 26 online students, twelve indicated video of the instructor's lecture should be available, eleven wanted and optional chat with the instructor, no student wanted a required chat however, and five requested online study groups. No additional suggestions were offered by the students.

The results of the last question, *What were the perceived benefits of these resources in both the online and face-to-face math courses?*, are summarized in Table 5. The survey item was a matrix listing the various resources in the software and students needed to rate whether the resources were beneficial. The scale went from 1 = not beneficial to 5 = very beneficial.

The majority of online and face-to-face students reported the S*how Me Example, Help Me Solve, and Sample tests* as beneficial or very beneficial. Reported use of the resources and students' opinions of the benefits of the resources were not always consistent. About one-half of the online students found the *example problem video* and the *study plan* to be beneficial although the frequency of use of *example problem video* did not reflect the rating. Ask instructor link was rated as not beneficial by a substantial number of students in both delivery methods.

Statement 42, *When I cannot understand the course material, I ask for help in the Academic Support Center*, was not included in the help seeking calculations or resource data. Students answered with the same 7-point Likert scale as in the strategies section of the survey. The school has recently moved the Academic Support Center to a more centralized, visible location and the math instructors encourage students to use it regularly either to access MyMathLab in a location with help available or to go in to get questions from class or homework answered. More than one-half of the students chose "not at all true of me" for this statement and the entire sample's mean value was 2.49. Successful participants had a mean of 2.83 and unsuccessful students had a mean of 2.21 for this item.

Table 5

Frequency of use of online resources and Benefit Rating of Resources by Percent of Students Reporting

Software resource	Frequency of use as % of student reporting 1 = never to 5 = extensively						Online Resource Benefit rating by % of students 1 = not beneficial to 5 = very beneficial					
	Usage Online			Usage F2F			Benefit rating Online			Benefit rating F2F		
	1-2	3	4-5	1-2	3	4-5	1-2	3	4-5	1-2	3	4-5
Digital text	69.2	15.4	15.4	46.7	23.3	23.3	65.4	19.2	15.3	46.3	20.0	36.7
Video lecture	80.8	7.7	11.5	60	16.7	23.3	46.2	23.1	30.8	26.7	26.7	46.7
Problem video	53.8	23.1	23.1	43.3	10	46.7	30.8	19.2	50	23.3	23.3	53.4
Show me an example	7.6	15.4	76.9	3.3	10	86.6	0	11.5	88.5	6.7	0	93.3
Help me solve	19.2	38.5	42.3	13.3	30	56.7	3.8	15.4	80.8	3.3	6.7	90.0
Ask instructor	100	0	0	80	13.3	6.7	42.3	26.9	30.8	36.6	20.0	33.3
Online tutoring	100	0	0	93.4	0	6.6	57.7	23.1	19.2	60.0	20.0	20.0
Study plans	46.1	7.7	46.2	53.3	23.3	23.3	19.2	30.8	50.0	26.6	30.0	43.4
Sample tests	65.4	3.8	30.7	40	20	40	19.2	19.2	61.6	13.3	13.3	73.3
Document sharing	73	15.4	11.5	90	0	10	46.1	15.4	38.4	63.7	16.7	20.0
Discussion board	38.4	38.5	23.1	96.7	0	3.3	46.2	34.6	19.2	63.3	20.0	16.7

Table 5

Notes: Usage 1 = never, 2 = rarely, 3 = occasional, 4 = often, 5 = extensively; Benefit Rating 1 = not beneficial to 5 = very beneficial.

Chapter V: Discussion

The purpose of the study was to identify perceived difficulties that students have in the math courses, compare the strategies and resources used by the students, and assess the perceived impact of instructional strategies in order to determine what can be done to improve the successful completion rate of online math courses. An online survey was sent to two different online courses and the two face-to-face versions of the same courses in order to compare the attitudes, strategies and resource use of the two delivery methods. This chapter will discuss the results of the study by addressing each of the study questions. In addition, it discusses the limitations of the study and provides course recommendations, further research recommendations and the conclusion.

Participants

Of the 86 total students in the courses, 56 respondents participated in the study that involved online or face-to-face students. Because 6 students were not able to identify their course grades, those 6 responses were excluded from items that looked at successful students and unsuccessful students. Successful and unsuccessful students only referred to whether those students who enrolled in a math course finished the course with a C or better. It did not differentiate between students who withdrew from the course either officially or unofficially due to extenuating circumstances unrelated to their academic performance in their math class. The designation also does not indicate if a student was successful in his or her overall academic experience. For the study, 30 participants were from the online courses and 27 came from the face-to-face courses. About 67% of the students were 25 and over, which reflects the average age of the students at the school was over 30 and that there had been a large influx of dislocated workers attending the college within the last few years due to the economic slowdown. Few students who participated were taking their first online course, therefore, the students were experienced in the expectations of online learning and comfortable using technology. Wang found the number of previous online courses positively influenced the effectiveness of student's learning strategies which then influenced achievement (2010).

Research Question 1: What was the attitude in terms of math anxiety level of the students in the online math courses compared to the students in the face-to-face courses.

