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THE EFFECT OF A MATH EMPORIUM COURSE REDESIGN

IN DEVELOPMENTAL AND INTRODUCTORY MATHEMATICS COURSES ON

STUDENT ACHIEVEMENT AND STUDENTS' ATTITUDES TOWARD

MATHEMATICS AT A TWO-YEAR COLLEGE

by

Amy Renée Bishop

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

December 2010

ABSTRACT

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The purpose of this research was to determine the effect of computer-based instruction on student mathematics achievement and students' attitudes toward mathematics in developmental and introductory mathematics courses, namely Elementary Algebra, Intermediate Algebra, and College Algebra, at a community college. The researcher also examined the relationship between attitudes and achievement.

The sample consisted of 112 students, and the study was conducted during the Spring 2010 semester at a community college in south Mississippi. The participants were enrolled in one of six classes taught by the researcher. The control group consisted of three classes (one Intermediate and two College Algebra sections) taught using traditional lecture instruction. The treatment group was comprised of three classes (one Beginning, one Intermediate, and one College Algebra section) that were taught using computer-based instruction via the interactive online software MathXL. Both the control and treatment groups were taught the same objectives and received instruction two days a week for 75 minutes per day.

Mathematics achievement was measured by a comprehensive final exam that

served as a pre-test and post-test. Achievement data were collected prior to any treatment and at the end of the study. Students' attitudes toward mathematics were measured both pre-survey and post-survey using the Attitudes Toward Mathematics Inventory (ATMI). Analyses of Covariance ANCOVA were used to determine whether there were significant differences in attitudes in the control and treatment groups and significant differences in achievement in the control and treatment groups, while controlling for pre-ATMI survey and pre-test scores. A correlation was used to determine whether there was a significant relationship between student achievement in mathematics and students' attitudes toward mathematics.

Results of the statistical analysis on pre- and post-ATMI surveys indicated a statistically significant difference in students' attitudes toward mathematics between the control and treatment groups. Students in the traditional lecture group had significantly higher attitudes than students in the computer-based classes. ANCOVA results of the pre- and post-tests showed no significant difference in achievement between the control and treatment groups. Results of the correlation showed a significant relationship between attitude and achievement in the traditional lecture control group.

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December 2010

DEDICATION

I dedicate this dissertation to my family. To my amazing parents, thank you for your unconditional love and for cultivating my fascination with science, mathematics, art and music at an early age. Your love of wisdom and standard of academic excellence inspired my academic pursuits and gave me the drive to achieve my goals. To my brother, Reuben, thank you for enduring the many hours of pretend school throughout our childhood in which you were the pupil in my imaginary classroom. To Kasey and my nephew, Raiden, thank you for your understanding as I sacrificed precious family time for this doctoral degree. Thank you all for sharing my pride and excitement in this endeavor. I would not be the person I am today without your love and support. Your unwavering faith in me gives me the strength and confidence to accomplish anything. I am grateful to you all, and I love you very much.

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TABLE OF CONTENTS

CHAPTER

           Statement of the Problem
           Purpose of the Study
           Research Questions and Hypotheses
           Assumptions
           Delimitations
           Definition of Terms
           Justification of the Study

           Active Learning
           Technology in Mathematics Education
           Computer Based Instruction and Achievement
           Attitudes and Achievement in Mathematics

           Research Design
           Participants
           Instrumentation
           Procedure
           Data Analysis

           Descriptive Statistics
           Inferential Statistics
           Summary

Summary
Discussion of Major Findings
Limitations
Recommendations

LIST OF TABLES

Table

CHAPTER I

INTRODUCTION

The declining number of students obtaining degrees in science, technology,

engineering, and mathematics (STEM) disciplines while there is an increased demand for

graduates with solid skills in math and science is a major issue in our society (Jacobs,

2005; Omdal et. al. 2006; Thiel, Peterman, & Brown, 2008). Many researchers attribute

this problem to poor performance in math and science at the elementary and secondary

school level (AAAS, 1990; Battista, 1999). The U.S. Department of Education (2004)

reported that more than 40% of four-year college students were placed in remedial

courses, and over 60% of two-year college students tested into developmental courses.

As these students enter college as freshmen, 22% of them are placed in developmental

and remedial mathematics courses (Thiel, Peterman, & Brown). Furthermore, less than

half of the students who initially major in STEM disciplines actually graduate and receive

a degree in a STEM field, according to Thiel, Peterman, & Brown. The "nation's report

card" and international studies like the TIMSS show that the United States now has

serious competition from other countries. How can educators improve student

achievement in the STEM disciplines in order to produce more college graduates in the

fields of math and science?

College students' success is certainly dependent on many factors. Low

achievement in pre-requisite, introductory college courses like College Algebra presents

a major obstacle, often delaying the anticipated date of graduation. Students who place in

developmental math courses are delayed even longer and are less likely to graduate

(USDE, 2004). Success in the core requirements in math and science is crucial for the

overall success of students having the goal of obtaining any undergraduate degree, but especially a degree in a STEM discipline. As a result, there have been calls for reform in the way math and science are taught (AAAS, 1993; NRC, 1996a).

The fall semester of 2009 saw record enrollment at two-year and four-year institutions of higher learning across the nation (USDE, 2009). Since approximately half of the students entering college will not be prepared for college-level work, and past trends have shown that a large number of these underprepared students fail the remedial classes making them more likely to drop out of college, it is crucial that educators try something new and better in the remedial courses if President Obama's goal of producing more college graduates is to have an honest chance (Carey, 2009). It is imperative that educators get on board with serious comprehensive reform and redesign efforts to transform developmental and introductory mathematics courses in order to battle the high attrition rates and improve student advancement toward a degree.

In the recent past, math departments have tweaked their lecture courses, retaining the traditional lecture component while adding a computer lab component, with little or no success in boosting achievement or course completion. Introductory math courses, that is, the gateway courses required for most majors, are problematic because the majority of students are uninterested, unprepared, or fearful of failure due to unpleasant experiences in high school mathematics (Thiel, Peterman, & Brown, 2008; Twigg, 2005). These issues are amplified as students entering these courses are re-taught the same content from their high school math classes by the same type of traditional teaching methods that were unsuccessful during the early years, resulting in introductory math courses impeding student progress and retention (Ball, 1993; Duranczyk & Higbee 2006;

Thiel, Peterman, & Brown, 2008; Twigg, 2005). The main reason for the high failure rates in the traditional lecture mathematics classes is because students do not actually get enough practice with the math problems. Students do not learn math by passively listening to lectures; students learn math by doing math (Twigg, 2005).

There is ample research suggesting that student learning and achievement increase significantly when material is presented in an active learning environment as compared to that of a traditional lecture method in which the learning environment is passive (Bonwell & Eison, 1991; Moore, 1996; NCTM, 1989; NRC, 1996b; Prince, 2004; Yoder & Hochevar, 2005). Driscoll (2002) insists upon the vital importance of actively involving learners in activities so that students are able to build new knowledge structures by connecting already familiar concepts to new ideas so that meaningful learning experiences may occur. An active learning environment accommodates various learning styles, boosts student achievement, and improves student attitudes (Astin, 1985; Ma, 1997).

Learning is a social process just as it is an active process. Schoenfeld (1992) insisted that "mathematics is inherently a social activity" (p. 335). The influential cognitive psychologist Piaget (1976) discussed the social aspect of learning and asserted "social interaction is a necessary condition for the development of logic" (p. 80). According to Prince (2004), active learning is generally defined as "any instructional method that engages students in the learning process" which introduces active learning activities in the classroom to involve students in tasks that facilitate meaningful learning and make them responsible for their own learning (p. 1). McKinney (2008) cites Bonwell and Eison (1991) to describe an active learning environment as one in which:

Students are involved in more than listening, less emphasis is placed on

transmitting information and more on developing students' skills, students are

involved in higher-order thinking (analysis, synthesis, evaluation), students are

engaged in activities (e.g., reading, discussing, writing), and greater emphasis is

placed on students' exploration of their own attitudes and values. (p. 2)

A math emporium, made popular by the National Center for Academic

Transformation, facilitates an active learning environment in contrast to traditional

lecture (Carey, 2009; Twigg, 2005). In an Emporium Model, the traditional classroom

lecture meetings are completely replaced with a student learning resource center

equipped with computer workstations with instructional software. The students use the

instructional software to actively participate in doing math rather than passively listen to

lectures about doing math. The instructional mathematics software provides the students

with resources such as videos, interactive tutorials, online practice problems, quizzes and

tests in order to address visual, auditory, and discovery-based styles of learning.

Mathematics instructors and tutors are available to help students individually as needed

during class time in the computer lab setting. Students are allowed to work in

cooperative learning groups. The instructional software gives students immediate

feedback as they solve math exercises and have at their disposal guided examples of the

exercises when they get an incorrect answer (Twigg, 2005).

The redesigned math course that adheres to the Emporium Model is built around a

mastery learning approach. Students may access the homework exercises in the course at

any time or place, but the course is not self-paced. Students are required to progress

through the course according to a schedule implemented by the instructor and master the

homework set, quiz, and test in each learning module before proceeding to the next module. It is recommended that attendance in lab is a requirement. Regular practice and low-stakes quizzes and tests with instant feedback reinforce student learning outcomes and allow students to proceed successfully through the course (Twigg, 2003).

Many studies have been conducted to analyze the effect of technology-enhanced learning on student achievement in mathematics. Many of these studies retained some or all of the traditional lecture component while supplementing the course with a lab component requiring completion of computer-based homework using instructional software (Twigg, 2005). According to Twigg (2005), these studies typically have shown that rather than improving student learning and achievement, most of these courses yielded no statistically significant improvement compared to the traditional style course.

There is a need to examine how courses that are redesigned based on the Emporium Model will affect student achievement in mathematics compared to traditional mathematics lecture courses. In addition to comparing the different learning environments, it is also important to consider the attitudes and perceptions toward mathematics under both traditional and emporium models and how student attitude toward mathematics relates to mathematics achievement (Ma & Xu, 2004). This research examines the effect of redesigned developmental and introductory mathematics courses using the Emporium Model on student achievement and attitudes. The researcher investigated if there is a relationship between math courses conducted in a computer lab setting, achievement, and attitude toward mathematics.

Statement of the Problem

It is widely held that an active-learning, student-centered environment is superior to a passive, traditional lecture, teacher-centered environment. However, the concept of the Emporium Model is fairly new, given that teachers have been very reluctant to give up their lecture method of teaching. So far, results of Emporium Model studies have been impressive (Rouse & Trigsted, 2005; Thiel, Peterman, & Brown, 2008; Twigg, 2003, 2005, 2009), but there is still much to learn and much to add to the existing body of literature. There is also a need to study the relationship between math achievement and attitudes toward mathematics as results have been inconsistent. Tapia and Marsh (2004) explain that results of the research on attitude toward mathematics were obtained from instruments that were developed before contemporary statistical standards. Thus, most of the dated instruments would not hold up to a confirmatory factor analysis. According to Tapia and Marsh (2002), during the past several years, reform efforts in mathematics education have been reduced to debates concerning constructivist or traditional teaching methods, professional development, use of various instructional materials, and ordering of courses in mathematics curricula. Very little attention has been given to the study of student attitudes toward mathematics. The problem examined in this research is whether there is a relationship among instructional strategies, attitudes, student achievement in mathematics.

Purpose of the Study

The purpose of this quasi-experimental study was to determine the effect of computer-based instruction on student mathematics achievement and attitudes toward

mathematics in developmental and introductory mathematics courses, namely Elementary

Algebra, Intermediate Algebra, and College Algebra, at a community college. This

investigation also sought to determine if a relationship between attitudes and achievement

existed. The researcher obtained permission to conduct research from the community

college administrator (see Appendix A).   The study involved one independent variable -

Instructional Format. The study involved two dependent variables. One dependent

variable was Student Achievement and was measured by differences in pre-test scores

and post-test scores using a Beginning Algebra comprehensive final exam (see Appendix

B), an Intermediate Algebra final exam (see Appendix C), and a College Algebra final

exam (see Appendix D) for each corresponding course. The post-tests for each course

consisted of the same type of questions as the pre-tests. The post-tests for the computer-

based treatment group were computerized versions of the Beginning Algebra

comprehensive final exam, Intermediate Algebra final exam, and College Algebra final

exam. The computerized post-tests consisted of the same type of questions as the paper

and pencil post-test for the control group.

