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**STUDENT SUCCESS: A STUDY OF COMPUTER – BASED INSTRUCTION
VERSUS LECTURE – BASED INSTRUCTION IN DEVELOPMENTAL
MATHEMATICS AT A TENNESSEE COMMUNITY COLLEGE**

A Dissertation Presented for the

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Degree

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DEDICATION

This dissertation is dedicated to my Dad and Mom, Marcell Burrow and Liz Burrow and to my dear husband, Brian Cannon, who has helped me all along the way by encouraging me when I did not think I could continue. They have always believed in me and encouraged me to be the best that I can be. I love you all very much!

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ABSTRACT

The purpose of this study was to examine the effects of incorporating computerized instruction into developmental mathematics courses. The study examined achievement, retention, persistence, and success of students who began in Elementary Algebra, progressed into Intermediate Algebra and subsequently obtained their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, or Contemporary Mathematics.

Two groups of elementary algebra students from Chattanooga State Technical Community College were used in this study. One group was taught using a lecture based approach and one group was taught using a computerized instructional approach. The lecture group consisted of 175 students where the computer group consisted of 208 students.

Achievement was studied using elementary algebra final exam grades and overall course grades from students who were enrolled in elementary algebra during the fall 2002 semester. Retention was studied using students who began in the fall 2002 semester in elementary algebra, tracking them, to see if they enrolled in a mathematics course during the spring 2003 semester. Persistence was studied using students who began elementary algebra in the fall 2002 semester, enrolled in a mathematics course during the spring 2003 semester and persisted with their mathematics by registering for a mathematics course in the summer 2003 semester or the fall 2003 semester. Student success was studied using students who began in the elementary algebra course in the fall 2002

semester and successfully completed a college mathematics course by the fall 2003 semester. Success was determined by the number of students who made a letter grade of an A, B or C in any college level mathematics course.

When examining achievement, retention, persistence and success, the only area in this study that showed a significant difference was among the achievement rates. The lecture students' achievement rates were significantly higher than the students who received computerized instruction. Retention, persistence and success did not show any significant difference between the two groups.

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CHAPTER I

INTRODUCTION

Community colleges are an increasingly important part of American education with approximately 1,200 community and technical colleges in the United States. The role of the community college is primarily viewed as a place to complete the first two years of college, but many people do not realize that the community college offers much more. Community colleges provide Adult Basic Education, General Education Degree (GED) preparation and testing, English as a Second Language, certificate and degree programs in career fields, customized training for industries, and developmental classes for students who are unprepared for college-level courses. The majority of community colleges have an open door admissions policy that allows students from various educational backgrounds to enroll in higher education. Many students would not have access to higher education without community colleges. Community colleges continuously have to revamp their educational services in order to meet the growing needs of their students, communities, and the American economy. The United States' economic prosperity is due in large to the many community college graduates that obtain jobs each year (Transue, 2001; Ronan & Kur, 2001).

While community colleges became a force in American education, another force was building throughout all levels of schooling, the microcomputer. Many K-12 schools received microcomputers to use for instructional purposes, record keeping, drill and practice, and other classroom functions during the 1970's.

American school systems received over two million microcomputers in the 1980's. Many schools required future teachers to be trained in the use of technology programs that could be implemented into classroom instruction. Numerous educators realized that the use of computers could help them improve what they were currently doing in the classroom in the 1990's. Teachers also discovered that the use of technology could create new opportunities for learning (Kinnaman, 2001).

By the year 2000, educators began to view computers from a different perspective. They realized that computer software could be used to impact the curriculum that was taught in the classroom. Teachers must be provided with a computerized curriculum that is best suited for their students in today's educational environment, and the teachers must be trained in ways to use it effectively in the classroom. This software must be used to promote critical thinking among all individual students. Students must learn to explore, manipulate, gather, analyze, and solve problems from data that they collect. Future classrooms must implement computer technology that goes beyond drill and practice exercises and electronic textbooks. Students should learn to be critical thinkers and independent learners in this world of advanced computer technology (Kinnaman, 2001).

Technology joins mathematics as major areas of concern in today's society, and, therefore, in education. Technology is advancing at a rapid pace, and educators are having a difficult time keeping up with the changes. Many students have poor mathematics skills, high levels of mathematics anxiety, poor retention

of mathematics, and have no insight into the use of the subject. Mathematics is often a subject students dread because it is not their strongest area of study. Students who have failed mathematics in the past often have low self-esteem when faced with mathematics (NCTM, 2000).

Placing mathematics together with computerized instruction may help increase self-esteem in students who are taking mathematics. A great number of families interact daily with computers, and because of this many students are very secure with this technology. Using technology in the classroom may help alleviate the negative outlook students have when faced with learning mathematics. Technology can help generate students' interests and help them to become individualized thinkers and active learners (Edwards, 2002).

Improving mathematics education should be a top priority for most mathematics educators, and the educational reform movement should definitely take advantage of the advancements in the use of technology in the classroom. Technology reform in mathematics is currently being implemented from elementary to post-secondary institutions. All students should have access to a superior mathematics education that actively engages learning, and one way to accomplish that engagement may be through the use of technology (NCTM, 1989; NCTM, 2000).

The Problem

The problem in community college developmental mathematics courses is that students generally have overall low achievement, retention, and persistence

rates. Developmental courses are offered to students who are unprepared for college-level mathematics. These courses are designed to help students obtain their goal of becoming successful in college-level mathematics. The students are generally taught using the same traditional lecture-based approach that is used in most high school mathematics classes (Higbee & Dwinell, 1997; Ebeling & Middlesworth, 2002; Perin, 2002).

The Purpose

The purpose of this study was to examine the effects of incorporating computerized instruction into developmental mathematics courses. The study examined achievement, retention, persistence, and success of students who began in Elementary Algebra, progressed into Intermediate Algebra and subsequently obtained their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, or Contemporary Mathematics.

Research Questions

The research questions guiding the study were:

1. How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
2. How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

3. How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
4. How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?
5. How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?
6. How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

Significance of the Study

The Economist (2002) stated that very few studies that involve computerized instruction actually compare classes of students taught both using computers and without using computers. Billions of dollars have been used to purchase computers, but few studies have been conducted to see if the money is being spent wisely. Studies have not been conducted to see if the use of software that allows students to work at their own pace really promotes mastery learning. The review of literature clearly shows that evaluations of computer based instructional programs are a necessary part of the educational process in order to propose changes for improvement to the program.

From the literature review, one can determine that there are three main components that define a successful college student. One must achieve success in each individual class, be persistent in his or her goals, and continue to be retained until the goal is complete.

This study was conducted in order to partially fill the gaps in research that examines computerized instruction in mathematics. The study compared developmental mathematics students taught with computers and without computers. The focus of this study was to see if there was a change in the achievement, persistence, retention, and success of students.

Assumptions of the Study

1. Students have accurately been placed in elementary algebra based on their ACT scores.
2. Representatives from Prentice Hall conducted a workshop for mathematics faculty at Chattanooga State Technical Community College (CSTCC). In this workshop, ways to use the Interactive Mathematics software in elementary algebra courses were demonstrated. The researcher assumes that teachers in the computer classes used the software as they had been trained.