The first research question concerned whether there were any differences in math attitudes in terms of math anxiety and math test anxiety between online students and face-to-face students. The results indicated there are no statistically significant differences between online students and face-to-face students in math attitudes, math anxiety or math test anxiety. The mean values for attitude, math anxiety and test anxiety were all between 3 and 4 (midpoint) of the 7-point Likert scale which indicates some anxiety is present in both groups, but they did not appear to be highly anxious. The mean values decreased only slightly for each of the three constructs for online students when only successful completers were used. This was likely because only three online students who responded were classified as unsuccessful in the course. Also, because there were more successful students who participated, the mean for each measure may have been skewed to a lower value indicating less anxiety than what may be expected.

There was also no significant difference in math attitudes, math anxiety or math test anxiety between successful online and successful face-to-face students. The means for these student groups were also between 3 and 4. The decrease in the three math attitude means was more pronounced when going from all face-to-face students to just successful face-to-face students, but means between 3 and 4 still indicate some anxiety being reported. There were more unsuccessful students (nine) in the face-to-face group, so the drop in the mean from all face-to-face to only successful face-to-face would be expected based on research that found students with high math anxiety had lower achievement (Ma, 1999).

Too few unsuccessful students filled out the survey to compare the unsuccessful students' attitudes and successful students' attitudes within a specific delivery method. The timing of the survey may be why so few unsuccessful students participated. Because the survey was distributed at the end of the semester, many students may have stopped any effort related to the course if grades were longer changeable. Students who had officially or unofficially withdrawn from their course likely ignored the correspondence from the instructor.

However, the unsuccessful students from the entire sample were compared to the successful students. The math attitude, math anxiety, and math test anxiety means of all the unsuccessful students from either delivery method were above the midpoint which implies higher anxiety for unsuccessful students. The successful students from both delivery methods had means for math attitude, math anxiety, and math test anxiety below 3.5 on the 7 point Likert scale suggesting lower than average anxiety.

The last *t* test done for the first study question was between unsuccessful students and successful students regardless of delivery method, and here there were statistically significant differences in all three measures: math attitudes, math anxiety and math test anxiety. The findings for this comparison agreed with other research that showed math anxiety was inversely correlated with achievement (Betz, 1978; Ma, 1999; Ashcraft and Kirk, 2001; Humbree, 1990). Ashcroft and Kirk (2001) reported that math anxiety lowered the capacity of working memory. They felt that since working memory is important to cognitive tasks such as mathematics, if the working memory is taxed as the result of anxiety, lower performance may ensue.

It is not unusual for postsecondary students to experience math anxiety. Researchers have found math anxiety at every educational level (Wigfield & Meece, 1988; Betz, 1978). Baloglu and Kocak (2006) correlated students' mathematics anxiety with their math background (2006). Based on the demographics of the study population, close to 50% of the students had their last math course over 6 years ago and 40% did not have a math course in over 10 years. A possible explanation for anxiety reported for even successful students may be the lapse of time since their last math course.

For the present research, math attitude was considered a motivational factor. Motivational beliefs have been shown to be predictive of math anxiety (Kesici & Erdogan, 2009). Although not the same construct as described in the motivation section of the MSLQ by Pintrich, Smith, Garcia, & McKeachie (1991), math attitude is an affective measurement and does have the capacity to influence areas within the motivation construct such as self-efficacy, goal orientation, expectancy, task value. Self-efficacy involves judgements in one's ability to accomplish as task as well as confidence in one's skills to perform the task. Goal orientation refers to the reason why a learning endeavor is taken on. Expectancy is the student's beliefs that the outcome of the task will be postitive. Task value is a personal assessment of a task's importance, usefulness or interest (Pintrich, et al, 1991). Success in an online course was significantly and positively correlated to intrinsic goal orientation, task value, self-efficacy, (Yukselturk and Bulut, 2007). In addition, Hembree (1990) concluded that math anxiety was a learned behavior unrelated to ability, and it was successfully treated using behavioral methods. Math anxiety has been related to metacognition, environmental management, effort regulation, study skills, and help seeking (Otts, 2010).

Students will sometimes attribute failure in math to high levels math anxiety. According to Linnenbrink and Pintrich (2002) instructors need to help students to determine the actual cause of the failure. "If the failure was due to lack of appropriate strategy use, it is not appropriate to tell the student to try hard. Rather, the teacher may need to work with the student to help them develop the strategies and skills necessary to succeed…" (Linnenbrink & Pintrich, 2002, p. 318).

Math attitude problems may be able to be addressed through self-regulation strategy instruction. Pressley (1986) stated, "A good strategy user calmly confronts problem situations with a general set to deploy effort in ways well matched to the problem encountered." Since Legg and Locker (2009) found that metacognition had a moderating effect on math anxiety, instruction in self-regulation strategies may be a way for students to overcome math anxiety or math test anxiety. Additional research should explore if math anxiety decreases with metacognitive self-regulation training.

Research Question 2: What strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses?