The other dependent variable is Student Attitude and was measured by differences

in pre-test scores and post-test scores collected from a survey instrument called the

Attitudes Toward Mathematics Inventory (ATMI) developed by Martha Tapia of Berry

College (see Appendix E). The goal of this research is to determine whether computer-

based instruction improves student achievement and attitudes toward mathematics.

Research Questions and Hypotheses

This study determined the effect of computer-based instruction on student

mathematics achievement and attitudes toward mathematics in developmental and

introductory mathematics courses, namely Elementary Algebra, Intermediate Algebra, and College Algebra, at a community college in the South. The following research questions were investigated:

1. What is the effect of computer-based instruction on student achievement in developmental and introductory college mathematics courses compared to traditional instruction?

2. What is the effect of computer-based instruction on student attitudes toward mathematics in developmental and introductory college mathematics courses compared to traditional instruction?

3. What is the relationship between attitudes and achievement for students in developmental and introductory college mathematics courses?

A quasi-experimental design was used to investigate the research questions. Statistical testing was performed on the following hypotheses:

1. Hypothesis I: There is a significant difference in student achievement as measured by a comprehensive final exam post-test between the traditional class students and the computer-based class students while controlling for pre-test achievement.

2. Hypothesis II: There is a significant difference in student attitudes toward mathematics as measured by the four subscales (self-confidence, value, enjoyment, and motivation) from the ATMI survey between the traditional class students and the computer-based class students while controlling for pre-test attitudes.

3. Hypothesis III: There is a significant relationship between student attitudes toward mathematics and student achievement in mathematics.

Assumptions

1.   The participants provided honest responses to survey instrument questions.

Delimitations

1.   Participants in this study were limited to those students who enrolled in one of 6
     mathematics courses taught by the researcher, specifically one Elementary
     Algebra section, two Intermediate Algebra sections, and three College Algebra
     sections at a community college in southern Mississippi.

2.   The study was limited to the spring semester of 2010.

3.   Computer-based instruction was limited to using the online instructional software
     package MathXL.

4.   Emporium model computer-based instruction was used for the first time at this
     community college in three courses, namely, one Elementary Algebra section, one
     Intermediate Algebra section, and one College Algebra section.

5.   Analysis of the data in this study can disaggregate Intermediate Algebra from
     College Algebra as ancillary findings.

Definition of Terms

1.   *Achievement* - Measured by differences in pre-test scores and post-test scores,
     using comprehensive final exams for both pre- and post-tests for each traditional
     and computer-based course section of Elementary Algebra, Intermediate Algebra,
     and College Algebra .

2.   *Attitude* – Feelings and emotions toward mathematics including confidence,
     value, enjoyment, and motivation (Tapia & Marsh, 2002).

3. *Computer-based instruction* – Based on the Emporium model popularized the National Center for Academic Transformation (NCAT). The classroom lectures were replaced with a learning resource center where courses are organized into 10 to 12 modules of weekly assignments, and students test each week for mastery of content. The students were required to use the instructional software package MathXL to watch online video tutorials on the content modules, make notes on the provided study guide outline, and then work the homework on MathXL. After completing the module homework, students took the module quiz and test. Students received instantaneous feedback on all homework, quizzes, and tests and are required to master the content in each module before moving forward. If the students did not master the material, they received more help and did more work until they earned at least 70% on each homework set, quiz, and test. Students were required to take quizzes and tests in the presence of the instructor during lab. Students had unlimited attempts on homework and were allowed to retake the quizzes to improve their scores. If a student did not pass a test with 70%, then the student had to seek help from the instructor before taking the test again. On-demand, individual help for students from the instructor or peer tutors was available during lab. Students were permitted to work in small groups on the homework to promote an active learning environment through interactive and cooperative learning. Attendance was required and graded based on attending labs and by completing at least one module per week. As part of their attendance grade, students had to show their notes to the instructor before testing. Students in the treatment group received computer-based instruction.

4. *Technology* – In the context of this study, technology refers to computers used to access the online instructional software package MathXL.

5. *Traditional instruction* – Instruction in which course content is delivered by lecture in a face-to-face classroom setting in which students listen passively and take notes. Homework was assigned and graded. Quizzes and tests were administered in class throughout the semester after completion of each unit. Students in the control group received traditional instruction.

Justification of the Study

This study was conducted in order to determine whether the emporium model computer-based learning is an appropriate and effective way to redesign the learning environments of developmental and introductory mathematics courses to improve student achievement. Record enrollment at two- and four-year institutions and unchanging high failure rates in remedial courses as well as gateway courses demonstrate the necessity to drastically redesign these courses. Past modification of these courses by simply supplementing with technology has made very little progress. The advancements in technology and instructional software make substantive redesign efforts possible. Enhancements to developmental and introductory mathematics can be carried out with greater ease. Information obtained from this research will help educators and administrators of two- and four-year institutions in planning and implementing a course redesign to boost student achievement in mathematics. If a relationship is found between attitudes and achievement under the redesigned computer-based instructional setting, this may assist college officials with retention and graduation rates. Therefore, findings from

this research may lead to improvement in student achievement in the STEM disciplines in

order to produce more college graduates in the fields of math and science.

CHAPTER II

REVIEW OF THE LITERATURE

This study is designed to determine the effect of computer-based instruction on student attitudes and achievement in mathematics. Several areas of the research literature will be investigated to provide a context for this study. First, the literature on active learning will be examined to provide clarification on what active learning entails and strategies that have been found to be most successful.   Second, research literature on the use of technology in mathematics education will be explored. Third, some of the literature on attitudes toward mathematics will be investigated. This review will allow me to show some areas where little research has been done and how this study fills a gap in the existing literature.

Active Learning

Definition of Active Learning

Thiel, Peterman, & Brown (2008) insist that "The essence of math is doing math, rather than passively listening," (p. 2). The active leaning strategies that will be used in this study are based on a social constructivist view of learning. Battista (1999) says that scientific research in mathematics education supports the constructivist view of mathematical learning that ideas must be constructed by the learners as they grapple with making sense of the concepts by collaborating with other students and the teacher.

While traditional lecture remains the typical method of instruction in the educational system, active learning is gaining popularity among educators searching for alternative methods of teaching (Prince, 2004).   According to Prince (2004), active learning is generally defined as "any instructional method that engages students in the

learning process" which introduces active learning activities in the classroom to involve

students in tasks that facilitate meaningful learning and make them responsible for their

own learning (p. 1). Bonwell and Eison (1991) describe active learning strategies as

involving learners in doing more than just passively listening to lectures and thinking

about activities in which they are participating. Bonwell and Eison (1991) to describe an

active learning environment as one in which:

> Students must do more than just listen: They must read, write, discuss, or be
>
> engaged in solving problems. Most important, to be actively involved, students
>
> must engage in such higher-order thinking tasks as analysis, synthesis, and
>
> evaluation. Within this context, it is proposed that strategies promoting active
>
> learning be defined as instructional activities involving students in doing things
>
> and thinking about what they are doing. (p. 2)

Bonwell and Eison argue that it is critical to facilitate an active learning environment

because the impact on student learning is substantial. However, traditional lecture is the

most commonly used teaching strategy and the method most familiar to educators

(Bonwell & Eison; Ebert-May, Brewer, & Allred, 1997; Prince). Instruction via

traditional lecture involves dissemination of information by the teacher while the learner

listens silently and passively to lectures in a teacher-centered classroom environment in

which interaction between the teacher and students is limited during the class session

(Smith, 1996; Thiel, Peterman, & Brown, 2008; Yoder & Hochevar, 2005).

Bonwell and Eison (1991) suggest that many educators are under the

misunderstanding that "all learning is active and therefore students are actively involved

while listening to formal presentations in the classroom" (p. 2). Yoder and Hochevar

(2005) assert that the thing that makes active learning inherently active is "the cognitive processing demanded to find patterns in the material, organize these patterns into meaningful clusters, understand the usefulness of the knowledge, and retrieve it fluently" (p. 91). Learning is a constructive process and requires both teacher and students to actively participate in the learning process (Ebert-May, Brewer, & Allred, 1997).

Miller and Cheetham (1990) assert that there is typically modest long-term retention of information with low student interest in courses employing a traditional lecture format. Halpern et al. (1994) argue that "learning rarely, if ever, occurs passively" and notes that "educators and cognitive psychologists realize that effective instruction focuses on the active involvement of students in their own learning, with opportunities for teacher and peer interactions that engage students' natural curiosity" (p. 11). Mintzes, Wandersee, and Novak (2005) contend that methods of instruction ought to promote "active participation and substantial interaction among teachers and learners" (p. 50). Active learning is an effective instructional approach in most any setting from first grade though graduate school, asserts McKinney (2008).

Issues with Interpretation of Literature on Active Learning

Prince (2004) discusses problems in determining which instructional method has the most impact, given the variety of instructional methods that are encompassed by the notion of active learning. He suggests that even the language used by various authors as interpreted by readers can result in problems of ambiguity. He says that many teachers feel strongly that students in a traditional lecture classroom are actively engaged in the learning process as they take notes, listen to the lectures, and attempt to comprehend the content of the topic.

Prince (2004) also suggests that it can be very difficult to measure some of the important learning outcomes, particularly the higher-level learning, when attempting to ascertain what method of instruction is actually effective. He also makes note of the tendency of supporters of active learning to report or cite increases in student achievement or attitude while neglecting to mention that the increase may be very small (2004). Smith (1996) also notes that it much easier to get quantitative feedback from students than to measure higher-order learning resulting from a given instructional method.

<div align="center">Technology in Mathematics Education</div>

Technology permeates every facet of our society. Cellular phones, text messaging, and email are primary means of communication for adults and children alike. National and international companies communicate and conduct business by satellite. Most new automobiles and other means of transportation come equipped with tracking systems and GPS technology. Undergraduate and graduate degrees may be completed with no face-to-face interaction between students and faculty. Everyday life is infused with technology, and the realm of education is no exception. When used appropriately, educational technology can have an immense impact on students, instructors, and administrators in our system of education.

There are differing views on what exactly educational technology entails, and four major perspectives will be discussed in this section. This first perspective defines educational technology as media and audiovisual communications. Advocates of this particular viewpoint, such as the Association for Educational Communications and Technology, consider technology as an alternative means to transfer information from

teacher to student. This perspective emphasizes the use of films, slides, and videos instead of books and lectures as a more effective way of conveying information (Roblyer, 2006).

The second perspective considers educational technology as instructional systems and equates educational technology with solutions to educational problems. Organizations such as the International Society for Performance Improvement focus on developing efficient systems of instruction and training using both teachers and technology. This approach has received criticism for its lack of flexibility and inability to promote higher-order thinking (Roblyer, 2006).

The third perspective views educational technology as technology education or vocational training. The International Technology Education Association is an example of an organization that advocates teaching technology using hands-on experiences within the context of mathematics, science, and other disciplines and focuses on improving technological literacy in order to prepare students for the workforce (Roblyer, 2006). The fourth perspective, as advocated by the International Society for Technology in Education, considers educational technology as educational computing or computer systems used to support administrative and instructional personnel. These computer systems help educators in both K-12 and higher education classrooms use technology to aid instruction (Roblyer).

Benefits of Using Educational Technology

When technology is used appropriately in an educational setting, it can provide many benefits for students and teachers. It can provide novel ways for the student to study and educators to expand their instructional methods. For example, technology used

in mathematics education can expand the range of the math content and problem situations that were previously beyond the grasp of students and facilitate higher-order learning such as posing problems, solving problems, and making decisions by using tools for computations and visual illustrations (NCTM, 2003).

Technology also gives teachers new ways to incorporate active learning into their instructional strategies in order to address different learning styles. Students can learn at their own pace by using educational software. Higher level students need not wait on the rest of the class to proceed to the next topic and lower level students may get the extra bit of time to understand the material. This educational software can also provide supplemental activities for students that would be difficult to include otherwise (Roblyer, 2006). Students are able to visualize concepts that are generally difficult to understand without using interactive software (Heide & Henderson, 1994). Abadir (1993) asserts that mathematics becomes useful to students when developed through a process in which the student has been engaged in order to create new understanding and proposes that students cannot learn mathematics successfully by only listening and mimicking the instructor.

Another benefit of using technology in education is its ability to motivate and engage students (Clements & Sarama, 2005). Students are so accustomed to living in an environment full of technology, whether from cellular phones, video games, television, or the Internet, and often are bored with the traditional classroom atmosphere. No wonder many students exhibit positive attitudes toward a classroom enhanced with technology. This type of classroom environment is more enjoyable and productive for both students and educators (Heide & Henderson, 1994). Students feel motivated when they can see

the relevance in the activities, and technology can provide an opportunity to apply classroom knowledge in their lives outside of the classroom.