Limitations of the Study

1. Students were not randomly assigned to classes. Each student chose the method of instruction that he or she preferred, computerized instruction or traditional lecture instruction.
2. The CSTCC Mathematics Department chose the computer software program, Interactive Mathematics by Prentice Hall, and it was custom published in order to better meet the objectives that are taught in the elementary algebra courses.
3. The computer software program's objectives were assumed to be aligned with the curriculum that was being used in the lecture classes.

Delimitations of the Study

1. The time period of the study was from the beginning of the Fall 2002 semester to the end of the Fall 2003 semester because this is the time frame that the computer software program was used with students in developmental mathematics.
2. A convenience sample was used for this study because the researcher had no control of the courses that were placed on the schedule.
3. The researcher had no control of the students' decisions to take a computer-based approach to instruction or a lecture-based approach to instruction, both of which were identified on the course schedule.
4. The final exam was designed for use in the lecture-based classes.

Definition of Terms

Success - achieving a set goal, which in this report will be completion of a college-level mathematics course with an A, B, or C.

Achievement - completion of a mathematics course with an A, B, or C grade.

Retention – continuing the educational process semester to semester.

Students are considered as no longer retained if they encounter any problem that keeps them from continuing the educational process in sequential semesters. This definition is based on the statistics that are collected by the Tennessee Board of Regents (TBR) that are used to evaluate retention.

Persistence – continuing the educational process until the student enrolls in a college-level mathematics class.

Computerized instruction – is a teaching methodology incorporating computer technology using a computer software package and a textbook as a reference resource to instruct students. The learning process is a student-centered approach to learning. Students progress at their own individual pace until a set of objectives is complete. Teachers assist individual students as needed. Computerized instruction is synonymous with computer-based instruction.

Lecture-based instruction – is a teaching methodology where the teacher verbally explains the steps to working a problem, along with writing the steps on the board. The students are observing and taking notes during this process. The students may be given opportunities to work problems on their own or in groups after the concepts are explained. This is a teacher-focused

approach to learning. The resources that are used in this classroom setting are paper and pencil along with a textbook. Lecture-based instruction is synonymous with traditional instruction or teacher-based instruction.

Developmental - defined by the Tennessee Board of Regents as a college course in which the content is at the tenth grade level up to the twelfth grade level.

Placement - assigning students to appropriate mathematics courses based on results of a placement test.

Open door policy – is a policy that allows any person to attend college as long as he or she has a high school diploma or a General Education Degree.

At risk students - students who have a low chance of succeeding in the college setting due to cultural, geographical, or academic backgrounds.

NCTM - An abbreviation for the National Council of Teachers of Mathematics.

AMATYC - An abbreviation for the American Mathematics Association of Two Year Colleges.

Mastery learning – is an instructional plan that is based on the idea that all students can learn a set of realistic objectives with the right instruction and adequate time to learn.

Verbal learners - students who learn more by using words, whether written or spoken.

Visual learners - students who learn more visually, using pictures, diagrams, or demonstrations.

Discovery learners - students who learn more by using their previous knowledge, conducting some form of research, and realizing a new concept.

Organization of the Study

This study is organized into the following five chapters:

Chapter I introduces the study and contains the following components: the problem, the purpose, research questions, significance of the study, assumptions of the study, limitations of the study, delimitations of the study, definition of terms, and organization of the study.

Chapter II includes a review of literature with the following topics: history of developmental education, standards in mathematics, implementing computer technology into the classroom, evaluating the implementation of computerized instruction, evaluating the success of developmental mathematics students, and a summary.

Chapter III includes the methodology that was used in the study. The following information is included: design of the study, setting, population, procedures, instrumentation, and data analysis.

Chapter IV contains a presentation of the findings of the study.

Chapter V includes a summary of the findings, conclusions, and recommendations for further research.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter provides a review of the literature related to developmental mathematics education and computer-based instruction. It consists of six sections: History of Developmental Education, Standards in Mathematics, Implementing Computer Technology into the Classroom, Evaluating the Implementation of Computerized Instruction, Evaluating the Success of Developmental Mathematics Students, and a Summary.

History of Developmental Education

Casazza (2000) observes that postsecondary education has grown at a rapid pace since 1960, and she predicts that by 2025 there will be approximately 200 million students enrolled in postsecondary education. In her article, she suggests that all people in the United States should be provided with an opportunity to learn if they so desire. Many students are not prepared for higher education; therefore developmental education programs have to be provided in order for students to achieve their educational goals. Universities often base their enrollment on placement, but most community colleges have an open door policy that allows any high school graduate or GED recipient to continue their education. Community colleges are often the only avenue that students have for completing a college education. Many students take the easiest route possible when completing high school, which places them behind educationally if they

decide to attend college. Inherent in the open door admissions policy of the community college is the responsibility to get all students prepared for college-level classes (Casazza, 2000).

Remediation in higher education has been a problem in the United States for many years. In 1830 at Cornell University College, the founder, Ezra Cornell, confronted a professor about the high number of applicants who failed their entrance exams. The professor explained that the students did not have enough knowledge. Cornell wanted to know why they were not taught what they needed to know. The professor stated that the faculty was not prepared to teach the alphabet and, if Ezra wanted the faculty to teach spelling, then he should have started a primary school. The first developmental education program, which had an enrollment exclusively of under-prepared university students, was introduced at the University of Wisconsin in 1849 (Brier, 1984; Casazza & Silverman, 1996; Casazza, 2000; Muse, 1999).

At Harvard, in 1871, professors were complaining about under-prepared students with bad spelling, writing, and punctuation. In 1879, about 50% of Harvard's applicants failed the entrance exam. The college decided to provide extra assistance to prepare the students for college-level courses. Harvard formed a committee to examine what was being taught at the college. The committee decided that the poor writing skills were due to poor thinking skills and placed the blame on the lower levels of education (Weidner, 1990; Casazza, 2000).

Around 1900, many colleges and universities were offering developmental courses. The main focus was on reading and study skills. Over 350 colleges were offering study skills courses by 1909 (Casazza & Silverman, 1996; Casazza, 2000).

In 1944, the World War II G. I. Bill of Rights was passed to provide an education for veterans returning from the war. Many took advantage of the opportunity, causing colleges to establish programs to help the students who were under-prepared (Wyatt, 1992; Casazza, 2000).

Many educators have learned to expect the need for remediation among entering college students in today's society. Some of the concerns facing community colleges today include the number of students coming from homes where English is not the primary language, the high number of diagnosed learning disabilities to be addressed, and the adult students who have decided to return to school after being out for a long period of time (Boss, 2002; Casazza, 2000; Ikenberry, 1999).

Looking at the past, present, and future of developmental education, the educator can see a never-ending need for academic preparedness. Roueche & Roueche (1999) explain that for over 30 years the developmental education program has been scrutinized and changed in order to meet the needs of unprepared college students. These programs were designed to fulfill the community college mission of allowing an open door policy that provides all students an opportunity to become successful college students. They explain that

there has been little evidence to show that community colleges are successfully fulfilling their mission.