The second study question involves whether different strategies were employed by successful students in the online math courses compared to the successful students in the face-to-face math courses? The results showed the only significant difference in strategy use between the two groups of students was for help seeking strategies. This indicates that face-to-face students were more likely to seek out peers, instructors or others when they did not understand a concept. Good students will seek out the support of others when needed (Pintrich, et al., 1991). A possible reason for online students using fewer help seeking strategies could be that online students were not aware of support services or did not know how to access support services. Also, students who are experienced in online learning would be more adept at finding help resources online such as video or tutorials. The other four strategies did not show any significant differences between successful online and successful face-to-face students. However, successful students showed the highest use of self-regulated learning processes related to time management and effort regulation for both delivery methods. This may mean that higher achieving students, regardless of chosen course delivery method, are more likely to manage their schedule and are more willing to extend effort when subject matter became difficult. This supposition would coincide with research by Puzziferro (2008) who found that out of the nine cognitive and metacognitive subscales on the MSLQ, only time and study environment regulation and effort regulation subscales had a significant relationship to achievement in online courses. Also, there were no significant differences between organization, time management, effort regulation or metacognitive self-regulation subscales which suggests that successful students use similar amounts of these strategies. This would be analogous to the Sankaran and Bui (2001) conclusion that students with similar learning strategies performed comparably in courses regardless whether the course was face-to-face or online.

As part of the same research question, the learning strategies of all online and all face-to-face students were also compared. Again, help seeking was the only strategy scale that showed a significant difference between all online and all face -to-face participants. The other four strategies did not show any significant differences, possibly due to the very low number of unsuccessful online students' responses that were included in the statistics which then may have skewed the mean to favor successful students. It is important to note the there was only a slight difference in the means between successful online students and all online students for organization, metacognitive self-regulation, time management and effort regulation. There is a more noticeable decrease in the mean between successful face-to-face students and all face-to-face students. The face-to-face category had more students who were not successful in their course. This may provide evidence that the mean for all online students was skewed.

Research Question 3: How did strategy use differ between successful and unsuccessful students in both the online and face-to-face math courses?

The third question intended to compare learning strategies of successful and unsuccessful students within a delivery method. There were not enough students in the unsuccessful category in either delivery method to make this type of comparison. Instead, all successful participants (N = 38) were compared to all unsuccessful participants (N = 12). The results of this comparison were the opposite of the previous groupings in from question 2. There were significant differences in organization, metacognitive self-regulation, time management and effort regulation. In each case the successful participants reported higher levels of the strategies. This would be consistent with the literature that has shown self-regulated learning strategies are positively correlated to academic achievement (Glogger et al., 2012; Lynch, 2010; Ruban, et al., 2002; Otts, 2010; Puzziferro, 2008; Paechter, et al., 2010; Barnard-Brak, Lan, & Paton, 2010; Garavalia & Gredler, 2002; Lindner & Harris, 1993; Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1990). Interestingly, however, help seeking did not show any statistically significant differences between successful students and unsuccessful students, but the unsuccessful student category’s mean was higher in help seeking than the successful students. This may be the result of instructors’ and other staffs’ efforts to assist struggling students with direct additional instruction as well as referrals to support services. A larger sample would allow for a greater analysis of the differences in strategy use between successful and unsuccessful students in a specific course delivery method.

Six of the participants were not able to identify their current grade in the course. One possible explanation for this may be the student's lack of self-regulation. Metacognitive self-regulation involves setting goals, planning, self-monitoring, self-testing and self-evaluating throughout the learning process (Zimmerman, 1990). Self-monitoring was identified as a key component of self- regulation (Bembenutty & Zimmerman, 2003). Bembenutty and Zimmerman wrote "self-monitoring involves observing and tracking one's own performance and outcomes, often recording them" (2003, p. 78). Students may be lacking self-monitoring skills if they do not have a general idea of how they are doing in a class when the grades are either continuously available online in the software used by all the courses or had been regularly distributed by instructors. However, it is possible the student chose not to disclose their grade even though they knew it.

Also, one item that was not included in the composite means of strategies above was item 42 regarding students use of the Academic Support Center on campus. The center was relocated into the library to provide more visible, easier access for students, and the hours were increased over past years' hours to provide more coverage. The mean for this one question was 2.49 on the 7-point Likert scale with more than one-half of the students responding "not at all like me." This seems to be a fairly low mean for a help seeking strategy. However, of those students who reported their course grade, 26 of the 50 reported an A or B and may have not needed help services. However, the mean of unsuccessful students was 2.83 while successful students had a mean of 2.21. Students who could use additional help do not appear to be using the Academic Support Center. Additional research should be done as to why it is not used or what could be made available to increase student use.

Research Question 4: Which resources within MyMathLab did online and face-to-face students utilize?

The fourth research question involved identifying what resources within MyMathLab that were utilized by online and face-to-face students. *Show Me Example* and *Help Me Solve* resources were the most heavily used by online students and face-to-face students. Around 77% of online students and 87%% of face-to-face students used Show Me Example option either often or extensively. The Help Me Solve was used often or extensively by 42% of online and 57% of face-to-face. *Show Me Example* would give a text based version of all the steps required to solve the problem while the *Help Me Solve* was interactive and would explain the step but require students to input the result of the step into the space provided. The software would check each step and provide a hint and the opportunity for the students to correct the mistake for the step before going to the next step; therefore, *Help Me Solve* may have required more effort and time to use this option.