Students living in this digital world expect to use technology at home and in the workplace, and therefore find educational activities that do not incorporate technology irrelevant to their lives. Students do not see the point in plotting a graph, performing computations, or writing papers by hand when they realize that the workplace will require technological literacy (Heide & Henderson). Allowing students to perform these activities using technology will give them more experience in using higher-order thinking and problem-solving, another demand in the workplace (Heide & Henderson, 1994).

Technology can provide students and educators with efficient ways to become more productive. Software is available that assists teachers with grading and gives students instant feedback (National Research Council, 2000). Using technology also saves time and money. Electronic submission of assignments can be very cost-effective and environmentally friendly by reducing the amount of paper consumed. Time is no longer an issue in getting information to teachers and students as online textbooks allow immediate access to information in the event of limited library access (Roblyer, 2006).

Using technology in classrooms will enable students to become technologically literate in order to be successful in today's society (Roblyer, 2006). Without this knowledge and ability to use technology, students will be dreadfully unprepared for life after school. It is also critical that students are able to not only find information, but be able to analyze and use it in their field (Roblyer). Another area of necessity is student interpretation of visual or graphical images rather than text only. Exposure to various

types of technology in the classroom will give students the tools necessary to adjust and find success in this age of technology (Roblyer).

Issues Surrounding Educational Technology

The primary issue that has shaped the use of technology in education is the standards movement which holds teachers accountable for their students' learning and emphasizes using technology to help teachers and students meet the requirements of the standards (Roblyer, 2006). Funding is another top issue in using technology in education. It becomes more and more difficult to justify spending educational funds on technology as the cost of technology rises and funding for education dwindles (Roblyer). A related issue with regard to funding and expenses surrounding educational technology is that school officials must use precious funds to protect school computers from computer viruses and hackers (Roblyer).

Economic, racial, and gender equity are other issues impacting the use of technology in education. Minority students from poor backgrounds are less likely to have computers and Internet access at home and school than other students while white males use computers more and enter careers in math, science, and technology at higher rates. It is the hope of many that the socioeconomic and gender divides will diminish with continued efforts to provide students with access to computers, Internet, and other technology in the classroom (Roblyer, 2006). It is not feasible to make everyone happy, and there will always be negative comments regarding the use of technology in education, but the issues must be addressed and resolved as much as possible in order to continue to improve our educational system.

Learning Motivated by Educational Technology

Learning through the use of technology is consistent with the constructivist theory

of learning, that is, students learn by doing. Students build on the knowledge they

already possess to construct new knowledge (National Research Council, 2000).

Learning is also contextual and technology provides an opportunity to include authentic

activities. Students are able to explore and investigate problems in real life situations

which aids in the transfer of information (National Research Council, 2000). Use of

technology in an educational setting promotes active learning. Students are actively

engaged in each activity and are interested in the learning experience. When technology

is employed, students do not sit passively while the teacher does everything (Wetzel,

2004). Rather, it is an environment centered on the student and not the teacher. This

type of learning environment promotes critical thinking. Students can collect, organize,

and evaluate information through simulations with interactive software (Wetzel). There

are countless possibilities for using technology as a tool to enhance learning. Students

are presented with many opportunities to take control of their own learning in a

technology-enhanced environment.

Limitations to Educational Technology

Technology has the power to enhance instruction, but it is certainly not without its

limitations. Teachers can be the greatest impediment to technology implementation in

the classroom. Many teachers bring into the classroom their own ideals of how

instruction should be carried out (Liljedahl, Rolka, & Rosken, 2007). Many veteran

teachers maintain a traditionalist standpoint, and the use of technology does not sit well

with their ideas. But in order to comply with the aims of the NCTM's *Principles and*

Standards for School Mathematics (2000), teachers must shift toward a less traditional,

more inquiry-based style of teaching (National Research Council, 1996b). This can easily be accomplished using technology. For teachers to adapt to using technology to teach, they must shed their old ideas and assumptions of how mathematics should be taught (Wetzel, 2004). Obviously, this will not happen quickly, but perseverance and training can help teachers learn to use technology efficiently for instruction.

Despite the technology's potential to enhance instruction, it is useless if teachers do not know how to use it. It is essential that teachers receive ongoing training on any technology they are expected to use in class (Wetzel, 2004). This is extremely important to both pre-service teacher education programs as well as practicing teachers (Wetzel). They must be given the opportunity and time to become familiar with the equipment before they use it in the classroom. Without appropriate training, many teachers lack the confidence to be successful at using technology (Wetzel).

Teachers are not the only obstacle in using technology in education. Budgets constrain many schools from incorporating the technology that is needed to improve education (Roblyer, 2006). With technology prices on the rise, it becomes more important for schools to make educated decisions on the types and quantity of technology purchased (Heide & Henderson, 1994). Money is a determining factor for many schools (Roblyer). The race, gender, and wealth gap remains between students (Sadker & Sadker, 2000). Leaders in education must strive to provide all students with access to technology and not just the students from higher income families (Anderson, 2007). School should not exacerbate inequity; rather, schools should encourage diversity and fair treatment of all students.

Discussion of Educational Technology

Our world is constantly changing with advancements in technology. It is only reasonable that the educational system change with it. Employees on the job will be expected to use word processing, reasoning and critical thinking skills (Heide & Henderson, 1994). If students are not taught to use these skills on a day-to-day basis in everyday life as well as in the classroom, they will go out into the world unprepared to cope with the expectations of technological literacy. Technology offers a variety of benefits for our educational system that are not limited to raising test scores. Students arrive in the technological classroom with a new attitude and eagerness to learn (National Research Council, 2000). New, innovative technology gives teachers the capabilities to implement lessons that can reach part of the student's brain that are typically exercised only through video games. The smallest technology sparks interest, and learning is now fun for students (Wetzel, 2004).

Research on educational technology acknowledges that student motivation and attitudes definitely reflect improvement when technology is used in the classroom (Clements & Sarama, 2005). Evidence is not as conclusive in evaluating the degree of knowledge attained (Veronesi, 2004). Research does not offer much evidence to support the idea that technologically enhanced classrooms lead to improved student achievement on standardized tests or a deeper understanding of subject matter (Sadker & Sadker, 2000). The pertinent question is whether these test scores really reflect learning. Standardized testing is a countrywide topic of debate associated with the No Child Left Behind legislation. Technology promotes constructivist learning (Wetzel, 2004). Learning via constructivist methods is difficult to assess whereas traditional standardized tests are easier to assess (Veronesi). Traditional, standardized tests overemphasize

recalling of facts and fail to measure the higher-order thinking skills on which technology is believed to impact (Veronesi). Thus, society must look to teachers to get a true assessment of the impact of technology in the classroom.

<center>Computer-Based Instruction and Achievement</center>

The use of computers and interactive instructional software in curriculum redesign efforts has dramatically increased as educators seek to find innovative ways to improve student learning and achievement. Web-based instructional software programs can be used as a supplement to teaching or as the primary mode of instruction (I CAN Learn® Education Systems, 2006; MathXL; MyMathLab, 2010).   These programs are accessible to anyone with an internet connection. Based on student performance on a diagnostic test, these web-based programs have the capability to provide individualized student assessment and develop a plan of study according to content already mastered by the student. These software programs are designed with applications such as animations and video lectures that will provide the student with instruction on the lesson, randomly generated homework exercises for practice and test questions for assessment (MathXL, 2010; MyMathLab, 2010). Heid (1997) suggested that computer technology attends to students' cognitive realms as amplifiers and reorganizers. These amplifiers and reorganizers, such as MathXL, MyMathLab, I CAN Learn® Math, provide alternative forms of delivering course content, and the instructor may choose to implement the program as a supplementary or primary mode of instruction.

Some research shows that student achievement increases as students actively engage in the learning process and interact with the content of the subject, and students show more interest in mathematics with increased use of computers in the classroom

(Florence, 2003; Griffin, 2008; Love, 2004; Nguyen, 2002; Thompson, 2004; Wighting, 2006). Compared to students who had minimal experience in the classroom, students who frequently used computers in the classroom exhibited increased motivation for learning. Maki and Maki (2003) investigated the differences between techniques of computer based instruction and traditional instruction and reported that instructional technology leads to better student learning outcomes and increased interaction with the subject matter. This could be attributed to the ability of the computer program to provide instruction, practice and assessment while simultaneously increasing student engagement, tasks that an instructor of a traditional class must work hard to organize.

Other studies show that computer based instruction is no more or less effective as other modes of instruction (Brewer, 2009; Carter, 2004; Gesshel-Green, 1987; Hamm, 1989; Lewis, 1995; Martin, 2005; Scott, 1995; Spradlin, 2009; Wohlgehagen, 1992; Wright, 1989). A great deal of comparative research exhibits the 'no significant difference' phenomenon referring to results of studies that indicate that technologically enhanced courses are no more or less effective than courses taught by traditional instruction (Twigg, 2003).

<center>Attitudes and Achievement in Mathematics</center>

In the context of this research, attitude refers to feelings and emotions of an individual toward mathematics. As students grow older, they often exhibit an aversion to mathematics and the idea that math is irrelevant and unimportant, even those students who claim to like mathematics (Wilkins & Ma, 2003). Factors affecting student attitudes toward mathematics include anxiety, self-confidence, value as it pertains to usefulness,

enjoyment, motivation, parent and teacher expectations (Higbee & Thomas, 1999; Tapia & Marsh, 2004).

Nguyen (2002) studied student achievement and attitudes comparing traditional and computer based instructional designs using a sample of 95 sixth, seventh, and eight grade students. Half of the students were randomly assigned to the computer based group and the other half to the traditional group. According to Nguyen, the computer group used "web-based assisted learning and assessment" software which provided the students with immediate instruction and feedback with the opportunity to repeat homework exercises while students in the traditional group were given the option to resubmit homework sets though feedback was provided the next class meeting (p. 26). Students in the computer based group showed better attitudes toward mathematics, and interview data showed that students especially liked the instantaneous feedback provided by the web based computer software and felt that computer based math courses increase their confidence in solving math problems (Nguyen).

Martin (2005) compared the effects of cooperative computer-based instruction with individual computer-based instruction on high school students' attitude and achievement in mathematics. Both cooperative and individual computer based groups performed at the same level of achievement. The computer-based group that allowed students to work in cooperative learning groups exhibited significantly better attitudes than the computer based group that required students to work individually. Martin attributed the lower attitudes of the individual group to the possibility that these students may have felt isolated from their peers and lack of teacher support.

Love (2004) researched the effect of computer assisted instruction using the web-based computer assisted learning system ALEKS. The sample consisted of 46 undergraduate students in remedial mathematics courses. Results of this study showed improved competence in mathematics and positive increases in attitudes toward mathematics in the group that received computer based instruction.

White (1998) conducted a study on mathematics achievement and computer assisted instruction using Academic Systems computer software at a community college campus in Beginning Algebra, Intermediate Algebra, and College Algebra courses. Results showed a significant difference in students' attitude toward mathematics in the control (traditional instruction) group and treatment (computer based instruction) group. However, the attitudes toward mathematics significantly increased in the control group while the attitudes significantly decreased in the treatment group (White).

Kulik, Kulik, and Cohen (1980) conducted a meta-analysis of the results of 59 independent studies on the effects of computer-based instruction at the college level on student achievement and students' attitudes toward the subject matter and found that computer-based instruction had small, but significant positive effects on achievement and attitudes. Several years later, Kulik and Kulik (1991) conducted another meta-analysis of 254 studies and reported that computer-based instruction generally affects students in positive ways. They report that 34 studies investigated the effect of computer based instruction on students' attitude toward a given subject matter, and 20 of the studies showed attitudes were better in computer based classes versus the traditional classes. The other 14 studies reported negative effects associated with computer based instruction. Results among research have varied greatly with contradictory findings.

Tapia and Marsh (2004) note that even though there is a great deal of research literature on attitudes toward math available, most of this research focused on anxiety. Furthermore, much of the research is based on results obtained from instruments that were developed before current standards of statistical factor analysis, such as the Fennema-Sherman Mathematics Attitude Scale on which later research revealed that the validity and reliability of the instrument was questionable and the scales may not measure attitudes toward math as intended (Tapia & Marsh). Thus, research findings derived from questionable instrumentation may not be meaningful.