Today, there is a very diverse population of students enrolled in community colleges. Today's college students may work many hours to support their families and/or parent several children as they attend college without any outside support. Many people are enrolling in college after they have been out of high school for a number of years. They often need refresher courses after such a long period of time. Some students pass high school with the minimum requirements. Numerous students have dropped out of high school and earned their GED instead of a high school diploma. These "at risk" students may have academic deficiencies when they enter college (Ikenberry, 1999).

Many of these students need various forms of remediation to be successful in college. When remediation is offered on a voluntary basis, research shows that it does not seem to work. Students who need the classes will not register for them, and people who do not need the classes will register just for review. There has been a debate whether remediation should be mandatory. Many educators believe that remediation should be required for students who place below college-level when assessed. Legislators seem to lean toward the idea that remediation should be students' responsibility. In the past few years, legislators have wanted to see evidence of success in remediation if the institutions are going to continue to receive financial support for such programs. More than 40 states are requiring colleges to provide outcome results. These reports must

provide evidence of student retention, completion, and passing of exit exams (Zeitlin, 1996).

Many people oppose the idea of developmental education in the university setting because they feel that students should have been prepared in high school. This opposition pushes remediation back to the community colleges. Academic deficiencies have to be addressed for students to be successful. The majority of these students usually have to complete one or two required classes before they are at college-level (Ikenberry, 1999).

Remediation has been completely removed from the curriculum in South Carolina universities. It is now the total responsibility of the community colleges to provide these services. Florida has now mandated assessment so that financial support can be based on outcomes (Roueche, 1999).

Tony Zeisuss (1999), President of Central Piedmont Community College, compares developmental education to the building of a tower. He believes that a firm foundation in the fundamentals has to be established before a student can be successful. He proposes that community colleges have an obligation to meet the needs of any student who chooses to attend. Colleges with open door policies must address the basic needs of students so that they can achieve academic success. The community college has an obligation to meet the needs of society by supplying skilled workers in the job market. The students must be assessed and offered remediation when appropriate.

McCabe (1999) deems that community colleges must reinforce their developmental education programs in order to assist adult learners who wish to

improve their education. This in turn helps our nation by preparing individuals to become independent.

The Roueches (1999) observe that there are more students today who are unprepared for college than in any other time in history. High school transcripts do not accurately describe the preparedness of college students. Colleges are now required to develop entrance exams in order to accurately place students. The colleges must use the information wisely in order to keep students out of classes where they have little chance for success.

Fifty community colleges were surveyed and asked about their developmental programs. All of the colleges required a mandatory assessment test when entering college. The colleges reported that 80% of all first time entering students tested showed deficiencies in one or more basic skills areas. The majority of the colleges required students to register for developmental classes in the areas where they showed deficiencies. This work had to be completed before they could continue with college-level classes. The time limit varied as to when the classes had to be completed. Most of the colleges required students to register for developmental classes in the first semester and continue until they were prepared for college-level courses. Some colleges had no time limit as to when students had to be finished with developmental courses (Bers & Smith, 1990).

Standards in Mathematics

As developmental education became firmly entrenched in community college education, standards in mathematics became a focus of educators. An

educational framework, The Curriculum and Evaluation Standards for School Mathematics, was established by the National Council of Teachers of Mathematics (NCTM) to promote reform in mathematics in 1989. This document suggested that reform should occur in curriculum and pedagogy for kindergarten through twelfth grade. The standards were written to reflect the mathematical community's concerns and demands for changes in the mathematics curriculum. Historically there have been three reasons to set standards: to ensure quality, to indicate goals, and to promote change (NCTM, 1989).

Most of the industrialized countries had changed from an industrial society to an information society by 1989. With this change in society, the NCTM (1989) clearly recognized that technology should play a crucial role in the mathematics classroom. It recommended that all students should be provided the necessary tools to enhance the learning of mathematics. Calculators should be allowed in all mathematics classrooms for student use. Computers should be made available for demonstration purposes, individual work, and group work. Students needed to be instructed in how to use these tools in order to process, investigate, and perform operations for problem solving. Calculators and computers should be used to help simplify mathematics, but implementation of these tools did not insure that students knew the fundamentals of mathematics. Students needed to be able to compute mentally and to do reasonable paper-and-pencil computations. The teacher had to develop a broader view of mathematical computations since calculators were so easily obtainable. Less emphasis needed to be placed on paper-and-pencil calculations and more on real life problems.

The mathematics teacher needed to instruct students in mathematics and in ways to implement technology. This placed a great burden on the teacher to be informed about new technology (NCTM, 1989).

In 1991, the NCTM developed the Professional Standards for Teaching Mathematics that focused on the teacher's role in the classroom. These standards were based on the premise that teachers are the most important players in changing how mathematics is taught and learned by students. In order to accomplish the goal of improving student mathematics skills, the teacher must have continuing support and sufficient resources. The changes in the classroom that need to support improved learning would include consideration of the classroom as a community, and students should be taught how to use logic and mathematical evidence to draw conclusions. Mathematical reasoning should be stressed along with making inferences, inventing and problem solving, and making mathematical connections to ideas and applications (NCTM, 1991).

An American Mathematics Association of Two-Year Colleges (AMATYC, 1995) report states that in 1990 the College Board of the Mathematical Sciences showed that of 1,295,000 students studying mathematics in a two-year college mathematics department, 724,000 had to take developmental level mathematics. Developmental mathematics programs were playing a crucial role in preparing students for college level mathematics. Therefore, in 1995 AMATYC, with assistance from other mathematics organizations, composed a set of standards for introductory college mathematics that precede calculus. It accepted the challenge of setting standards for curriculum and pedagogy in introductory

college mathematics. Faculty and administrators in higher education realized that they were sitting at a crossroads. A great need in the workforce for well-educated citizens who should be well prepared in mathematics, science, engineering, and technology were on one road. A great number of academically unprepared students seeking to enter college were on the other road. This great problem had to be addressed (AMATYC, 1995).

The AMATYC committee established several basic principles that were used to write the standards. The first principle states that all college students should increase their knowledge of mathematics. Accommodations had to be made for under-prepared mathematics students for this to occur. The next principle states that mathematics had to be relevant and meaningful to the student, which involved understanding word problems and knowing how to solve them. The third principle suggests that mathematics should be taught using a laboratory approach with active student participation. The fourth principle declares that technology should be a major component of an up-to-date curriculum. The fifth principle suggests establishment of a carefully balanced educational program that stresses content and instructional strategies. The sixth principle states that college mathematics should give students better options in educational and career choices. The last principle says that there should be more students who choose mathematics as a career and who participate in mathematics (AMATYC, 1995).

In Crossroads in Mathematics (1995), technology is recognized as a resource to enhance learning. Mathematics teachers are encouraged to help students use

the appropriate technology to make them better prepared for the workforce. It was determined that technology could be used to help students become better problem solvers and enhance mathematical thinking and reasoning. To better understand mathematics, technology should be used in two ways: to aid in understanding of mathematical principles, and as a tool to solve realistic mathematical problems. Technology is looked on as a tool to enhance the study of mathematics, but it is not the main focus of instruction. Teachers are expected to model the use of appropriate technology as they teach. The effort spent on teaching students to use technology is considered an investment in their future (AMATYC, 1995).