A concern regarding the high use of *Show Me Example* and *Help Me Solve* options would be that students were focused more on completing the required assignment than on understanding the concept. The lower use of *Help Me Solve* may be additional evidence that completion was the goal rather than understanding. If these types of compensatory strategies were used for most or all homework problems, the student would not develop strategy skills needed to work through a problem that has a format unfamiliar to the student. These strategies would include comprehending the text of the problem, analyzing relationships between components within the problem, choosing a procedure or algorithm to solve the problem, monitoring the progress toward the solution with the chosen algorithm and adapting or replacing the algorithm as needed, and then checking the solution in relation to the problem (Pape &

Smith, 2002). By choosing the *Show an Example* or *Help Me Solve* options too often, the students would be just copying the steps shown rather than critically analyzing the problem. This could be somewhat similar to the research by Ruban et al. (2002) that showed the use of compensatory supports was negatively related to GPA's for non-learning disabled students, so the more compensatory supports that were used, the lower the reported GPA. Learning disabled students' use of compensatory support was positively correlated with GPA's. Although the supports that were used in Ruban et al. (2002) were not the same as those in the MyMathLab software, the result may be similar. Using a support to compensate for a disability required expanded effort from the disabled person which helped in the learning process. Using a support to avoid additional effort needed to understand a concept would not improve the learning process.

By focusing study efforts on completing homework without seeing the larger context would also be considered emphasis on rehearsal strategies. Rehearsal strategies are considered to be only surface level learning (Pintrich, 2004) and are negatively correlated with achievement (Glogger et al., 2012).

Other resources that would be more directed at learning concepts rather than completion of homework would be *Section Video Lectures, Study Plan* and *Sample Tests*. Students reported low levels of use for these resources. The majority of students (81% online and 60% face-to-face) reported never using or rarely using the *Section Video Lecture* resource which was publisher-developed lectures of each section. However, it should be noted that 12 of the 26 online students had indicated they would like to see the course instructor's lecture available online. It is unclear why instructors' videos would be requested if the students did not use the available videos. *Sample tests* were reported not used by 65% of online and 40% of face-to-face.

The sample tests and study plans worked together. Each section included a pre-test and post-test for students to try which would produce a study plan for students for the areas identified by the testing that students needed additional practice to master. The student could click on the *Study Plan* to get a list of problems to work based on the results of the test. The *Study Plan* was not used by 46% of online and 53% of face-to-face participants. These were optional resources that could help the student monitor their understanding of concepts. Not using this type of resource may again point to the emphasis on quick completion rather than understanding of general concepts.

The digital textbook also showed little use but that was expected since most students purchased the physical textbook with the online software access. This result brings with it an additional question to be addressed: how often did the student use the physical textbook? Anecdotal observations by this researcher have indicated students do not read math textbooks. The textbook would also a more general discussion of topics, and therefore, reading the textbook would be more concept driven rather than problem driven.

Interestingly, the two online help seeking resources, *Ask Instructor* and *Online Tutoring*, were not used by the participants of the study. After the initial one-half hour free session of online tutoring, subsequent sessions were available on a fee per hour basis. The fee probably kept students from using this service, but the *Ask Instructor* could be used by anyone at anytime. It would send an email to the instructor with a link to the specific question the student needed help with and the option for the student to include comments and questions like any email. The most likely reasons for not using this option would be students needed or wanted an immediate response to the question and did not want to wait for the instructor to return the email, or both online and face-to-face students were reluctant to ask questions.

There are many available resources within the MYMATHLAB software that instructors can integrate into the course to increase learning options for students. The learning resources that were never or rarely utilized by the students suggest that instructors were not incorporating all resources into course learning activities to making full use of the software. For example, the *Discussion Board*, was not used by almost 40% of the online respondents. Also, since some of the resources are used more by face-to-face students, it would seem to show the instructors explain the resources or encourage the use of the resources in the face-to-face classroom. It may also suggest that instructors are not orienting online students sufficiently into the software so the students understand how, when and why to use the available resources, or the instructors do not explain and encourage use of the resources regularly for students in the online versions.

Research Question 5: What were the perceived benefits of these resources in both the online and face-to-face math courses?

The final research question asked what were the perceived benefits of the MyMathLab resources to both online and face-to-face students. *Show Me Example*, and *Help Me Solve* were rated either very beneficial (4 or 5 on Likert scale) by 80 – 90% of students. This would be expected based on the number of students who reported using the two resources often or extensively. Sample Tests were rated beneficial or very beneficial by 62% of online and 73% of face-to-face respondents. For the *Sample Tests*, the ratings were not reflective of the usage. Other resource also had perceived benefits to be rated high although usage was considerably lower. There are a few possible reasons that students perceived resources as beneficial even though they did not use them often. First, the student may appreciate the availability of the resource even if the student did not personally use the resource. Another possibility is the students were not totally aware of all the resources in the software or how to use the resource but felt it would have been beneficial when asked to rate it. A third reason would be the students did not understand the strategies the software was trying to promote with the resources and the importance of the strategies to academic outcomes so the students did not use resources, but students answered based on how instructor expectations. For example, a student may not have been aware that sample tests and the study plan were available to monitor progress and self-evaluate but the student knew that a sample test is often encouraged by instructors. An additional explanation would be the students did not pursue using additional resources because of lack of time, meaning their only concern was getting the homework completed before it was due. Lastly, the students were at a high math level already, so rarely using the resources was appropriate but beneficial at the time. Future research should explore the reasons students decide to use or not to use the resources and the reasons why students find certain resources beneficial.