Student attitudes and achievement are typically high in elementary school when the introduction of material is slow and repetitious, but the attitude and achievement levels begin to fall as the curriculum content becomes more abstract (Ma & Xu, 2004). Former attitudes affect future attitudes. Former achievement affects later achievement. Ma and Xu found that achievement exhibited causal predominance over attitude in a longitudinal study to determine the causal relationship between attitude toward mathematics and achievement in mathematics using data from the Longitudinal Study of American Youth on secondary school students in grades 7-12. Former achievement predicted future achievement at a statistically significant level, but former attitude did not predict future achievement (Ma & Xu).

Even though the above studies found that the relationship between attitude and achievement was one-sided, findings by Schiefele & Csikszentmihalyi (1995) suggest that interest in mathematics and achievement in mathematics "mutually influence one another" in a study of student motivation that included 108 freshmen and sophomores from two suburban high schools (p. 177). The study examined the relationships among

mathematical ability, interest in math, achievement motivation, and the quality of experience when doing mathematics (Schiefele & Csikszentmihalyi). However, all participants in this study were chosen based on nominations by their teachers as being gifted and talented students, and the instrument used to measure interest was based on a single item in which students were asked to rate the "extent to which mathematics is their favorite subject" on a five point scale (Schiefele & Csikszentmihalyi, p. 166). Thus, the contradiction in the results of these studies mentioned above may be due to the fact that Schiefele and Csikszentmihalyi only looked at high-ability freshmen and sophomores from two Chicago high schools rather than the sample used by Ma and Xu that better represents the population of secondary school students.

Tapia and Marsh (2002) argue that achievement in mathematics is considerably influenced by personal beliefs about one's own mathematical ability, the value of mathematics, enjoyment of mathematics, and motivation to achieve success in mathematics. Schoenfeld (1985) asserts that development of mathematical understanding is influenced by student belief in mathematics. Anxiety toward mathematics may be a contributing factor to the lack of student desire to pursue careers in mathematics. Studies have shown that students achieve at higher levels when they enjoy and find value in mathematics, and low levels of achievement have been associated with a deteriorating attitude (Gottfried, 1985; Ma & Xu, 2004). Ruffins (2007) suggests that math anxiety may be alleviated by cooperative learning groups. He notes that working in groups provides a supportive social network, peer role models, and an opportunity for peer and self-assessment to make corrections without penalizing grades.

Conclusion

From the review of this literature, it is clear that technology can affect attitudes toward mathematics and achievement in mathematics. This investigation of the existing literature also revealed important gaps:

1. The majority of mathematics education research focuses on elementary and secondary school mathematics or mathematics on the university level, but not on the community college level.

2. Most research literature on educational technology in mathematics focuses on supplementing traditional lecture class with a technology component.

3. The literature examining attitudes toward mathematics looks at students on the secondary or university level in traditional classroom environments.

This research attempts to fill these gaps since this study focuses on students on the community college level, compares computer-based instruction to traditional lecture instruction, and investigates the relationship between attitudes and achievement of community college students in computer-based class setting. It is vital to find a more effective instructional environment for mathematics for the growing student populations that continue to require remediation in order for retention and graduation rates to improve. Duranczyk & Higbee (2006) insist that many students who are ready for college level work and meet college admission criteria still need remediation in mathematics. More studies need to be conducted to determine whether a fully computer-based instructional setting will improve attitudes and achievement in mathematics. This project is important because it seeks to add to the body of research in educational technology and its effect on attitudes and achievement in mathematics. The results of

this study may assist educators and administration in the redesign efforts of

developmental and introductory math courses in institutions of higher learning.

CHAPTER III

METHODOLOGY

The purpose of this study was to determine the effect of computer-based instruction on student mathematics achievement and attitudes toward mathematics in developmental and introductory mathematics courses, namely Elementary Algebra, Intermediate Algebra, and College Algebra, at a community college in south Mississippi. The study also examined the relationship between student achievement and student attitude toward mathematics under traditional lecture and computer-based instructional formats. This chapter contains a description of the research design, participants in the study, and instrumentation used in data collection as well as a discussion of the procedures that were used to collect and analyze data.

Research Design

A quasi-experimental design was used in this study since the participants were not randomly assigned to treatment and control groups, but selected based on the way the students enrolled in the classes. In this study, the independent variable was Type of Instruction (Computer-based or Traditional). The study involved two dependent variables. One dependent variable is Student Achievement and was measured by differences in pre-test scores and post-test scores, using a comprehensive final exam as both the pre-test and the post-test. The other dependent variable was Student Attitude and is measured by a survey instrument called the Attitudes Toward Mathematics Inventory (ATMI). The goal of this research was to determine whether computer-based instruction improves student achievement and attitudes toward mathematics. The following research questions were addressed:

1. What is the effect of computer-based instruction on student achievement in developmental and introductory college mathematics courses compared to traditional instruction?

2. What is the effect of computer-based instruction on student attitudes toward mathematics in developmental and introductory college mathematics courses compared to traditional instruction?

3. What is the relationship between attitudes and achievement for students in developmental and introductory college mathematics courses?

Participants

The sample consisted of 112 students enrolled in 6 sections of developmental and introductory mathematics courses taught by the researcher at a community college in south Mississippi in the spring semester of 2010. Participants were at least 18 years of age, and each course contained up to 30 students. All six courses in this study were taught by the researcher who is a full-time community college mathematics instructor and included one Elementary Algebra section, two Intermediate Algebra sections, and three College Algebra sections.

Instrumentation

The instrument that was used to determine Student Achievement in this study was a comprehensive final exam consisting of 30 open-ended items developed by the community college mathematics department according to Mississippi state-approved course objectives for Elementary Algebra, Intermediate Algebra, and College Algebra. The final exam served as the pre-test and post-test for each corresponding course. It has been standard practice at this community college for students in every mathematics

course to take a diagnostic pre-test that corresponds to the comprehensive final exam. Faculty create the diagnostic pre-tests and the comprehensive final exams to evaluate the same objectives, but the actual test items are different from semester to semester. Specifically, the test questions are scrambled and numerical values are randomly generated using test generator software.

The instrument used to measure student attitudes was the Attitudes Toward Mathematics Inventory (ATMI) developed by Martha Tapia of Berry College. Written permission was granted by Martha Tapia to use the ATMI instrument in this study (see Appendix F). The ATMI is a Likert scale survey containing 40 items. Students responded to survey items by indicating whether they *Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree*. This instrument measures four factors that relate to attitudes toward mathematics that include self-confidence, value, enjoyment, and motivation.

The ATMI was originally intended for use with American and Hispanic students to determine students' attitudes toward mathematics on the secondary level. The initial version of the ATMI developed by Tapia (1996) was a 49-item attitude survey designed to discover the factors that encompass attitudes toward mathematics and was used with a sample of 544 students at a bilingual private school in Mexico City. The instrument contained twelve reversed items. Tapia (1996) investigated six variables including value, anxiety, motivation, confidence, enjoyment, and adult perspectives in the development of the ATMI. The alpha reliability coefficient was 0.96 for the entire inventory.

To determine instrument reliability, Tapia (1996) used item-to-total correlations to decide which items to delete from the inventory to increase the value of alpha. With

item deletion criteria set at values less than 0.3, the items with a negative or low item-to-total correlation were deleted one by one until alpha no longer increased. After deleting nine of the weakest items from the survey, the reliability of the instrument increased to 0.97 which suggests good internal consistency and reliability for the revised 40-item ATMI.

Tapia (1996) established content validity by having two experienced mathematics teachers examine the ATMI survey items. Exploratory factor analysis established construct validity and identified a four factor structure as the best simple structure fit. Tapia and Marsh (2004) performed a reliability analysis and reported Cronbach alpha coefficients for the scores on each subscale that indicated that the instrument was reliable. Self-Confidence consisted of 15 items with a reliability of 0.95. Value consisted of 10 items with reliability 0.89. Motivation consisted of 10 items with a reliability of 0.89, and Enjoyment consisted of five items with a reliability of 0.88.

To determine whether the four subscales of the revised 40-item ATMI survey would be suitable for a college population and maintain similar statistical properties, Tapia and Marsh (2005) conducted a confirmatory factor analysis using 134 American undergraduate college students in mathematics courses at a state university in the Southeast. Chi-square goodness of fit, the root mean square error of approximation (RMSEA), the ratio of the Chi-square goodness of fit to the degrees of freedom, the normed fit index (NFI), and the expected cross-validation index (ECVI) were used to evaluate the fit of the four-factor model. Results of correlations of the subscales yielded a correlation value of 0.52 between Self-Confidence and Value, 0.75 between Self-Confidence and Enjoyment, 0.76 between Self-Confidence and Motivation, 0.63 between

Value and Enjoyment, 0.65 between Value and Motivation, and 0.81 between Enjoyment

and Motivation. LISREL8 was used to determine if the four factor model was adequate.

The Chi-square goodness of fit was 2.834 which was based on two degrees of freedom

with a probability 0.242, which indicated a good fit when the associated probability is

higher than 0.05. LISREL results indicated a goodness of fit index (GFI) of 0.99 with an

adjusted GFI of 0.94 since the GFI and adjusted GFI were greater than 0.90. The root

mean square error of approximation (RMSEA) was reported to be 0.056, suggesting a

good model fit when the RMSEA value is less than 0.06. The NFI was 0.99.

Tapia and Marsh (2005) validated the ATMI instrument and showed that the

subscales Self-Confidence, Value, Enjoyment, and Motivation are appropriate for use

with a population of college students by confirmatory factor analysis on the responses of

134 college students. Thus, the ATMI is a reliable instrument for data collection and is

appropriate for American college students. The overall Cronbach alpha coefficient was

calculated to be .97, and the standard error of measurement was 5.28 (Tapia & Marsh,

2004). Cronbach alpha coefficients were calculated for the 4 subscales and were found

to be .96 for self-confidence, .93 for value, .88 for enjoyment, and .87 for motivation

(Tapia & Marsh, 2005).

<div align="center">Procedure</div>

Data was collected using the Attitudes Toward Mathematics Inventory (ATMI)

survey and a comprehensive final exam as the pre-test/post test. The researcher obtained

permission from the Institutional Review Board of The University of Southern

Mississippi to conduct this research (see Appendix G). On the first day of class in each

of the six class sections after a brief discussion of the syllabus, the researcher distributed

informed consent statements to all students and explained the research and procedures to the participants. Students were informed that participation in this study was voluntary. Participants were informed that data for individuals that did not wish to participate in the study would not be used in the final data analysis. This research posed no foreseeable risks for participants. All student records were kept strictly confidential and no names were disclosed. Names do not appear anywhere in the research, but were only used to determine the post-test scores (final exam grade) for each student involved in the study.

Next, participants were given instructions to complete the ATMI pre-survey and the achievement pre-test. Participants were instructed to use a 10-digit number as a unique identifier on both instruments rather than their name so that the researcher could match their individual scores anonymously. This 10-digit number was to be composed of the last four digits of the student ID number and the 6-digit date of birth. The ATMI survey was administered first. Participants were given a survey questionnaire answer sheet and instructed to fill in the blank with the number corresponding to how they feel about each survey item according to the Likert scale: (1) *Strongly Disagree*, (2) *Disagree*, (3) *Neutral*, (4) *Agree*, (5) *Strongly Agree*. As soon as the participants completed the ATMI survey, they were asked to complete the pre-test. The pre-test was administered as a paper-and-pencil test to all six class sections on the first day of class prior to any instruction in order to determine the degree of prior knowledge of the participants. Throughout the semester, participants in both the treatment and control groups were taught the same course objectives and given the same types of questions on homework assignments, quizzes, and exams.

At the end of the 2010 spring semester, all six groups completed an ATMI post-survey and took a comprehensive final exam (post-test) with the same type of test items as the 30 questions from the pre-test. The only differences in the pre-test and post-test were the number values in each problem and the order of the test items. The post-test for the treatment group was administered on the computer using the MathXL instructional software, just as all other tests were administered in the treatment group. This was done in an effort to avoid confounding the results. The post-test items on the computer were the same types of problems that were on the paper-and-pencil post-test for the control group and the paper-and-pencil pre-test. These test items were pooled, and number values were randomly generated. The control groups took a paper-and-pencil post-test with the same type of problems on the paper-and-pencil pre-test in scrambled order and different number values.

Treatment Group

The treatment group consisted of one Elementary Algebra section, one Intermediate Algebra section, and one College Algebra section in which all three classes used computer-based instruction. At the beginning of the 2010 spring semester, each of the three classes in the treatment group completed the ATMI pre-survey and a paper-and-pencil pre-test that corresponded to the final exam for that specific course (Elementary, Intermediate, or College Algebra). Throughout the semester, the participants received course content via MathXL instructional software tutorials.