The New York Times published an article by Peter Appleborne (1996) summarizing a report by the Third International Mathematics and Science Study. A study of mathematics and science achievement was conducted among 500,000 students in 41 different countries. This survey showed that the United States ranked 28th in mathematics and 17th in science. The highest-ranking countries set national or federal educational standards and expectations, and all schools in these countries were expected to follow these guidelines. Appleborne indicated that the mathematics and science reform standards set in the United States were written by professional organizations, but nationwide educators were not encouraged to follow the guidelines. Many countries took the standards set by these professional organizations in the United States and adopted them as part of their own national or federal educational standards (Appleborne, 1996).

Appleborne reports that in the highest-ranking countries individual students

were tracked and expected to perform. The teacher notified the parents if students fell behind in their studies. Steps were then taken to improve the performance of the student. Education seemed to be a top priority in the upper ranking countries from the first day that a student entered school. He reported that student study habits and daily activities were very similar around the world (Appleborne, 1996).

Appleborne states that a goal was set in the United States in 1990 to be number one among the world in mathematics education by the year 2000. Based on the Third International Mathematics and Science Study survey, the United States fell behind in achieving this goal, even though it had improved from earlier studies that ranked the United States below average in mathematics and science. Appleborne recommends that in the United States attention needs to be directed to the basics: curriculum, instruction, and the demands of the students. The report implies that schools in the United States taught too many concepts in fragmented ways, which produced inferior results. Appleborne implies that the United States has a lot of catching up to do when it comes to education, and the state and federal government should assume an important role in improving educational outcomes (Appleborne, 1996).

In Appleborne's (1996) article, he reports that Bruce Alberts, president of the National Academy of Sciences, believes this country has failed to accentuate the value of education. Appleborne indicates that the educational experience of the American school child could improve if the educators in the United States would take the mathematics standards that have been established and seriously

implement them into instruction. He deems that it is the responsibility of the educational system to provide the needed support and the necessary training for teachers in mathematics and science. Appleborne suggests that the government should allot more money in the educational budget for training and establishment of national educational goals and reform (Applebome, 1996).

A study was conducted in 1991 to see if teachers were implementing the NCTM standards in their instruction. One of the main components of the standards is the focus on implementation of technology. A survey was distributed to every mathematics department chair in all public high schools that had a twelfth grade class within a 100-mile radius of Chicago. The sample included four states: Illinois, Indiana, Michigan, and Wisconsin. Approximately 550 schools were surveyed. Responses came from 397 schools, about 72% of the sample. In the survey, the chairs were given a list of seven software packages and asked if they were used in instruction. The report shows that the graphing, drill, and exploration software packages were used most, whereas the statistics packages were used least. The report found that little emphasis was placed on statistics and probability as topics in first-year algebra classes. Researchers asked about the use of calculators and computers to support problem solving, the use of calculators or computers for graphing, and the use of tests that required calculators and computers. Based on the data gathered, the study concluded that instruction was shifting toward the standards. The data indicate that the use of calculators in instruction had increased drastically since 1986, but the use of computers in instruction did not show a significant increase (Garet & Mills, 1995)

The NCTM wrote the Assessment Standards for School Mathematics in 1995 to expand and complement the 1989 Curriculum and Evaluation Standards. The previous documents composed by the NCTM were designed to illustrate mathematical goals for all students and to represent major changes in the way that students were taught, but little change occurred in assessment methods. In the assessment document, student assessment was to be associated with instruction, various forms of assessment were to be used, appropriate assessment for the content taught was to be implemented, all topics of mathematical knowledge were to be assessed and, when evaluating the quality of a program, instruction and curriculum were to be considered equal (NCTM, 1995).

In addition to the standards developed by the NCTM, several mathematical interest groups and even the business world have tried to develop standards to help educators train future employees. Many business organizations are concerned with the lack of skills their employees possess. Their employees need organizational and technological skills to compete in the global economy. Many jobs require individuals coming from high school and post-secondary institutions to possess certain workplace skills such as problem solving, effective communication, and personal interactive capabilities, all of which are greatly enhanced by computer learning (D'Ignazio, 1993).

The National Council of Teachers of Mathematics (NCTM) revised their standards in 2000 to help guide and improve mathematics education. The Council had a vision of classrooms where all students would have access to

valuable mathematics instruction. The principles for school mathematics include equity for all students, a coherent curriculum, effective teaching methods, active learning, informative assessment, and enhancing technology. The criteria needed to facilitate these principles include a solid mathematics curriculum, knowledgeable teachers who can integrate instruction with assessment, educational policies which address successful learning, technologically accessible classrooms, and commitment to excellence. Mathematics plays a crucial role in providing opportunities for students' futures in this frequently changing world. Mathematics has to be an integral part of life, cultural heritage, the workplace, and the scientific and technical community (NCTM, 2000).

In the 2000 NCTM standards document, technology is stressed as a major component of effective teaching. Technology has been implemented to foster understanding and intuitions rather than to replace basic understanding of mathematics. Technology can and should be used to improve student decision-making, reflection, reasoning, and problem solving. Technology allows students to view ideas from multiple perspectives. Effective technology enables students to get instant feedback, allows them to focus and share ideas, and allows for adaptations for special needs students. Teachers play a crucial role in determining how technology can be used successfully in the classroom (NCTM, 2000).

Edwards (2002) suggests that for computer technology to work in education standards have to be established and reestablished as the process evolves, but the major emphasis must be on student learning. The initial stages of

implementation of computers into the learning process must include planning for assessment and revisions. Few, if any, guidelines have been established for integrating computer technology in the classroom because doing so is a relatively new process. Software developers have to establish methods to improve existing strategies, to implement new strategies, to learn what works in different situations, and to determine the most valuable end results (Edwards, 2002).

Implementing Computer Technology into the Classroom

The new standards frequently insisted on use of technology. Indeed, many technological creations were believed to be the answer to improved learning prior to the creation of the standards. Implementation of technologies such as radio, television, overhead projectors, and VCR's in the classroom allowed teachers to continue to do the same things they were doing in the past, only more efficiently. These technologies did little to improve learning in the classroom, but because of their low cost many people did not question their usefulness. With the advancement of computers, there has never been a greater opportunity for technology to help reform the learning process, but the higher cost of computers will require more research to justify their use in the classroom. There will be higher learning expectations from the use of computers than any other technology that has been used in the past (Thorpe, 2002).

Fulton & Honey (2002) propose that today's graduates enter completely different working environments than ever before. To be successful workers, they have to be well endowed with a variety of skills. These skills must include

teamwork, higher-order and critical thinking skills, confidence in communication in various areas and methods, the ability to take initiative, and the ability to reason, process and critically analyze information in various forms. Meeting the needs of all students means schools have a great challenge ahead of them. Schools must tailor a plan to meet the needs and priorities of their students. Technology can be an effective tool that can be used to help prepare students for this frequently changing work environment. Implementing technology will continue to be a challenge, but it can be used as a great instrument for educational change (Fulton & Honey, 2002).