Limitations

Although the study showed significant differences between unsuccessful and successful students in math attitudes and self-regulated learning strategy use, methodological limitations of this study need to be considered when interpreting the results. First, the adequacy of the math anxiety scale in this survey should be considered. The questions used for the construct were taken from an original Fennema-Sherman Mathematics Attitudes Scale (MAS) (1976). The math anxiety scale for the MAS was originally 10 questions relating to math and test anxiety. Although the items seemed representative of math anxiety questionnaires, not using the complete scale may have changed the validity of the items and therefore it may have been inappropriate to measure math anxiety alone or in combination with the math test anxiety items from the MSLQ. In addition, the MAS and MSLQ original scales were not developed for online learning environments. Some of the items may not have been well suited for online environments.

Another limitation of the study concerned the small sample size for the entire study as well as the difference in the number of unsuccessful versus successful students completing the survey. When calculating the means of total online and total face-to-face students, the means may have been skewed in favor of successful students, since high achieving students tend to have less math anxiety and demonstrate the use of more self-regulated learning strategies. Also because of the small sample size, the results should not be generalized to a larger population.

Next, the appropriateness of the five learning strategies chosen should be addressed. The five strategies assessed were chosen based on the current researcher's interpretation of necessary strategies in online learning as well as the results of the meta-analytic study by Crede and Phillips (2011) that showed organization, metacognitive self-regulation, effort regulation and time and environment management were significantly correlated with grades. There may have been other strategies that would have shown significant differences between groups of students and delivery methods that were more appropriate to mathematics specifically.

Overall course grade may not have been the best indicator of achievement. Although tests were weighted similarly in the calculation of final grades between instructors, other requirements of the courses may not have been given the same weight by different instructors. If the success of a student had been based on test grades alone, the number of unsuccessful participants would have increased by five. In addition, the course grades were self-reported, so they may have not been actual grades.

Conclusion

This study compared the math attitudes, self-regulated learning strategies and software resource use of students in two online and two face-to-face mathematics courses in order to work toward improvement in the successful completion rate of online mathematics courses at LTC.

The study showed that unsuccessful students had significantly higher levels of negative attitudes toward mathematics in terms of math anxiety and math test anxiety than students who successfully completed the courses that were studied. In general, the levels of math or test anxiety, separately or combined, did not differ between online math students or face-to-face math students. There was also no significant difference between math attitudes in successful online students and successful face-to-face students. This agreed with the literature that has reported that high levels of math anxiety and test anxiety were negatively correlated with performance.

This study then looked at the self-regulated learning strategy use between online student and face-to-face students, between successful online and successful face-to-face students, and between unsuccessful students and successful students. The self-regulated learning strategies that were studied using the survey instrument MSLQ were organization, metacognitive self-regulation, effort management, time management and help seeking. Successful students were especially high in effort management and time management categories, two areas that others have found to be significantly related to achievement in online courses. The only significant difference between online and face-to-face students or between successful online and successful face-to-face was in help seeking with face-to-face reporting higher levels of help seeking. Since the other four areas were very similar for both successful online and face-to-face students, the result agreed with others who have found the student with similar learning strategies performed comparably. The comparison between unsuccessful students and successful students resulted in significantly lower levels of organization, metacognitive self-regulation, time management and effort management. This was also consistent with the literature that has found that cognitive, metacognitive and resource management strategies were related to performance.

Finally, this study explored the resources within the MyMathLab software that were used by the students. The resources most used and valued by the students were the *Help Me Solve* and *Show Me Example*. Both resources were focused on working individual problems rather than working with broader concepts. Both had the potential of bypassing the need for the student to analyze the problem for himself and plan, monitor and self-evaluate the processes used to arrive at the solution. If students used these resources as a way to complete homework quickly without concerns for deeper learning, the result is likely to be less positive. The results suggest that students may benefit from additional instruction in self-regulated learning strategies and from additional instruction on the software that is used.

Recommendations

Previous studies have documented significant relationships between self-regulated learning and achievement (Glogger et al., 2012; Lynch, 2010; Ruban, et al., 2002; Otts, 2010; Puzziferro, 2008; Paechter, et al., 2010; Barnard-Brak, Lan, & Paton, 2010; Garavalia & Gredler, 2002; Lindner & Harris, 1993; Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1990). Research has also shown instruction in self-regulated learning increased achievement (Azevedo & Cromley, 2004; Camahalan, 2006; Pape, & Smith, 2002; Moseki & Schulze, 2010; Montague, Enders and Dietz , 2011; Bembenutty and Zimmerman, 2003). Since the unsuccessful students in this study showed significantly higher math and test anxieties and significantly lower levels of the self-regulation learning strategies of organization, metacognitive self-regulation, effort management and time management, the next appropriate step toward improving successful completion of courses would be to integrate self-regulated learning strategy instruction into the courses.