Students enrolled in these redesigned courses met in the computer lab two days each week for 75 minutes per class meeting. The classroom lectures were replaced with a learning resource center where courses were organized into 10 to 12 modules of weekly

assignments, and students tested each week for mastery of content. These class meetings consisted of individual and/or group work on the computer using MathXL to complete course objectives in a student-centered, active learning environment. Students spent the bulk of their time doing math problems.

Attendance was required in both lab meetings per week. As part of their weekly attendance grade, students completed one module containing a homework set, a quiz, a test, and had to show their notes to the instructor before testing. The instructor spoke with each student in the class during the class period to take attendance, assess student progress, and was available to give one-on-one assistance to students. The students were required to use the instructional software package MathXL to watch online video tutorials on the content modules, make notes on the provided study guide outline, and then work the homework on MathXL.

After completing the module homework, students took the module quiz and test. Students received instant feedback on all homework, quizzes, and tests and were expected to master the content in each module before moving forward. If the students did not master the material, they received more help and did more work until they earned at least 70% on each homework set, quiz, and test. Students took quizzes and tests in the presence of the instructor during lab. Students had unlimited attempts on homework and were allowed to retake the quizzes to improve their scores. If a student did not pass a test with 70%, then the student had to get help from the instructor before taking the test again. On-demand, individual help for students from the instructor or peer tutors was available during lab.

At the end of the 2010 spring semester, each of the three classes in the treatment group completed the ATMI post-survey and a computer-based post-test (comprehensive final exam) that corresponded to the final exam for that specific course (Elementary, Intermediate, or College Algebra).

Control Group

The control group consisted of one Intermediate Algebra section and two College Algebra sections in which all three classes used traditional lecture instruction. At the beginning of the 2010 spring semester, each of the three classes in the control group completed the ATMI survey and a paper-and-pencil pre-test that corresponded to the final exam for that specific course (Intermediate or College Algebra). Throughout the semester, the participants received course content strictly via lecture given by the instructor researcher in a face-to-face classroom.

This traditional lecture classroom environment was a passive, teacher-centered, learning environment. No computer component was required nor suggested. Students took notes during class and submitted homework assignments from the textbook for a grade. These homework exercises corresponded to problems in the computerized modules of the treatment group. The instructor gave quizzes and five unit tests throughout the semester. The problems on these quizzes and tests also corresponded to problems assigned to the treatment group on computer in MathXL. The students in the control group were given the same opportunity as the treatment group to correct homework assignments and re-take the quizzes before the test. If a student did not pass a test with 70%, then the student was given the opportunity to re-take the test. The student was given the opportunity to seek help from the instructor before taking the test again.

At the end of the 2010 spring semester, each of the three control group classes completed the ATMI survey and a paper-and-pencil post-test that corresponded to the final exam for that specific course.

Data Analysis

Data from the ATMI attitudes survey of all participants from the six course sections were compiled and descriptive statistics were calculated to determine the overall attitudes toward mathematics. Using the data from the pre-test and post-test exams, descriptive statistics were calculated to assess the overall achievement in the treatment group and the control group. Pre- and post-test scores were analyzed using Analysis of Covariance (ANCOVA) to determine whether the computer-based instruction improved student achievement in mathematics, using pre-test scores as a covariate to determine whether there were initial group differences. The attitude and achievement data from the treatment and control groups was analyzed using a correlation to determine whether there is a statistically significant relationship between attitudes and achievement in computer-based instruction. Statistical tests were performed using an alpha of 0.05 to determine significance.

CHAPTER IV

RESULTS

The purpose of this study was to determine the effect of computer-based instruction on student mathematics achievement and attitudes toward mathematics in developmental and introductory mathematics courses, namely Elementary Algebra, Intermediate Algebra, and College Algebra, at a community college. The study also examined the relationship between attitudes and achievement. The study involved one independent variable - Instructional Format. The study involved two dependent variables. One dependent variable was Student Achievement and was measured by differences in pre-test scores and post-test scores, using a comprehensive final exam to administer both pre- and post-tests. The second dependent variable was Student Attitude and was measured by differences in pre-test scores and post-test scores collected from a survey instrument called the Attitudes Toward Mathematics Inventory (ATMI).

The goal of this research was to determine whether computer-based instruction improves student achievement and attitudes toward mathematics. This chapter discusses the results of the quantitative data analysis on the achievement and attitudes of the control group (traditional lecture instruction) and treatment group (computer-based instruction). Descriptive and inferential statistics are reported, and decisions on the research hypotheses are presented.

Descriptive Statistics

Sample

The sample for this investigation consisted of 112 students enrolled in one of six courses taught by the researcher, specifically one Beginning Algebra section, two

Intermediate Algebra sections, and three College Algebra sections who completed both pre-test and post-test. Three of these sections, specifically one Beginning Algebra, one Intermediate, and one College Algebra, were redesigned courses which used a computer-based instructional format. The remaining three sections included one Intermediate Algebra and two College Algebra sections and were traditional lecture classes. The treatment group (computer-based instruction) was composed of 55 students, and the control group (traditional lecture instruction) consisted of 57 students.

Descriptive Analysis of Data

Attitude data were collected by a pre-survey in all six classes on the first day of each class in January of the Spring 2010 semester and a post-survey in all six classes on the last day of class in May just before the final exam post-test using the 40-item attitude survey (based on a 5-point Likert scale) called the Attitudes Toward Mathematics Inventory (ATMI). Achievement data were collected by pre-test and post-test in all six courses, using a 30-item comprehensive final exam (based on a 100-point scale) to administer both pre- and post-tests. The post-test for the treatment group was administered using the interactive software MathXL in the computer lab setting in the same fashion as all other assignments were completed over the course of the semester. The post-test questions for the computer-based courses were the same type of questions as the post-test for the traditional lecture courses. Both pre- and post-test consisted of 30 open-ended, non-multiple choice questions that were scored either correct or incorrect with no partial credit given. A detailed analysis of descriptive statistics was conducted on pre-and post-test achievement data and pre- and post-survey attitude data as measured by the 4 subscales: Self-Confidence (SC), Value, Enjoyment, and Motivation. The

minimum, maximum, mean, and standard deviation were calculated for control (Lecture) and treatment (Lab) groups and can be found in Table 1.

Table 1

Descriptive Statistics

	Format	*Minimum*	*Maximum*	*Mean*	*SD*
Pre-Test	Lecture	0	3	.29	.60
	Computer Lab	0	14	1.31	2.73
Post-Test	Lecture	0	27	12.26	6.79
	Computer Lab	1	27	12.16	7.33
Pre-SC	Lecture	1.00	5.00	3.30	1.05
	Computer Lab	1.07	5.00	3.15	1.11
Post-SC	Lecture	1.33	5.00	3.59	.96
	Computer Lab	1.13	4.80	3.14	.92
Pre-Value	Lecture	3.00	5.00	4.18	.51
	Computer Lab	2.30	4.90	4.16	.58
Post-Value	Lecture	3.30	5.00	4.32	.50
	Computer Lab	1.20	5.00	3.92	.72
Pre-Enjoy	Lecture	1.20	4.30	3.46	1.12
	Computer Lab	1.00	5.00	3.31	.93
Post-Enjoy	Lecture	1.50	5.00	3.70	.79
	Computer Lab	1.20	4.90	3.27	.87

Table 1 (continued).

	Format	*Minimum*	*Maximum*	*Mean*	*SD*
Pre-Motiv	Lecture	1.00	5.00	3.22	.96
	Computer Lab	1.00	5.00	3.18	.95
Post-Motiv	Lecture	1.00	5.00	3.54	.97
	Computer Lab	1.00	4.60	2.93	.86

Note. SD=Standard Deviation; SC=Self-Confidence. The Pre-Test and Post-Test Minimum, Maximum, and Mean values are based

on number of correct responses out of a total of 30 items. Pre- and Post-SC, Pre- and Post-Value, Pre- and Post-Enjoy, and Pre- and

Post-Motiv Minimum, Maximum, and Mean values based on a 5-point Likert scale.

Achievement

Student achievement was determined by comparing pre-test and post-test scores

of all participants in this study. According to Table 1, the pre-test scores for the control

group (Mean=.29, SD=.60) range from a minimum of zero correct to a maximum of three

correct on the pre-test while the treatment group (Mean=1.31, SD=2.73) range from a

minimum of zero correct to a maximum of 14 correct on the pre-test. Post-test scores for

the control group (Mean=12.26, SD=6.80) range from a minimum of zero correct to a

maximum of 27 correct on the final exam post-test while scores from the treatment group

(Mean=12.16, SD=7.34) range from a minimum of one correct to a maximum of 27

correct on the post-test.

Attitudes toward Mathematics

The minimum, maximum, mean and standard deviation were calculated for ATMI

pre-and post-survey responses on a 5-point Likert scale (1=*Strongly Disagree* to

5=*Strongly Agree*) for control and treatment groups using each of the 4 subscales Self-

Confidence, Value, Enjoyment, and Motivation. As shown in Table 1, pre-survey

responses under the subscale Self-Confidence for the control group (Mean=3.30,

SD=1.05) range from a minimum of 1.00 to a maximum of 5.00 while responses of the

treatment group (Mean= 3.15, SD=1.11) range from a minimum of 1.07 to a maximum of

5.00. Post-survey results for the Self-Confidence subscale reflect a minimum of 1.33 to a

maximum of 5.00 for the control group (Mean= 3.59, SD=.96) while responses of the

treatment group (Mean= 3.14, SD=.92) range from a minimum of 1.13 to a maximum of

4.80.

Value was the second subscale from the ATMI survey. Pre-Value responses from

the control group (Mean= 4.18, SD=.51) range from a minimum of 3.00 to a maximum of

5.00 while pre-value responses of the treatment group (Mean= 4.16, SD=.58) range from

a minimum of 2.30 to a maximum of 4.90. Post-Value responses from the control group

(Mean= 4.32, SD=.50) range from a minimum of 3.30 to a maximum of 5.00 while post-

value responses of the treatment group (Mean= 3.92, SD=.72) range from a minimum of

1.20 to a maximum of 5.00.

The third subscale analyzed from the ATMI survey was Enjoyment. Pre-Enjoy

responses from the control group (Mean= 3.46, SD=1.12) range from a minimum of 1.20

to a maximum of 4.30 while pre-enjoyment responses of the treatment group (Mean=

3.31, SD=.93) range from a minimum of 1.00 to a maximum of 5.00. Post-Enjoyment

responses from the control group (Mean= 3.70, SD=.79) range from a minimum of 1.50

to a maximum of 5.00 while post-enjoyment responses of the treatment group (Mean=

3.27, SD=.87) range from a minimum of 1.20 to a maximum of 4.90.

Motivation was the fourth subscale. Pre-Motivation responses from the control group (Mean= 3.22, SD=.96) range from a minimum of 1.00 to a maximum of 5.00 while pre-motivation responses of the treatment group (Mean= 3.18, SD=.95) range from a minimum of 1.00 to a maximum of 5.00. Post-Motivation responses from the control group (Mean= 3.54, SD=.97) range from a minimum of 1.00 to a maximum of 5.00 while post-motivation responses of the treatment group (Mean= 2.93, SD=.86) range from a minimum of 1.00 to a maximum of 4.60 on a 5-point Likert scale.

In all of the four subscales, the attitudes of the control group (Lecture) slightly improved when comparing pre-survey and post-survey means while attitudes of the treatment group (Computer Lab) slightly worsened as indicated by a decrease in mean values from pre-survey to post-survey.

<center>Inferential Statistics</center>

The purpose of this research was to determine the effect of computer-based instruction on student achievement and student attitudes toward mathematics and to investigate the relationship between attitudes and achievement. The independent variable was instructional format (computer-based or traditional lecture). The study involved two dependent variables. One dependent variable was student achievement and was measured by differences in pre-test scores and post-test scores, using a comprehensive final exam as both the pre-test and the post-test. The other dependent variable was student attitude and is measured by a survey instrument called the Attitudes Toward Mathematics Inventory (ATMI).