The use of computer technology in the classroom is bringing focus to the techniques being used to advance student learning. With the methods of instruction being the focus, the educational system must utilize more feedback to address what is working and what is not. Evidence will have to be gathered in order to develop new strategies to improve learning. A new relationship will have to take place among teachers, students, and the learning process, one that fully integrates computer technology as a method of instruction (Thorpe, 2002).

With the use of computer technology, teachers are able to expand their curriculum to include worldwide information, whereas textbooks seem to limit the amount of information that is available. Students can now be moved from information gathering to creative performance-based work that involves more in-depth critical thinking. As with any change in curriculum, end results of learning will need to be assessed. Implementing computer technology in the classroom calls for research that reveals how technology impacts the learning process and

how improvements can be made over time to enhance the methods being used (Thorpe, 2002).

Thorpe (2002) implies that many issues pertaining to cost must be considered when implementing a successful learning program using technology. Teachers must be wholly committed. There must be an established process for implementing the new method of instruction in order to make it an overall success, and there has to be a period of commitment established before the program is implemented in order to produce overall valuable results. Adequate planning and end result evaluations are required if computer technology is to have a successful impact on learning. Thorpe believes that schools must learn to utilize and integrate computer technology into the educational practices of the classroom (Thorpe, 2002).

To this point, technology integration has been used primarily to support current methods of teaching. With the push for mathematics reform using technology, the focus needs to be redirected to finding new ways to use technology to transform teaching methods and thereby improve learning. Since children progress in their learning at different rates, technology can be used to allow for time variation in their achieving set standards. Technology can be used for instructor-supervised individualized instruction, which can help to develop a learner-focused environment. Software programs have been developed to assess the knowledge of students, and create a plan that when followed will help strengthen the students' weaknesses. This type of software will produce an individualized instructional plan based on the objectives that the student has not

mastered. This type of instruction transforms the teacher's role from presenter of material to provider of methods to meet the needs of the individual learner. The individualized lesson plan enables a teacher to assist each student in finding the necessary resources the individual student needs to succeed. This method of instruction places the responsibility of learning back on the learner and not primarily on the teacher, which is a very new concept in the field of mathematics (Reigeluth & Joseph, 2002; McKinney, 1996).

Several areas need to be addressed for this educational paradigm shift to successfully occur. A list of set objectives has to be established in order to determine achievement. The students are no longer competing against each other for grades, but they are competing against themselves in order to achieve their individual objectives. A teacher must be able to help a classroom of students who are all in different places in their learning processes, map their learning advancements, and document their accomplishments. The right computer software program can help the teacher track each student's progression and accomplishments. Technology used in this capacity can transform teaching and learning. A classroom of students can all be at different places in the learning process if the students are using computers for instructional purposes. Using computers in this way encourages mastery learning, which occurs when students successfully meet all the previously set standards. The results of each student can be monitored by the computer software program and recorded for the instructor and the student. The teacher can walk around and address the individual needs of the students while the

process of learning is occurring. Students can help each other, which sequentially reinforces concepts that the students have mastered (Reigeluth & Joseph, 2002).

Thus, technology can be used in the classroom to perform several basic functions. Technology can present students with drill and practice problems, provide them with computerized instruction, lead them through steps in working problems, and present them with small video clips that model certain concepts. Technology can allow students to explore the world around them using simulations and microcomputer-based laboratories. Students can use technology to manipulate data; they can create, compose, store, and analyze. Technology can also be used to help students communicate with other people. Students can be exposed to new ideas, conduct research, explore, and problem solve, all in one class period. However, the teacher must determine the specific purpose of technology to address student learning and achievement for it to be effectively used. Technology is ever changing and offers many different opportunities for students to discover (Honey, Culp, & Spielvogel, 1999).

Johnston (1996) suggests that the use of technology does more than assist in mathematics instruction; it plays a critical role in the success of individuals in a growing technological world. Computer use demands logic and accuracy. Technology in the classroom can help advance existing talents and can help students overcome learning disabilities. The use of technology in the classroom can also help students develop a code of ethics. The students must learn of issues pertaining to confidentiality of information, unauthorized use of computer

software, and maintenance of public equipment. In addition to improved knowledge of academic subjects, students who use computers on a daily basis develop improved keyboarding techniques and are more intuitive when using basic equipment. Computer use helps to develop reading and understanding of technical resources, because the students have to become familiar with the use of manuals, on-line information, and on screen instructions. The classroom is a great place to provide instruction in technical reading and writing (Johnston, 1996).

Johnston (1996) compares educational technology with an Automatic Teller Machine. Educational technology can be used as an extra teacher similar to the way that the teller machine can be compared to the teller. The computer can be used to deliver information, to gather information, to provide drill and practice, and to evaluate. The computer, along with the right software program, can allow teachers to work on a more individual basis with each student and to offer more efficient and timely instruction of basic skills.

Johnston suggests that the classroom should become a workplace for students to use technology to explore more real life applications. Students should be allowed to focus on authentic problems, issues, and opportunities. Johnston is of the opinion that real life problems along with the right technology help students analyze, plan, and report data in a more consistent format (Johnston 1996).

The NCTM Standards (1989) suggest that the high school student needs to be prepared for a continually changing world when he/she graduates from school. In technology, the student needs to be confident in his/her mathematical

ability as a mathematical problem solver as well as his/her ability to communicate and reason mathematically. Computing technology allows schools to provide a better and more accessible mathematical experience for all students.

Mathematical understanding is developed when the students perform data analysis, problem formulations, and mathematical modeling using computers and calculators (NCTM, 1989).

The NCTM Standards (1989) propose that the way students are instructed in their first years of school can help establish their view of technology and mathematics. Students need to know that the best way to compute mathematics is not always with the calculator. Frequent use of mental mathematics and estimation in addition to calculators can help students make rational decisions and have a more realistic view of computations. The students should realize that the best use of calculators is as an aid to help solve problems that require tedious calculations. Estimation can help students check to see if they are calculating reasonable results. Mental computations and estimations should be developed prior to and in connection with paper-and-pencil computations. Traditional instruction suggests to students that computing means pencil-and-paper. Instruction should include a mixture of estimation, mental mathematics, paper-and-pencil calculations, and the use of technology. Students need to learn how to do each method of computation and to choose which one to use in various situations. Technology should include calculators, computers, videos, and access to the internet when appropriate. These devices help the student concentrate on the problem instead of the tedious computations, and the student

will have new means to explore mathematical content. The skill and understanding required to make proficient use of technology becomes even more important. Basic skills instruction, therefore, should incorporate other ideas besides computational proficiencies. Because of improvements in technology, advanced mathematics courses such as geometry, probability, statistics, and algebra have become more important and accessible to students. Students should have a growing interest in exploring mathematical ideas. This interest can be nurtured by the use of technology and presentation of challenging mathematical situations in the classroom. Students should be able to use mathematical reasoning in real-life situations by the time they reach the middle school years (NCTM, 1989).