Based on the results and discussions of this study, the following classroom recommendations should be considered:

1. The college should consider a course in self-regulated learning that is an elective for new students and encourage instructors to embed self-regulated learning strategies into existing courses. In addition, the school should provide a way for students to assess their strategy use to help students identify weaknesses in self-regulated learning strategy skills so students can make an informed decision about the course.
2. Remedial mathematics courses should determine if students show signs of math anxiety and math test anxiety and try addressing it using metacognitive self-regulation strategies. This may make students more comfortable and successful taking the math course(s) needed for their program.
3. Online math instructors should experiment with embedding self-regulation instruction and self-regulation strategy prompts into courses to encourage strategy use to see if outcomes improve. Activities should be developed that require students to use the strategies.
4. Online instructors need to provide a more thorough orientation to online learners regarding the software that is used in the course. Included in the instruction should be how to navigate through the software, what is available in the software, what the educational benefits could be for each resource in the software, how the resources could be used to improve outcomes, and how to access help resources in the software or within the school. The orientation should also give the students an opportunity to assess their self-regulation learning strategies to make sure their skills match the requirements and rigor of the online course.

5. Instructors should monitor low-achieving students in online courses closely and provide more timely feedback and recommendations.
6. Online instructors should incorporate more of the resources available within the software into the online course. For example, the discussion board can provide an area for students to compare problem solving methods or have other conversations regarding the course with peers or the instructor so students do not feel isolated when encountering difficulties. Students can share how they overcame obstacles, used resources, and met expectations of the course.
7. Results of this research should be shared with the Student Retention Committee and the deans of departments.

Recommendations for Future Research:

The following research recommendations are based on the results and discussion from this study:

1. Additional research regarding math attitudes and self-regulated learning should be done with a larger sample to acquire a better understanding of online math students who do not successfully complete the course. A larger sample will ensure results are generalizable.
2. This study should be repeated earlier in a semester to obtain a better cross section of students. If done earlier in the semester, final grades should be requested from instructors and linked at the end of the semester rather than self-reported.
3. Additional research should be done to determine the relationship between other variables, such as technology expertise, work status, age and family responsibilities, and successful completion of an online course.

4. Future research should explore the reasons students decide to use or not to use the software resources and the reasons why students find certain resources beneficial.
5. Additional research should be done to determine if adequate help resources are available for online students and why students do or do not use the resources that are available and what could be done to increase student's use.
6. Research should investigate whether metacognitive self-regulation instruction decreases math and test anxiety.

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Appendix A: Survey

Consent to Participate In UW-Stout Approved Research

Title: *The Relationship Among Math Attitudes, Learning Strategies and Resources Used Leading to Successful Completion of Online Mathematics Courses in a Two Year Technical College*

Investigator:
Pamela Steltenpohl
Lakeshore Technical College
920-693-1765

Research Sponsor:
Jana Reeg-Steidinger
715-232-1553
reegj@uwstout.edu

Description:

I am requesting your assistance with a research study investigating students' attitudes towards mathematics, students' use of learning strategies in their math class and students' use of MYMATHLAB in hopes of improving success rates in online math classes. Your participation in the research project would involve completing a survey that asks you to rate situations on a seven point scale from "not at all true of me" to "very true of me." In addition, there are some questions regarding MyMathLab usage and benefits and finally some demographic questions. This research study is part of the requirements for a master's degree. The title for the study is ***The Relationship Among Math Attitudes, Learning Strategies and Resources Used Leading to Successful Completion of Online Mathematics Courses in a Two Year Technical College.***

Risks and Benefits:

It is not anticipated that this study will present any significant risk to participants. Participation or non-participation will not affect your grade in the course. Your responses to the survey will not affect your grade in the course.

The possible benefit to you from participating in the research study is (1) assisting math educators at your school gain an understanding of factors for increasing retention in and successful completion of online mathematics courses; (2) a sense of satisfaction from helping future math students.

Time Commitment and Payment:

Your participation in the study would involve completing a survey. **All students who complete the entire survey can choose to be included in a drawing for a $50 gas card.** The survey will take approximately 10 - 15 minutes to complete.

Confidentiality:

Be assured that every effort will be taken to ensure your privacy, and all information gathered from this survey will be kept strictly confidential. The study will not have any identifiable information within it. The researcher will retain the survey information in a password protected file. All information obtained from the survey will only be available to the researcher who will destroy the information after the research has been completed. The online software, Qualtrics, used to gather information does not provide any connecting link between respondents and the survey report.

Right to Withdraw:

Your participation in this study is entirely voluntary and not a requirement of your course. You may choose not to participate without any adverse consequences to you. You have the right to stop the survey at any time. However, should you choose to participate and later wish to withdraw from the study, there is no way to identify your anonymous online submission. Once you submit your response, the data cannot be linked to you and cannot be withdrawn.