Pre- and post-survey scores were analyzed using Analysis of Covariance (ANCOVA) to determine whether the computer-based instruction improved student

achievement in mathematics and whether the computer-based instruction improved

student attitudes in mathematics, using pre-test scores as a covariate to determine whether

there were initial group differences. The attitude and achievement data from the

treatment and control groups was analyzed using a correlation to determine whether there

was a statistically significant relationship between attitudes and achievement in

computer-based instruction. Statistical tests were performed using an alpha of 0.05 to

determine significance. Three hypotheses were tested and decisions were made to reject

or fail to reject the hypotheses.

Testing of Hypotheses

The first two research hypotheses were tested using Analysis of Covariance

(ANCOVA) and the third hypothesis was tested using a correlation. The hypotheses

were as follows:

H_1:   There is a significant difference in student achievement as measured by a

comprehensive final exam post-test between the traditional class students and the

computer-based class students while controlling for pre-test achievement. As a

null hypothesis:

There is no significant difference in student achievement as measured by a

comprehensive final exam post-test between the traditional class students

and the computer-based class students while controlling for pre-test

achievement.

Results from the ANCOVA were $F(1,109) = .162$, $p = .688$ and indicate that there

is no statistically significant difference in student achievement between students in

traditional lecture classes and computer-based classes. The research hypothesis H_1 was

not supported and the decision was to fail to reject the null Hypothesis I. This suggests

that computer-based instruction neither helps nor hurts student achievement. When

considering the descriptive data, it appears that the participants achieved on the same

level, and this is reflected in the results of the ANCOVA. The adjusted means for the

traditional lecture control group (Adjusted Mean = 12.38) and the computer-based

treatment group (Adjusted Mean = 11.85) were virtually the same.

H_2:   There is a significant difference in student attitudes toward mathematics as

measured by the four subscales (self-confidence, value, enjoyment, and

motivation) from the ATMI survey between the traditional class students and the

computer-based class students while controlling for pre-test attitudes. As a null

hypothesis:

> *There is no significant difference in student attitudes toward mathematics*
>
> *as measured by the four subscales (self-confidence, value, enjoyment, and*
>
> *motivation) from the ATMI survey between the traditional class students*
>
> *and the computer-based class students while controlling for pre-test*
>
> *attitudes.*

Results from the ANCOVA on the 4 subscales were as follows: For the first

subscale Self-Confidence, the results were $F(1,107) = 7.25$, $p = .008$ and indicate that

there is a statistically significant difference in student attitudes with respect to self-

confidence between students in traditional lecture classes and computer-based classes.

However, the control group exhibited improvement in that the adjusted mean for self-

confidence of the lecture group (Adjusted Mean=3.50) is greater than that of the

computer lab treatment group (Adjusted Mean=3.19). This suggests that traditional

lecture instruction improves student self-confidence.

The results for the second subscale Value were $F(1,107) = 21.26$, $p < .001$ and

indicate that there is a statistically significant difference in student attitudes with respect

to value of mathematics between students in traditional lecture classes and computer-

based classes. Again, the control group exhibited improvement in that the adjusted mean

for value of mathematics for the lecture group (Adjusted Mean=4.33) is greater than that

of the computer lab treatment group (Adjusted Mean=3.91). This suggests that

traditional lecture instruction improves student value of mathematics.

The results for Enjoyment were $F(1,107) = 9.75$, $p = .002$ and indicate that there

is a statistically significant difference in student attitudes with respect to enjoyment of

mathematics between students in traditional lecture classes and computer-based classes.

As with first two subscales of self-confidence and value, the control group's enjoyment

of mathematics exhibited improvement in that the adjusted mean for enjoyment of

mathematics for the lecture group (Adjusted Mean = 3.65) is greater than that of the

computer lab treatment group (Adjusted Mean = 3.28). This suggests that traditional

lecture instruction improves student enjoyment of mathematics.

The fourth subscale was Motivation and the results of the analysis were $F(1,107)$

$= 24.35$, $p < .001$ and indicate that there is a statistically significant difference in student

attitudes with respect to motivation to pursue mathematical endeavors between students

in traditional lecture classes and computer-based classes. Just as lecture showed

improvement in the first 3 subscales, the control group's motivation exhibited

improvement in that the adjusted mean for motivation for the lecture group (Adjusted

Mean = 3.50) is greater than that of the computer lab treatment group (Adjusted Mean = 2.92). This suggests that traditional lecture instruction improves student motivation to pursue mathematical endeavors.

The research hypothesis H_2 was supported since results of the ANCOVA showed a statistically significant difference in student attitudes toward mathematics as measured by the four subscales (self-confidence, value, enjoyment, and motivation) from the ATMI survey between the traditional class students and the computer-based class students while controlling for pre-test attitudes. Thus, H_2 was supported. However, the goal of this research was to determine whether computer-based instruction improves student achievement and attitude toward mathematics, but the above results suggest that traditional lecture instruction improves student attitudes toward mathematics. When considering the descriptive statistics, the means of the computer lab treatment group attitude subscales slightly worsen from pre-survey to post-survey while the traditional lecture control group attitudes consistently improved across the four subscales at a statistically significant level.

H_3:   There is a significant relationship between student attitudes toward mathematics and student achievement in mathematics. As a null hypothesis:

> *There is no significant relationship between student attitudes toward mathematics and student achievement in mathematics.*

The results of the pre-treatment correlation show that there was no significant relationship between students' attitudes toward mathematics and student math achievement at the beginning of this study. Results also show that there is no significant relationship between post-treatment student math achievement and students' attitudes

toward mathematics in the treatment group using the computer-based instruction.

However, the results of the correlation reveal a statistically significant relationship

between post-treatment attitudes and achievement in the control group that used

traditional lecture as the instructional format. Table 2 presents the correlation results.

Table 2

Correlation between Attitudes and Achievement

Pre-Treatment Correlations		Post-Treatment Correlations		
All Groups Pre-Test			Treatment Post-Test	Control Post-Test
Pre-Confidence		Post-Confidence		
Pearson Correlation	-0.02		0.205	.322**
Sig. (2-tailed)	0.816		0.126	0.009
N	139		57	64
Pre-Value		Post-Value		
Pearson Correlation	-0.031		0.016	0.219
Sig. (2-tailed)	0.715		0.905	0.081
N	139		57	64
Pre-Enjoy		Post-Enjoy		
Pearson Correlation	-0.022		0.065	.300*
Sig. (2-tailed)	0.802		0.63	0.016
N	139		57	64
Pre-Motivation		Post-Motivation		
Pearson Correlation	0.047		0.059	.264*
Sig. (2-tailed)	0.584		0.664	0.035
N	139		57	64

*Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Correlation results indicate a statistically significant relationship between post-

survey attitude subscale Self-Confidence and post-test scores ($r = .32$, $p = .009$) and is

significant at the 0.01 level in the traditional lecture control group. There is also a significant relationship between post-survey attitude subscale Enjoyment and control group post-test achievement scores (r = .30, p = .016) and is significant at the 0.05 level. A third significant correlation resulted between post-survey attitude subscale Motivation and control group post-test achievement scores (r = .26, p = .035) and is significant at the 0.05 level. The hypothesis of a correlation between students' attitudes toward mathematics and student achievement in mathematics was supported and H_3 was accepted.

Summary

The statistical analysis indicated that the post-test attitude means of each of the four subscales of the control (traditional lecture) group were significantly higher than the treatment (computer-based instruction) group. However, there was no significant difference in the post-test achievement means of the control and treatment groups. The analysis also showed no significant relationship was found between attitudes and achievement in the sample prior to treatment and no significant relationship in the treatment group between post-test student achievement in math and students' attitude toward mathematics. The analysis revealed a statistically significant relationship between post-test attitudes and achievement in the control group.

CHAPTER V

DISCUSSION

The purpose of this research was to determine the effect of computer-based instruction on student mathematics achievement and students' attitudes toward mathematics in developmental and introductory mathematics courses, namely Elementary Algebra, Intermediate Algebra, and College Algebra, at a community college. The researcher also examined the relationship between attitudes and achievement. This chapter provides a summary of the study, discussion of the findings, and recommendations for future research.

Summary

The interactive online computer software MathXL was used in this study to determine whether computer-based instruction had an effect on student mathematics achievement and students' attitudes toward mathematics in developmental and introductory math courses at a two-year college. Spring 2010 was the first semester in which the mathematics course redesign was implemented at this community college. In contrast to traditional lecture course, redesigned courses were conducted in a computer lab setting where students received instruction via MathXL video lectures and animations and completed all homework assignments and tests using the interactive computer software. To maintain consistency in this research, great care was taken to ensure that the same type of homework, quiz and test questions were used in the traditional lecture control groups and computer lab treatment group.

Sample

Six classes consisting of three redesigned sections (one Beginning, one Intermediate, one College Algebra) and three traditional lecture sections (one Intermediate, two College Algebra) were included in this study, and all sections were taught by the researcher. The sample consisted of 112 community college students, with 55 students in treatment group and 57 students in the control group.

Procedure

Attitudes toward mathematics were measured using the Attitudes Toward Mathematics Inventory (ATMI) by Martha Tapia. This survey instrument consisted of 40 items, 11 of which are reversed items, based on a 5-point Likert scale that ranged from 1 for *strongly disagree* to 5 for *strongly agree* and evaluated students' attitude based on four subscales: Self-Confidence (SC), Value, Enjoyment, and Motivation. A comprehensive final exam consisting of 30 questions was used to measure student achievement in mathematics. Data collection involved having participants complete a pre-ATMI survey and pre-test on the first day of class prior to any treatment and then a post-ATMI survey and post-test (comprehensive final exam) on the last day of class.

Results

Descriptive analysis of the achievement data suggested that students achieved on the same level regardless of instructional format. Descriptive analysis of the attitude data suggested that students' attitudes toward mathematics slightly worsened in the treatment group while students' attitudes improved in the traditional lecture control group when compared to pre-survey responses.

Results of the statistical analysis reflected the results of the descriptive data. Analysis of the achievement data was performed by analysis of covariance ANCOVA which tested for differences in post-test means while controlling for pre-test scores, yet results showed no significant differences between treatment and control group for student achievement. Thus, these results did not support H_1.

The attitude data were also tested using analysis of covariance ANCOVA on the four subscales: Self-Confidence (SC), Value, Enjoyment, and Motivation while controlling for pre-ATMI survey scores. Results indicated statistically significant differences for all four attitude subscales between traditional class students and computer lab students. The differences for the control group were greater than the treatment group. Thus, H_2 was supported. It is important to note that the descriptive statistics exhibited an increase in the control group means under all four subscales while the treatment group showed a decrease in the attitude means for each of the four subscales.

The relationship between students' attitude toward mathematics and student math achievement was investigated by performing a correlation on the pre-ATMI surveys and pre-tests and then a correlation on the post-ATMI survey and post-tests for control and treatment groups. The correlation on the post-ATMI and post-tests for the control (traditional lecture) group indicated a statistically significant relationship between attitude and achievement, but no significant relationship between attitude and achievement was found in the treatment group. Therefore, H_3 was supported.

Discussion of Major Findings

Attitude Findings

Some research has shown that computer based instruction improved students' attutide toward mathematics (Kulik & Kulik, 1991; Love, 2004; Martin, 2005; Nguyen, 2002). Other research computer based instruction has shown that students' attitude toward mathematics remained unchanged (Carter, 2004; Griffin, 2008; Hamm, 1989; Wohlgehagen, 1992). However, White (1998) conducted a study on mathematics achievement and computer assisted instruction using Academic Systems computer software at a community college campus in Beginning Algebra, Intermediate Algebra, and College Algebra courses. Results showed a significant difference in students' attitude toward mathematics in the control (traditional instruction) group and treatment (computer based instruction) group. However, the attitudes toward mathematics significantly increased in the control group in which no computer component was used while the attitudes significantly decreased in the computer based treatment group (White).

This current research has shown that redesigned developmental and introductory mathematics courses based on a math emporium model have an effect on students' attitudes toward mathematics, though it was the traditional lecture class students' attitudes that significantly improved rather than the treatment group. The results of the current study were similar the study conducted by White (1998) in that results of the statistical analysis showed that the control group exhibited a significant increase in students' attitude toward mathematics. Even though the decreases in attitude of the treatment group were too small to be statistically significant in this current study, the fact

that a slight decrease in the means was reflected in all four subscales suggests that there may be a real effect. This decrease in the means of the four attitude subscales can be observed in comparing the pre-and post-ATMI survey descriptive data. Thus, the results of the current study found no support for the idea that computer-based instruction using interactive computer software such as MathXL will improve students' attitudes toward mathematics.