Because of the present and future importance of technology in learning, teachers must require new skills. In an article by Jamie McKenzie (1993), the writer declares that teachers of today's children need to be capable of implementing technology in the mathematics classroom. Training in the use of new technology and mathematics should be required of new teachers. The expectations and timelines need to be emphasized in the structure of licensing, certification, and employment requirements. New teachers should be willing to commit to training on a regular basis to enhance their proficiencies. McKenzie says that if a faculty member is within three to five years of retirement, then he/she should be given the option to sign an agreement to refrain from training in exchange for a commitment to retire before the end of the five-year period. Faculty members, who have more than five years before retirement, should be

required to attain literacy within a certain time period. Once the teacher is educated and trained, he/she should be required to maintain their skills (McKenzie, 1993).

Though teachers are given equipment to work with in most schools, often they are not given the training and instruction on how to use the equipment efficiently. McKenzie (1994) explains that teachers are not being given staff development opportunities to improve their technological expertise and confidence. Most teachers are expected to teach themselves (McKenzie, 1994).

Because of this common problem, McKenzie (1993) proposes that a staff development planning committee at institutions should be established to provide the training needed by faculty members. The following guidelines were discussed:

- The program should meet the needs of different learning styles of the participants.
- Faculty members should be given the opportunity to practice the new technologies as they would be used in their classrooms.
- Time for learning new technologies should be provided on a paid basis by the school district.
- Instruction should be provided with the comfort of the learner in mind.
- Staff development should also take into account other opportunities of learning such as those available from other schools, businesses, and graduate courses.

- Administrators should also be expected to achieve literacy in the use of technology.
- The instructors for staff development should be selected from a broad range of teaching staff and support groups.
- Help lines should be established for the teachers so that they can ask questions and receive help.
- Technology should be integrated with staff development activities, and demonstration of teacher mastery, literacy, and competency should be established along with innovative thinking skills and group decision-making.

McKenzie seems to think that the use of technology in instruction will change the teaching and the learning of mathematics to establish a thriving environment of learning (McKenzie, 1993).

Similar to McKenzie, Johnston (1996) suggests that administrators should look for and reward the use of technology in the classroom, invest in up-to-date technology, and solicit partnerships with businesses, government agencies, universities, and other organizations for involvement in educational programs and for funding to support technology innovations. Educational leaders must be willing to learn technological skills in order to help guide teachers and students in the technological age (Johnston, 1996).

Reigeluth & Joseph (2002) agree that, with the persistently changing needs of today's society, traditional lecture-based methods of instruction should be reexamined and changed in order to shift to a learning-focused environment

incorporating technology. New methods of instruction must be established using available technology. Changing teaching methods to integrate the use of computers is a never-ending process. The authors indicate technology should not be used to support instruction primarily, but it should be used to transform teaching and learning (Reigeluth & Joseph, 2002).

The previous authors reveal that it is essential to continuously conduct research to determine what is working in the field of computerized instruction. Theorists have debated the effects of technology on the learning process over the years. One of the first theorists to emerge was Richard Clark in 1983, and he had the viewpoint that technology had no effect on student learning. His thinking caused many researchers to question how technology influenced learning. In 1994, Robert Kozma examined ways that technology could be implemented into the learning process in order to help students accomplish certain tasks. He learned the use of computers does not guarantee that learning is taking place. The learner plays a major role in the success of the learning process. Every student has his or her own set of learning styles, motivations, and previous experiences. The teacher also plays a crucial role in the learning process. Teachers must be trained in order for technology to be used successfully in the classrooms. The use of a piece of software is not going to be the only method of instruction that a student needs in order to be a successful learner. The teacher has to be available to help students make learning connections. Teachers must integrate computerized instruction along with other resources in order to motivate and excite the student in the learning process (Mellon, 1999).

Evaluating the Implementation of Computerized Instruction

In 1985, Richard Clark suggested that the ideal way to measure the impact of technology in the learning process is to conduct a study that compares two classes taught by the same instructor. The teacher should use the same methods with the same materials. The difference in the two classes would be that one class has access to computers to supplement the learning process and the other class does not. Clark suggested that research should compare what was occurring in the classrooms and not the end results of student learning (Means, 2002).

The United States Department of Education Expert Panel on Educational Technology seems to disagree with this method, suggesting that the computer provides a different type of learning if used successfully. Computers provide a type of instructional media that cannot be reproduced with just a textbook. The Panel suggests that educational computer-based studies should compare the different effects that occur from using a combination of materials such as computer software programs, textbooks, and various media, along with teacher instruction. Some of the students learning outcomes that the Panel suggests evaluating are as follows: understanding and attainment of competencies in subject areas, ability to communicate ideas clearly and think creatively, ability to be a critical consumer and producer of technology, and preparedness to use technology in the work place. The Panel established a process for evaluating effectiveness. They suggest that research should include a fully described method, an appropriate sample size, clearly and completely documented results,

analysis of the data for various groups, and support of key claims by use of numerous methods. Means (2002) explains that implementing technology is not an easy process; it can be very intricate and take many hours of devotion. She suggests that it is very hard to be objective in the evaluation of a program if the person who is using or even designing the program is conducting the evaluation. Consequently, it stands to reason that it would be better to allow evaluation to be conducted by an outside observer (Means, 2002).

Honey, Culp, & Spielvogel (1999) state that in the past many different technologies have failed to have a significant impact on student learning. In order to better address this deficiency there must be an established set of standards constructed that concentrate on student achievement and expectations concerning how technology can support student learning. The integration of technology with student learning should accentuate the student's ability to access information, interpret the information, and synthesize information. These goals are very different from the traditional rote memorization and attainment of individual skills. Integration of technology should be used to help students make connections with other knowledge and form thought-out conclusions about information (Honey, Culp, & Spielvogel, 1999).

A few studies have attempted to measure the effectiveness of computerized instruction in various areas of mathematics. Hamtini (2000) conducted a research study that compared computerized instruction to no computer instruction in developmental algebra courses at a university. The focus was directed toward student attitudes and achievement in this study. The Interactive Mathematics

program was used in the computerized instruction classes. A pre-test was given to students at the beginning of the semester in order to determine the attitudes and achievement of the students concerning developmental algebra. At the end of the semester a posttest was given to determine if there were any changes in the student's attitudes and achievement. The researcher used the test scores to compare the two groups of students. The traditional lecture-based classes showed a significantly higher amount of achievement than the computer classes. The attitudes of the traditional classes did not significantly change, but the attitudes of the computer classes did have a positive change. Even though it is possible that the use of computers was responsible for this change, the researcher indicated that these outcomes might have been due to confounding variables such as age, gender, and amount of classroom instruction (Hamtni, 2000).

Also, Baharvand (2001) conducted a research project in geometry that compared the effectiveness of computer-based instruction to a traditional lecture-based instruction. A pretest and a posttest were given to determine the effect of using a software program called Geometer's Sketchpad versus instruction that utilized strictly paper and pencil activities. This study examined student performance, student retention levels, and student attitude toward learning geometric concepts. This study used only a small group of 26 seventh graders in the control group and 24 seventh graders in the experimental group. The report showed that the experimental group scored significantly higher on the posttest than the control group. The experimental group also showed a significant

difference in the students' positive attitudes toward the subject. This study showed that implementing computerized instruction was an effective tool in improving learning in geometry (Baharvand, 2001).