IRB Approval:

This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator:
Pamela Steltenpohl
920-693-1765
pamela.steltenpohl@gotoltc.edu
Advisor:
Jana Reeg-Steidinger
715-232-1553
reegj@uwstout.edu

IRB Administrator
Sue Foxwell, Director, Research Services
152 Vocational Rehabilitation Bldg.
UW-Stout
Menomonie, WI 54751
715-232-2477
foxwells@uwstout.edu

Statement of Consent:

By completing the following survey you:

- Confirm that you are at least 18 years old.
- Agree to participate in the project entitled, *The Relationship Among Math Attitudes, Learning Strategies and Resources Used Leading to Successful Completion of Online Mathematics Courses in a Two Year Technical College.*

Part 1. Attitudes

The following questions ask about your attitudes towards your math course. **There are no right or wrong answers. Answer the questions as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, choose 7. If a statement is not at all true of you, choose 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
Not at all true of me						very true of me

1. I would be comfortable taking additional math courses.
2. When I take a math test I think about how poorly I am doing compared with other students.
3. I am usually at ease during math tests.
4. When I work math problems, I often cannot think clearly and my mind goes blank.
5. When I take a math test, I think about the items on other parts of the test I cannot answer.
6. I am confident in my ability to solve math problems.
7. When I take a math test, I think about the consequences of failing.
8. When I think about trying hard math problems, I get a sinking feeling.
9. I have an uneasy, upset feeling when I take a math test.
10. Mathematics makes me feel uncomfortable and uneasy.
11. I feel my heart beating fast when I take a math exam.

Part 2. Learning Strategies

The following questions ask about your learning strategies and study skills for your math course. Again, **there are no right or wrong answers.** Answer the questions about **how you study in this math course** as accurately as possible. Use the same scale as in part one to answer the questions. If you think a statement is very true of you, click on 7; if a statement is not at all true of you, click 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
Not at all true of me						very true of me

12. When I study the textbook for this course, I outline the material to help me organize my thoughts.

13. During class time or when viewing material online, I often miss important points because I'm thinking of other things.

14. When reading for this course, I make up questions to help focus my reading.

15. I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.

16. Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.

17. When I become confused about something I'm reading for this class, I go back and try to figure it out.

18. When I study for this course, I go through the textbook and my class notes and try to find the most important ideas.

19. I make good use of my study time for this course.

20. If the textbook is difficult to understand, I change the way I read the material.

21. I work hard to do well in this class even if I don't like what we are doing.

22. I make simple charts, diagrams, or tables to help me organize course material.

23. I find it hard to stick to a study schedule.

24. Before I study new course material thoroughly, I often skim it to see how it is organized.

25. I ask myself questions to make sure I understand the material I have been studying in this class.

26. I try to change the way I study in order to fit the course requirements and the instructor's teaching style.

27. I often find that I have been reading the textbook for this class but don't know what it was all about.

28. I ask the instructor to clarify concepts I don't understand well.

29. When course work is difficult, I either give up or only study the easy parts.

30. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.

31. When I study for this course, I go over my class notes and make an outline of important concepts.

32. When I cannot understand the material in this course, I ask another student in this class for help.

33. I make sure that I keep up with the weekly readings and assignments for this course.

34. I work on this class regularly so I do not have to rush to complete assignments right before they are due.

35. Even when course materials are dull and uninteresting, I manage to keep working until I finish.

36. I try to identify students in this class whom I can ask for help if necessary.

37. When studying for this course I try to determine which concepts I do not understand well.

38. I often find that I do not spend very much time on this course because of other activities.

39. When I study for this class, I set goals for myself in order to direct my activities in each study period.

40. If I get confused taking notes in class, I make sure I sort it out afterwards.

41. I rarely find time to review my notes or readings before an exam.

42. When I cannot understand the course material, I ask for help in the Academic Support Center.

Part 3:

MYMATHLAB questions and demographics

43. Below are the features within MYMATHLAB. Please click on the circle that corresponds to the amount you used each feature when studying a chapter.

	Never used	Used Rarely	Used Occasionally	Used Often	Used extensively in every chapter
Digital textbook in MYMATHLAB	○	○	○	○	○
Section video lectures	○	○	○	○	○
Problem example video or animations	○	○	○	○	○
"Show me an example" button	○	○	○	○	○
"Help me solve this problem" button	○	○	○	○	○
"Ask my instructor" button	○	○	○	○	○
Online tutoring service through MYMATHLAB	○	○	○	○	○
Study plan	○	○	○	○	○
Sample tests	○	○	○	○	○
Accessed course documents using "document sharing"	○	○	○	○	○
Discussion Board	○	○	○	○	○

Part 3:

MYMATHLAB questions and demographics

43. Below are the features within MYMATHLAB. Please click on the circle that corresponds to the amount you used each feature when studying a chapter.

	Never used	Used Rarely	Used Occasionally	Used Often	Used extensively in every chapter
Digital textbook in MYMATHLAB	○	○	○	○	○
Section video lectures	○	○	○	○	○
Problem example video or animations	○	○	○	○	○
"Show me an example" button	○	○	○	○	○
"Help me solve this problem" button	○	○	○	○	○
"Ask my instructor" button	○	○	○	○	○
Online tutoring service through MYMATHLAB	○	○	○	○	○
Study plan	○	○	○	○	○
Sample tests	○	○	○	○	○
Accessed course documents using "document sharing"	○	○	○	○	○
Discussion Board	○	○	○	○	○

44. On a scale from 1 to 5, with one being not beneficial and 5 being very beneficial, how would you rate each of the features in MYMATHLAB.