It is interesting to note the similarities between this current study and the study conducted by White (1998). Both studies were conducted with a sample of community college students enrolled in of the courses Beginning Algebra, Intermediate Algebra, or College Algebra using web-based instructional software as the primary mode of instruction in the treatment group, though different teachers were used in the study White conducted. White used the Fennema-Sherman Attitude Scales to measure attitudes. In addition, White used interviews from focus groups to obtain student opinions in order to illustrate and understand changes in attitude. White also studied student personality and the success of students in mathematics with respect to method of instruction but found no relationship between behavior type and success in mathematics using traditional or computer based instruction. However, results indicated that student behavior type appeared to predict success in mathematics regardless of method of instruction (White).

Results of this current research differ from the results of other studies that found increases in attitude in the computer based groups even though the procedures among studies were virtually the same in that all used pre-test post-test design, taught same content coverage for both traditional and computer based courses, provided the opportunity to repeat exercises and receive immediate feedback from web based

software, and allowed traditional students to resubmit corrected homework. Love (2004) used a sample of undergraduate students in remedial basic skills mathematics courses in California. Martin (2005) used a sample composed of 9-12 grade students from Miami-Dade County Public Schools, and Nguyen (2002) used a sample of sixth, seventh, and eight grade students from three different schools in Texas.

Even though all procedures detailed in Chapter III were followed and executed, this study was the first time the instructor researcher had facilitated a course redesign. This research was conducted in a rural, low socioeconomic area. It is possible that the results of the attitude survey could have been confounded by students' lack of computer skills. Students' lack of experience using the computer and Internet may have contributed to the negative attitudes in the computer-based treatment group. Mathematics anxiety coupled with computer anxiety may have had an impact on attitudes in the computer based courses.

Achievement Findings

Statistical analysis of pre- and post-test scores indicated no significant difference between traditional lecture class student achievement and computer-based class student achievement in mathematics, though both treatment and control groups exhibited improvement in achievement from pre-test to post-test. Several studies have shown that computer based instruction is no more or less effective as other modes of instruction (Brewer, 2009; Carter, 2004; Gesshel-Green, 1987; Hamm, 1989; Lewis, 1995; Martin, 2005; Scott, 1995; Spradlin, 2009; Wohlgehagen, 1992; Wright, 1989). The current study produced similar results. Based on these findings, students in either instructional setting achieved at the same level. This is a reassuring result since the computer-based

instructional approach of redesigned courses did not negatively affect student achievement in mathematics compared to the traditional lecture classes. Comparison of both the pre-and post-tests means of the treatment group and control group showed both groups improved in math achievement by the end of the treatment, though the difference was not statistically significant. It seems that computer-based instruction is a valid alternative instructional approach to traditional lecture that can be an effective method of instruction in developmental and introductory mathematics courses on the community college level.

Relationship between Attitudes and Achievement

Results of the correlation on the post-ATMI and post-tests indicated a statistically significant relationship between attitude and achievement in the control (traditional lecture) group. These findings are consistent with other research. Tapia and Marsh (2002) said that achievement in mathematics is considerably influenced by personal beliefs about one's own mathematical ability, the value of mathematics, enjoyment of mathematics, and motivation to achieve success in mathematics. Schoenfeld (1985) asserts that development of mathematical understanding is influenced by student belief in mathematics. Anxiety toward mathematics may be a contributing factor to the lack of student desire to pursue careers in mathematics. Other studies have shown that student achieve at higher levels when they enjoy and find value in mathematics, and low levels of achievement have been associated with a deteriorating attitude (Gottfried, 1985; Ma & Xu, 2004). However, the correlation performed on the pre-ATMI and pre-tests for all groups indicated no significant relationship between attitude and achievement at the beginning of this study. A correlation on the post-ATMI and post-tests of the computer

based class treatment group also showed no significant relationship between attitude and achievement.

Limitations

Participants in this study were limited to those students who enrolled in one of six mathematics courses taught by the researcher, specifically one Elementary Algebra section, two Intermediate Algebra sections, and three College Algebra sections at a community college in southern Mississippi. These participants were not randomly selected, but assigned to control or treatment groups based on the way students registered for classes. The study was limited to the spring semester of 2010, and this treatment period may not have been an adequate length of time to investigate the effect of computer-based instruction on student achievement in mathematics and students' attitudes toward mathematics. Computer-based instruction was limited to using the online instructional software package MathXL. Emporium model computer-based instruction was used for the first time at this community college in three courses, namely, one Elementary Algebra section, one Intermediate Algebra section, and one College Algebra section. Another limitation for students in the treatment group may have been limited time and access to a computer with an internet connection. These students may also have had little or no knowledge of or experience with computers.

Recommendations

It is very important to continue research on the effects of technology on teaching and learning. More research is needed on student achievement in mathematics, students' attitudes toward mathematics, and the relationship between the two variables. The new computer-based instructional approach used in the redesigned mathematics courses also

needs to be researched to find better ways to implement this redesign in order to improve student learning and students' attitudes toward mathematics.

The researcher suggests the implementation of the following recommendations at the institution where this research was conducted. Since results from this study showed that there was no significant difference in student achievement in mathematics, it is recommended that both traditional and computer-based developmental and introductory level mathematics courses remain as options for students. Results of this study also showed that students' attitude toward mathematics significantly improved in traditional lecture courses and that attitudes slightly worsened in computer-based courses. Based on these results, another recommendation is the screening of students' ability to operate a computer and navigate the Internet as a preemptive measure in order to minimize anxiety in the computer-based courses and improve student attitudes. It is also recommended that traditional lecture mathematics courses implement a computer component in which students are required to complete assignments using web-based interactive software so that students receive instantaneous feedback on assignments. It is important that students actively engage in doing mathematics to facilitate meaningful learning. However, based on the results of this study, the researcher believes that it is just as important that students have a face to face course instructor with whom they can interact to compensate for the limitations of the interactive web-based software.

Further research could use a larger sample and focus on students placed in developmental courses. The time frame of the study could be expanded. Future studies would benefit from conducting interviews with students in computer based classes in order to help clarify sources or causes of anxiety, especially in differentiating computer

anxiety and mathematics anxiety as influences on attitudes toward mathematics. It would be useful to study the personality types and behavior patterns of a large sample of students who are underprepared for college level mathematics to investigate whether computer based instruction is more effective for certain personality types of the student population. Research could be conducted on students who are placed in Beginning Algebra by following these students as they progress through the developmental courses (Intermediate Algebra) and proceed to introductory college level courses (College Algebra). Research could be extended to randomly assigning the students who are placed in Beginning Algebra into one of three instructional settings: (a) a traditional lecture group with no computer component, (b) a traditional lecture group supplemented with homework and quiz assignments using interactive software such as MathXL, and (c) a computer-based redesigned course group with no traditional lecture component.

Student achievement and attitude research could study students who remain in either the traditional lecture or redesigned courses throughout the duration of the math sequence in addition to simultaneously studying students who switch from redesign to traditional courses or vice versa. This type of research could be very helpful in identifying factors that impact attrition rates, factors that affect student achievement in mathematics, and factors that influence students' attitude toward math. More of this type of research is needed to determine whether there is a correlation between student achievement in mathematics and students' attitudes toward mathematics. Results could provide valuable information on the use of computer-based learning as an effective and appropriate instructional technique on the community college level with respect to attitudes and achievement in mathematics.

APPENDIX A

PERMISSION FROM COLLEGE ADMINISTRATOR

Bishop, Amy

From:	Dickerson, John
Sent:	Monday, November 09, 2009 12:10 PM
To:	Bishop, Amy
Subject:	RE: Permission to Conduct Research for Dissertation

Ms. Bishop,

You have my permission to conduct your research. We wish you the best in conducting your study and look forward to hearing the results.

Dr. John Dickerson
Vice President of the Simpson County Center
Copiah-Lincoln Community College

From: Bishop, Amy
Sent: Monday, November 09, 2009 10:15 AM
To: Dickerson, John
Subject: Permission to Conduct Research for Dissertation

Dear Dr. Dickerson,

May I please have permission to conduct research during the spring semester of 2010 in my Beginning, Intermediate, and College Algebra classes here at Copiah-Lincoln Community College - Simpson County Center. I am working on my Ph.D. in mathematics education at The University of Southern Mississippi. I would like to collect data from my Beginning, Intermediate, and College Algebra classes to determine the effect of a math emporium (computer-based instruction) on student attitudes toward mathematics and achievement in developmental and introductory mathematics courses on the community college level.

Thank you very much,

Amy Bishop
Mathematics Instructor
Copiah-Lincoln Community College
Simpson County Center
151 Co-Lin Drive
Mendenhall, MS 39114
601.849.0129
amy.bishop@colin.edu

1

APPENDIX B

BEGINNING ALGEBRA PRE-TEST/POST-TEST

Beginning Algebra   ID# _____

Final Exam

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Simplify the expression.

1) $7 \cdot 5 - 6$ 1) _____

Add.

2) $|7 + (-14)|$ 2) _____

Multiply.

3) $(3)(-8)$ 3) _____

Perform the indicated operation.

4) $(-3)(4) - (-19)(8)$ 4) _____

Simplify.

5) $\dfrac{8(4) + 4}{1 - 4(8)}$ 5) _____

Subtract.

6) $\dfrac{8}{9} - \left(-\dfrac{2}{27}\right)$ 6) _____

Solve the equation.

7) $b + 7 = 9$ 7) _____

8) $-9x = -81$ 8) _____

9) $\dfrac{x}{9} + 3 = 9$ 9) _____

Solve the equation. Don't forget to first simplify each side of the equation, if possible.

10) $8(3x - 3) = 25x$ 10) _____

Solve the equation.

11) $\dfrac{3(y - 2)}{5} = 1 - 3y$ 11) _____

Solve the inequality. Graph the solution set and write it in interval notation.

12) $x - 6 < -9$

12) _____

$$\longleftarrow \; + \quad + \quad + \quad + \quad + \quad + \quad + \longrightarrow$$
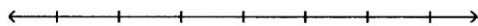
13) $20 < 5x \le 25$

13) _____

$$\longleftarrow + \; + \; + \; + \; + \; + \; + \; + \; + \; + \; + \; + \longrightarrow$$
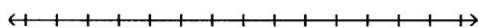
Simplify the following.

14) $3^2 + 3^3$

14) _____

Use the product rule to simplify. Write the results using exponents.

15) $(6x)(4x^5)(x^3)$

15) _____

Use the power rule and the power of a product or quotient rule to simplify the expression.

16) $\left(\dfrac{pm^5}{q^4}\right)^3$

16) _____

Simplify the following.

17) $\dfrac{(24pq)^3}{64p^3q^3}$

17) _____

18) $(4b)^0$

18) _____

Simplify by combining like terms.

19) $12y^7 - 3y^7$

19) _____

Perform the indicated operations.

20) $(5x + 2) + (12x - 7)$

20) _____

21) $(7x^7 + 10x^4 - 6) - (-20x^4 + 9x^7 - 20)$

21) _____

Find the following product.

22) $-3z^2(7z^2 + 8z - 3)$

22) _____

Find the product using the FOIL method.

23) $(4x + 9)(x - 5)$

23) _____

Find the product.

24) $(5a - 4)^2$

24) _____

Perform the division.

25) $\dfrac{21x^6 + 56x^5 + 42x^4}{7x^5}$

25) _____

2

Factor out the GCF from the polynomial.

26) $-21y^3 + 15y$ 26) _____

Factor by grouping.

27) $2x - 16 + xy - 8y$ 27) _____

Factor the polynomial completely. If the polynomial cannot be factored, write prime.

28) $9x^2 - 4$ 28) _____

29) $x^2 - 4x - 32$ 29) _____

30) $3x^2 + 11x - 4$ 30) _____

3

APPENDIX C

INTERMEDIATE ALGEBRA PRE-TEST/POST-TEST

INTERMEDIATE ALGEBRA ID#_____

Final Exam

Last 4 digits of Student ID and 6 digit birthdate

10 digit # (NoSpaces)

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Solve the equation.

1) $4(3x + 2) + 38 = 7x + 1$ 1) _____

2) $\dfrac{x + 5}{2} + \dfrac{x - 1}{3} = 3$ 2) _____

Write the solution set using interval notation.

3) $11x + 16 \geq 3x + 72$ 3) _____

Solve the absolute value equation.

4) $|5x + 2| + 6 = 9$ 4) _____

Solve the inequality. Graph the solution set.

5) $|4k + 1| \geq 6$ 5) _____
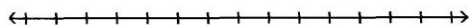
Factor the polynomial completely.