Another study by Zumwalt (2001) examined the effectiveness of computer-based instruction in a pre-algebra classroom. Two different types of computer-based instruction were compared to lecture-based teaching strategies using a sample of 350 eighth graders from six different schools. Ninety-four students received traditional lecture-based instruction. In the computer-based instruction, 162 students used Accelerated Mathematics and 94 students were taught using Jostens computerized curriculum or Computer Curriculum Corporation (CCC) software. A basics skills test was given to each student in October and again in May. The difference in the scores was used to measure academic progress. All groups showed significant gains. The group that used the Accelerated Mathematics program scored significantly higher than the students that received the lecture-based instruction and the students that were taught using Jostens or CCC software. Students that were originally in the bottom quartile and were taught using the Accelerated Mathematics program performed significantly higher than the other two groups. However, there was no significant difference in the students that were originally in the upper quartile (Zumwalt, 2001).

Evaluating the Success of Developmental Mathematics Students

Since developmental mathematics has been part of college curricula for decades, a common focus has been the measurement of the success of these

programs. A group of ten mathematics instructors jointly formed the Pathways Taskforce in 2000 under the direction of a National Science Foundation Grant and a Lumina Foundation Grant. Their main focus was to adapt, implement, investigate, and determine strategies that could be used with at risk community college students in elementary algebra courses. Information was collected by the taskforce using surveys that were gathered from 107 community colleges throughout California and from examining information from the American Mathematics Association of Two Year Colleges (AMATYC) and the California Mathematics Council of Community Colleges (CM3). The surveys were used to identify programs and strategies that were being implemented to increase student success in beginning algebra classes. The taskforce's report stated that members from AMATYC considered student success to have several different elements. These parts include:

- The cumulative grade point average of the student
- Improved feelings toward mathematics
- The student's ability to use mathematics on the job
- The grade in the previous course
- The grade in the succeeding course
- Retention
- Persistence (even if the student did not make a passing grade)
- Improved study skills
- Attainment of the student's goals

The taskforce also reported that CM3 viewed student success with the following essentials:

- A student earns a C or better
- The student is more fervent about mathematics
- The student is not as anxious about mathematics
- The student can do well on a statewide standardized test
- The student is successful in the next class
- The student's critical thinking skills progress
- The student is successful in the following mathematics course where elementary algebra is a requirement
- The student believes that he/she is successful, based on student evaluations
- The student has the confidence to take an additional mathematics course
- The student requests the same mathematics instructor
- The student can utilize the mathematics
- The student files the textbook for reference (Pathways Task Force, 2000).

From examining the available information, the taskforce developed a plan to best determine the success of at risk students in college mathematics courses.

There are three actions in this plan that has to occur for a student to be considered successful in mathematics. The first factor in success is a passing grade in an elementary algebra course, which in this case would be considered achievement. The next factor is persistence in mathematics courses, where the

student enrolls in mathematics courses that follow elementary algebra. The last factor to consider is performance in college-level courses that follow an elementary algebra course. These college-level mathematics courses should use elementary algebra as a prerequisite (Pathways Task Force, 2000).

The taskforce defined a successful student as one who receives a grade of an A, B, C, or CR on the final roster. This definition does not include student learning; therefore, the task force had to examine the students' performance in mathematics courses that follow elementary algebra. When a student registers for another mathematics course it shows persistence even if the student did not make a passing grade in elementary algebra. The grades that students make in mathematics courses that follow elementary algebra show that a student has actually learned the needed material to be a successful college mathematics student (Pathways Task Force, 2000).

Retention is a very important key in the success of the developmental mathematics student. Tinto (1993) states in 1993 there were about 2.4 million students who entered higher education for the first time. About 1.1 million of those students will leave the higher education system, never to return again. Retention is an area that has become priority in many colleges. Researchers are continuously seeking ways to better understand and identify variables of student retention. Many existing programs are coming under the microscope in order to identify specific areas of change that can better enhance the retention of college students. Approximately 77% of all first-time students will enter higher education in the fall semester, rather than the spring semester. The majority of these

students will be high school graduates that graduated the previous spring (Tinto, 1993).

In the community college environment, there is a smaller number of recent high school graduates than in the university setting. The community college population consists of a higher percentage of adults who began their higher education career after being out of high school for many years. The first year of college is very important because the majority of students that depart will leave within the first year of their educational endeavor. Beginning college experiences can have a significant influence on student retention and, consequently, on the success of the student. The student enters with set expectations, and if these are not met, then the student may leave the college. Modifications often have to be made to the learning environment in order to prepare for students with these expectations. The student's needs must be met in order to produce a successful college student. To accomplish this, students' needs must be identified at the beginning of their college experience. Once the needs are identified, then the student can be counseled, advised, and accurately placed in first-year courses. If a student is actually learning a subject, then that student is more likely to continue on with his/her education and be retained. Obviously, a major aspect to helping the student actually learn is to develop the classroom, the main environment beneficial to learning. Classrooms are small learning communities that are made up of students and teachers. Student involvement in the learning process, encouraged by a supportive classroom, is very important in getting the student interested in learning. Students must be actively engaged in the

classroom and in the educational process. The teacher plays a crucial role in student learning and therefore in student persistence. Teachers must encourage student involvement in the intellectual and social aspects of the classroom in order to encourage persistence as well (Tinto, 1993).

Examining effective retention plans on different campuses shows similarities. The campuses are committed to the welfare of the student and to education, not merely retention. Moreover, the campuses emphasize the social and intellectual communities of the student. Student departure can occur anytime during the higher educational process; therefore, retention studies must be an ongoing process in order to gather information continuously to connect the learning institution with the success of the student. Tinto suggests that the actions of institutions may play a key role in the retention of the college student. In today's society, a college degree is very important because of the occupational, monetary, and social rewards that come with the attainment of higher education. Therefore, it is very important to meet the needs of the students in order to retain them and, in turn, produce successful students (Tinto, 1993).

Persistence is another area that affects the success of the developmental student. Students must be persistent in order to achieve their goals. Many college students come to an institution with specific goals in mind, and these goals do not necessarily involve completion of a degree. Numerous students attend college in order to enhance certain skills. These skills may be used on their jobs or even to help their own children with their education. In the college setting, working toward a goal is a very important part of persistence. The first

year of college seems to be the most important year in establishing persistence. By examining a student's first year of college, one can see a pattern to the persistence of that student. A student has to be able to adjust both socially and intellectually as well as being able to perform academically. The college experience must be satisfying in order for the student to persist until goal attainment (Tinto, 1993).

In a study by the New York State Education Department, several factors were identified that can help increase the persistence and retention rates of at risk students. Some of the factors are as follows: there must be positive faculty and student relationships, retention services must be made available to the students, special courses and support services must be made available for new and returning students, and at risk students must be identified before they encounter serious academic problems (Parker, 1989).

Summary

Honey, Culp, & Spielvogel (1999) suggest that the researcher must assess changes in student performance when examining the impact of technology. Assessment has to be appropriate to the learning outcomes that have been supported by the technology. They state that technology can no longer be used just for technology's sake, but there must be set plans that center around educational goals. The researcher must investigate to see if the technology is accomplishing its intended purpose. Many educators expect technology to solve the educational problems with student learning and achievement. For technology

to be used successfully there must be new learning goals established, and new teaching strategies implemented. There must also be a student-centered environment that promotes collaboration, engaged learning, self-direction, and opportunities to use higher order thinking skills. Learning how to use the tools may take more time than the actual learning process, when new technologies are introduced into the classroom (Honey, Culp, & Spielvogel, 1999).