	1 not beneficial	2	3	4	5- very beneficial
Digital textbook in MYMATHLAB	○	○	○	○	○
Section video lectures	○	○	○	○	○
Problem example video or animations	○	○	○	○	○
"Show me an example" button	○	○	○	○	○
"Help me solve this problem" button	○	○	○	○	○
"Ask my instructor" button	○	○	○	○	○
Online tutoring service through MYMATHLAB	○	○	○	○	○
Study plan	○	○	○	○	○
Sample tests	○	○	○	○	○
Accessed course documents using "document sharing"	○	○	○	○	○
Discussion Board	○	○	○	○	○

45. What additional resources would you like to have available in an online mathematics course. Pick all that apply.

○ Video of instructor’s lecture

○ Required online chat with instructor at a scheduled time every week

○ Optional online chat with instructor at a scheduled time every week

○ Online study groups assigned

○ Other resources, list or describe all that may help in completing a online math class

____

46. In which course are you currently enrolled?

- Math with Business Applications
- College Mathematics

47. How is this course delivered?

- Online
- Face-to-face

48. Student status

- I am a full time student (12 or more credits this semester).
- I am a part time student (3 - 11 credits this semester).

49. Not counting the current semester, how many semesters of college have you completed (at the current school or another college)?

- Zero, this is my first semester
- 1 semester
- 2 semesters
- 3 semesters
- 4 semesters
- More than 4 semester

50. What is your age?

- 18 - 24
- 25 - 29
- 30 - 39
- 40 or over

51. What is your current overall average in your math course?

- My overall average is _______
- I withdrew from this math course.

52. What is your current test average in your math course?

- My test average is _______
- I withdrew from this math course.

53. Not including this course, how many totally online courses have you taken?

- 1
- 2
- 3
- 4 or more

54. How many years has it been since your last math course?

- Less than 1 year
- 1 - 5 year
- 6 - 10 years
- More than 10 years

55. If you withdrew from your math course, what factors contributed to your decision to withdraw? _______________________

Appendix B Permission to Use MSLQ

UNIVERSITY OF MICHIGAN

COMBINED PROGRAM IN EDUCATION AND PSYCHOLOGY
1406 SCHOOL OF EDUCATION
610 E. UNIVERSITY AVENUE
ANN ARBOR, MI 48109-1259
(734) 647-0626 FAX: (734) 615-2164

December 9, 2011

Pamela Steltenpohl
Mathematics Instructor
Lakeshore Technical College
920-693-1765
pamela.steltenpohl@gotoltc.edu

Dear Pamela

I mail out the MSLQ for a fee of $20. With this payment, you are allowed to use the MSLQ **for your needs but making sure you give the authors credit. Consider this your letter for permission to use the MSLQ for your needs.** If you have any further questions, email us at cpep@umich.edu.

Sincerely,

Marie

____

Marie-Anne Bien, Secretary
The University of Michigan
Combined Program in Education & Psychology (CPEP)
610 East University, 1413 School of Education
Ann Arbor, MI 8109-1259
PH (734) 647-0626; FAX (734) 615-2164
mabien@umich.edu
http://www.soe.umich.edu

Appendix C: Permission to Use MAS

LTC mail

Pamela Steltenpohl <pamela.steltenpohl@gotoltc.edu>

Re: Permission to use the Math Attitudes Scales

1 message

Elizabeth Fennema <efennema@wisc.edu> Fri, Dec 9, 2011 at 3:05 PM

To: Pamela Steltenpohl <pamela.steltenpohl@gotoltc.edu>

On 12/9/2011 10:52 AM, Pamela Steltenpohl wrote:

Dr. Fennema-

I would like to request permission to use a portion of the Fennema-Sherman Math Attitudes Scales in my thesis research entitled *The Relationship Among Math Attitudes, Learning Strategies and Resources Used Leading to Successful Completion of Online Mathematics Courses in a Two Year Technical College.* I am specifically looking the at the Math Anxiety scale items only. If you have any questions regarding my research, I would be glad to provide additional information.

Thank you for considering my request,

Pamela Steltenpohl

Graduate Student in Career and Technical Education

University of Wisconsin-Stout

Mathematics Instructor

Lakeshore Technical College

Cleveland, Wisconsin

Dear Pamela,

You have my permission to use a portion of the Fennema-Sherman Math. Attitudes Scales in your research. However, if I were your adviser I would question at length the suitability of a scale constructed several decades ago for research in the 21st century.

My best to you.

Elizabeth Fennema

44. On a scale from 1 to 5, with one being not beneficial and 5 being very beneficial, how would you rate each of the features in MYMATHLAB.

	1 not beneficial	2	3	4	5- very beneficial
Digital textbook in MYMATHLAB	○	○	○	○	○
Section video lectures	○	○	○	○	○
Problem example video or animations	○	○	○	○	○
"Show me an example" button	○	○	○	○	○
"Help me solve this problem" button	○	○	○	○	○
"Ask my instructor" button	○	○	○	○	○
Online tutoring service through MYMATHLAB	○	○	○	○	○
Study plan	○	○	○	○	○
Sample tests	○	○	○	○	○
Accessed course documents using "document sharing"	○	○	○	○	○
Discussion Board	○	○	○	○	○

45. What additional resources would you like to have available in an online mathematics course. Pick all that apply.

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____

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52. What is your current test average in your math course?

- ○ My test average is _______
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- ○ 2
- ○ 3
- ○ 4 or more

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- ○ 1 - 5 year
- ○ 6 - 10 years
- ○ More than 10 years

55. If you withdrew from your math course, what factors contributed to your decision to withdraw? ________________________