6) $32x^4y + 20xy^6$ 6) _____

7) $4y - 24 + xy - 6x$ 7) _____

8) $x^2 + x - 56$ 8) _____

9) $10x^2 - 19x + 6$ 9) _____

10) $49x^2 - 36y^2$ 10) _____

11) $x^3 + 1000$ 11) _____

Simplify the rational expression.

12) $\dfrac{x^2 + 11x + 18}{x^2 + 13x + 36}$ 12) _____

Factor and multiply or divide as indicated. Simplify competely.

13) $\dfrac{x^2 + 9x + 14}{x^2 + 13x + 42} \cdot \dfrac{x^2 + 6x}{x^2 - 6x - 16}$ 13) _____

1

14) $\dfrac{x^2 + 5x - 6}{x^2 + 9x + 18} \div \dfrac{x^2 - 1}{x^2 + 7x + 12}$

14) _____

Perform the indicated operation. Simplify if possible.

15) $\dfrac{3}{12x} + \dfrac{4}{12x}$

15) _____

16) $\dfrac{3}{y^2 - 3y + 2} + \dfrac{7}{y^2 - 1}$

16) _____

Use radical notation to write the expression. Simplify if possible.

17) $27^{4/3}$

17) _____

18) $\left(\dfrac{1}{64}\right)^{2/3}$

18) _____

Write with positive exponents. Simplify if possible.

19) $81^{-3/2}$

19) _____

Simplify the radical expression. Assume that all variables represent positive real numbers.

20) $\sqrt{32k^7 q^8}$

20) _____

21) $\sqrt[3]{64x^4 y^5}$

21) _____

22) $\dfrac{\sqrt[3]{128x^{16}}}{\sqrt[3]{2x}}$

22) _____

Add or subtract. Assume all variables represent positive real numbers.

23) $\sqrt{2} + 3\sqrt{98} + 4\sqrt{50}$

23) _____

Multiply, and then simplify if possible. Assume all variables represent positive real numbers.

24) $(\sqrt{8} + 3)(\sqrt{8} - 3)$

24) _____

25) $(2\sqrt{3} + 5)(2\sqrt{3} + 8)$

25) _____

Rationalize the denominator and simplify. Assume that all variables represent positive real numbers.

26) $\sqrt{\dfrac{1}{5}}$

26) _____

Simplify. Write the answer with positive exponents.

27) $-7x^8 \cdot -6x^4$

27) _____

28) $\dfrac{x^9 y^{12}}{x^4 y^4}$

28) _____

29) $\dfrac{x^{-14} y^{12}}{x^{-6} y^{-3}}$

29) _____

30) 5^{-4}

30) _____

APPENDIX D

COLLEGE ALGEBRA PRE-TEST/POST-TEST

COLLEGE ALGEBRA Final Exam   ID#_____
                  Ten Digit # (No Spaces)
                  Last 4 digits of Student ID and 6 Digit Birthdate

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

First, write the value(s) that make the denominator(s) zero. Then solve the equation.

1) $\dfrac{4}{x} + 7 = \dfrac{1}{2x} + \dfrac{14}{5}$ 1) _____

Let x represent the number. Use the given conditions to write an equation.
Solve the equation and find the number.

2) Seven times a number is 20 more than three times that number.   2) _____

Find the product and write the result in standard form.

3) $(9 + 3i)(5 - 8i)$ 3) _____

Solve the equation by the square root method.

4) $(4x + 2)^2 = 36$ 4) _____

Solve the equation using the quadratic formula.

5) $2x^2 + x - 5 = 0$ 5) _____

Solve and check the equation.

6) $3x^{5/2} - 9 = 0$ 6) _____

Find the domain of the function.

7) $f(x) = \dfrac{\sqrt{x + 7}}{(x + 5)(x + 2)}$ 7) _____

For the given functions f and g , find the indicated composition.

8) $f(x) = 4x^2 + 2x + 8, \quad g(x) = 2x - 5$ 8) _____
$(g \circ f)(x)$

Find the inverse of the one–to–one function.

9) $f(x) = (x - 7)^3$ 9) _____

1

Graph the equation.

10) $y = x^2 + 4$
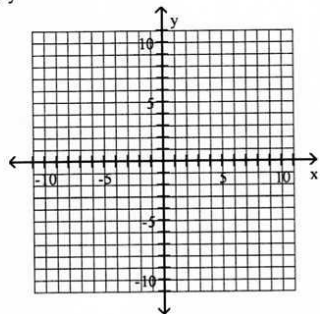
10) _____

Find the slope of the line that goes through the given points.

11) $(3, -5), (7, -6)$

11) _____

Use the given conditions to write an equation for the line in slope–intercept form.

12) Passing through $(7, 2)$ and $(2, 8)$

12) _____

Use the given conditions to write an equation for the line in the indicated form.

13) Passing through $(5, 4)$ and perpendicular to the line whose equation is $y = 3x + 7$; point–slope form

13) _____

Graph the line whose equation is given.

14) $y = -\dfrac{3}{5}x - 3$

14) _____

2
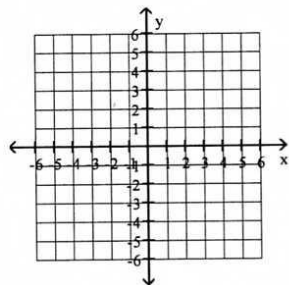
Graph the equation in the rectangular coordinate system.

15) $y = -1$
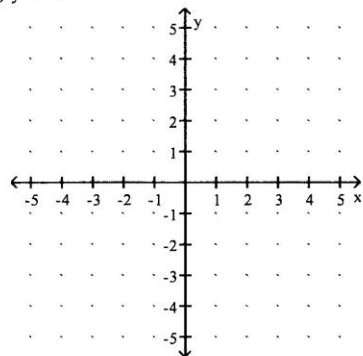
```
                 5 ┤y
                 4 ┤
                 3 ┤
                 2 ┤
                 1 ┤
  ┼─┼─┼─┼─┼─┼────┼─┼─┼─┼─┼─→
 -5 -4 -3 -2 -1  1  2  3  4  5  x
                -1 ┤
                -2 ┤
                -3 ┤
                -4 ┤
                -5 ┤
```

Determine the slope and the y–intercept of the graph of the equation.

16) $4x - 8y - 32 = 0$

16) _____

Find the distance between the pair of points.

17) $(6, -7)$ and $(2, -5)$

17) _____

Find the midpoint of the line segment whose end points are given.

18) $(-9, 1)$ and $(-2, 2)$

18) _____

Write the standard form of the equation of the circle with the given center and radius.

19) $(0, -2); \sqrt{14}$

19) _____

Evaluate the expression without using a calculator.

20) $\log_2 \frac{1}{4}$

20) _____

21) $\log_3 3^{11}$

21) _____

Evaluate or simplify the expression without using a calculator.

22) $\log 10{,}000$

22) _____

23) $\ln e^9$

23) _____

Use common logarithms or natural logarithms and a calculator to evaluate to four decimal places

24) $\log_5 24$

24) _____

Use properties of logarithms to condense the logarithmic expression. Write the expression as a single logarithm whose coefficient is 1. Where possible, evaluate logarithmic expressions.

25) $4 \log_b m - \log_b n$

25) _____

3

Solve the equation by expressing each side as a power of the same base and then equating exponents.

26) $2^{(7-3x)} = \dfrac{1}{4}$

26) _____

Solve the logarithmic equation. Be sure to reject any value that is not in the domain of the original logarithmic expressions. Give the exact answer.

27) $\log_6 (x - 3) = 2$

27) _____

Solve the logarithmic equation. Be sure to reject any value of x that produces the logarithm of a negative number or the logarithm of 0.

28) $\log_4 (x + 3) + \log_4 (x - 3) = 2$

28) _____

Solve the system by the addition method.

29) $3x - 5y = -12$
$6x + 8y = -24$

29) _____

Solve the system by the substitution method.

30) $x^2 + y^2 = 41$
$x + y = 9$

30) _____

APPENDIX E

ATTITUDES TOWARD MATHEMATICS INVENTORY (ATMI)

ID#: _____

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the letter that most closely corresponds to how the statements best describes your feelings. Use the following response scale to respond to each item.

PLEASE USE THESE RESPONSE CODES: 1 – Strongly Disagree
                                                                     2 – Disagree
                                                                     3 – Neutral
                                                                     4 – Agree
                                                                     5 – Strongly Agree

1. Mathematics is a very worthwhile and necessary subject.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. I want to develop my mathematical skills.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I get a great deal of satisfaction out of solving a mathematics problem.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. Mathematics helps develop the mind and teaches a person to think.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. Mathematics is important in everyday life.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. Mathematics is one of the most important subjects for people to study.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. Math courses would be very helpful no matter what I decide to study.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. I can think of many ways that I use math outside of school.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. Mathematics is one of my most dreaded subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. My mind goes blank and I am unable to think clearly when working with mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. Studying mathematics makes me feel nervous.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. Mathematics makes me feel uncomfortable.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. I am always under a terrible strain in a math class.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. When I hear the word mathematics, I have a feeling of dislike.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

15. It makes me nervous to even think about having to do a mathematics problem.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

16. Mathematics does not scare me at all.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

17. I have a lot of self-confidence when it comes to mathematics

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

18. I am able to solve mathematics problems without too much difficulty.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

19. I expect to do fairly well in any math class I take.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

20. I am always confused in my mathematics class.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

21. I feel a sense of insecurity when attempting mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

22. I learn mathematics easily.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

23. I am confident that I could learn advanced mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

24. I have usually enjoyed studying mathematics in school.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

25. Mathematics is dull and boring.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

26. I like to solve new problems in mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

27. I would prefer to do an assignment in math than to write an essay.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

28. I would like to avoid using mathematics in college.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

29. I really like mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

30. I am happier in a math class than in any other class.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

31. Mathematics is a very interesting subject.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

32. I am willing to take more than the required amount of mathematics.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

33. I plan to take as much mathematics as I can during my education.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

34. The challenge of math appeals to me.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

35. I think studying advanced mathematics is useful.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

36. I believe studying math helps me with problem solving in other areas.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

37. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

38. I am comfortable answering questions in math class.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

39. A strong math background could help me in my professional life.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

40. I believe I am good at solving math problems.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

APPENDIX F

PERMISSION TO USE ATMI SURVEY

Bishop, Amy
_____

From:	Tapia, Martha [mtapia@berry.edu]
Sent:	Friday, October 23, 2009 9:15 AM
To:	Bishop, Amy
Subject:	RE: Permission to use ATMI survey

Dear Amy,

You have permission to use the Attitudes Toward Mathematics Inventory (ATMI) in your dissertation studies. If you have any questions, please do not hesitate to ask me.

Please let me know of the findings in your study.

Sincerely,

Martha Tapia

Martha Tapia, Ph.D.
Associate Professor
Department of Mathematics and Computer Science
Berry College
P.O. Box 495014
Mount. Berry, Georgia 30149-5014

_____
From: Bishop, Amy [mailto:amy.bishop@colin.edu]
Sent: Tuesday, October 20, 2009 11:22 AM
To: Tapia, Martha
Subject: Permission to use ATMI survey

Dear Dr. Tapia,

I hope you are doing well. I am writing to ask your permission to use your Attitudes Toward Mathematics Inventory (ATMI) as an instrument in my dissertation. I am a doctoral student in Mathematics Education at the University of Southern Mississippi. I am interested in examining the effect of the Emporium Model (computer-based instruction) on student attitudes and achievement in developmental and introductory mathematics courses at a community college in south Mississippi. Thank you very much for your time.

Sincerely,

Amy Bishop
Mathematics Instructor
Copiah-Lincoln Community College
Simpson County Center
151 Co-Lin Drive
Mendenhall, MS 39114
601.849.0129
amy.bishop@colin.edu

1

APPENDIX G

HUMAN SUBJECTS REVIEW COMMITTEE LETTER

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **29111205**
PROJECT TITLE: **The Effect of a Math Emporium on Student Attitudes and Achievement in Developmental and Introductry Mathematics Courses at a Community College**
PROPOSED PROJECT DATES: **01/04/10 to 12/20/10**
PROJECT TYPE: **Dissertation or Thesis**
PRINCIPAL INVESTIGATORS: **Amy Renee Bishop**
COLLEGE/DIVISION: **College of Science & Technology**
DEPARTMENT: **Science Education**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **11/17/09 to 11/16/10**

Lawrence A. Hosman   _11-19-09_
Lawrence A. Hosman, Ph.D.   Date
HSPRC Chair

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