Honey, Culp & Spielvogel (1999) reported that since technology has been implemented in the classroom, researchers have been trying to evaluate whether it has a significant impact on student achievement. In order to judge the impact of the technology on the learning environment, the researcher must examine several different variables. They suggest that the researcher must understand how the technology is being used in the classroom, what instructional goals are being addressed, the type of assessment used to assess student achievement, and any changes that may occur in the learning environment (Honey, Culp, & Spielvogel, 1999).

Helping students to attain their educational goals is one of the greatest challenges of the community college, since there are so many students who are entering college unprepared. We are in a time period where technology is constantly changing and this causes the community college to be challenged. Many college students have outside barriers that hinder their persistence and retention, and, in turn, their achievement. For students to be successful there must be an early intervention process for these at risk college students. Community colleges must view these challenges as opportunities to cultivate

academic persistence, retention, and achievement of educational goals, and this in turn produces successful college students (Parker, 1998).

The literature review shows that community colleges play a significant role in providing the necessary remediation needed by a growing number of first time entering college students. The need for developmental education has increased significantly over the years, especially in the area of mathematics. Many mathematics educators have joined together with other organizations in order to establish necessary standards that can be used in mathematics classrooms to help produce successful mathematics students. These standards suggest that the utilization of computer software can be an effective tool to help prepare students in the area of mathematics. The literature review shows that evaluating the implementation of computerized instruction is a major component in determining the effectiveness of its use; the evaluation can be used to make changes in the areas that are not effective. Further, the literature stresses the importance of carefully designed research studies that evaluate the effectiveness of computerized instruction. Besides evaluating the implementation of computerized instruction, the literature review suggests that it is important to evaluate the success of students when computer technology is used to enhance education. With more students seeking college degrees, it is also necessary to evaluate the success of developmental mathematics students in the areas of achievement, retention, and persistence, and determine whether computer instruction is effective in improving these measures.

This study partially meets the need for conducting such research. Based on the Review of Literature, this study was designed to examine the effects of incorporating computerized instruction into developmental mathematics courses. The study examined the achievement, retention, persistence, and success of the mathematics students enrolled in these courses.

CHAPTER III

METHODOLOGY

The purpose of this study was to examine the effects of incorporating computerized instruction into developmental mathematics courses. The study examined achievement, retention, persistence, and success of students who began in Elementary Algebra, progressed into Intermediate Algebra, and subsequently obtained their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, and Contemporary Mathematics. This study tried to answer the following research questions based on a sample of community college students enrolled in elementary algebra courses at Chattanooga State Technical Community College (CSTCC).

1. How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
2. How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
3. How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
4. How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?

5. How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?
6. How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

Design of the Study

In order to try to answer the questions that were presented in the previous section, this quasi-experimental design study compared the achievement rates, retention rates, persistence rates, and success rates of two groups of students who began in Elementary Algebra, advance into Intermediate Algebra, and later obtained their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, and Contemporary Mathematics. The two groups consisted of a group that was taught using a lecture-based method and a group that was taught using computerized instruction.

Two measures were used for comparing the achievement rate of each group. The number of students that completed Elementary Algebra with a grade of A, B, or C determined one measure of achievement. The other measure was determined by final exam scores, using seventy or above as passing. The number of students from each group who signed up for a mathematics course

the following semester was used to determine the retention rate. The number of students from each group who registered for a mathematics class the third semester was used to determine the persistence rate. The number of students from each group that completed a college-level course with a grade of A, B, or C by the end of the third semester was used to determine the success rate. The data covered a three semester time period that began in the fall of 2002 and ended at the close of the fall 2003 semester. The researcher examined descriptive data that was gathered from each subject including age, gender, and ethnicity.

The CSTCC Office of Institutional Research provided all data except for the final exam scores. The CSTCC Mathematics Center provided the final exams from which the researcher gathered the final exam scores along with the number of correct and incorrect responses on the exams. The table in Appendix A was used to gather individual student data for each class in the study. The table in Appendix B was used to collect the correct and incorrect responses to exam questions in order to calculate the reliability of the final exam.

Setting

The site for this study was Chattanooga State Technical Community College (CSTCC), located in Chattanooga, Tennessee. CSTCC has an open door admissions policy that allows students from various educational backgrounds to enroll in higher education. Many of the students are unprepared for college level mathematics when they enroll. Developmental Mathematics courses are

provided to give students an opportunity to improve their math skills and become successful college level mathematics students.

The Office of Institutional Research at CSTCC reports on its Intranet site, a total enrollment of 8,411 students during the fall 2002 semester. Approximately 39% of the students were male and 61% were female. The ethnicity of the college consisted of about 16.9% Black, 1% Hispanic, 79.7% White, 1.9% Asian, and .4% other. When examining the age of the students, about 5.5% were 17 years old or less, 26% were 18 to 20 years old, 21.9% were 21 to 24 years old, 25.7% were 25 to 34 years old, 20.5% were 35 to 64 years old, and .1% were over 64 years of age. These data can be viewed in Table 1.

Population

The population of the study consisted of students enrolled in Elementary Algebra at Chattanooga State Technical Community College (CSTCC) in the fall 2002 semester and advances into Intermediate Algebra, and then achieves their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, and Contemporary Mathematics. To make the samples more compatible, the researcher did not use any Elementary Algebra classes that were taught at off campus sites, at night, or in class periods of more than 50 minutes per class meeting because no computer classes were taught with these criteria. The courses that were used in the study were composed of those taught for 50 minute time periods, during the day, and

Table 1 CSTCC Fall 2002 Data

Chattanooga State Technical Community College Fall 2002 Data	
Gender	
Males	39%
Females	61%
Ethnicity	
Black	16.9%
Hispanic	1%
White	79.7%
Asian	1.9%
Other	0.4%
Age	
17 Years Old or Less	5.5%
18 to 20 Years Old	26%
21 to 24 Years Old	21.9%
25 to 34 Years Old	25.7%
35 to 64 Years Old	20.5%
Over 64 Years of Age	0.1%

on the main campus, using the lecture-based approach and the computerized instructional approach. These stipulations eliminated 391 students which narrowed the sample from a total of 774 students down to 383 students enrolled in the Elementary Algebra courses in the fall 2002 semester.

Procedures

The initial subjects were tracked over a three-semester period: semester one determined achievement rate, semester two determined retention rate, and semester three determined persistence and success. The table in Appendix A was used for collecting the necessary data.

Instrumentation

The students taught by means of computerized instruction used the Prentice Hall Interactive Math software package included in the Prentice Hall Interactive Math Introductory and Intermediate Algebra Student Package (Martin-Gay, 2002). The software was custom published to include all of the objectives that were required for Elementary Algebra at CSTCC. The textbook that was used for reference was Introductory and Intermediate Algebra Review, Reference, and Practice by Martin-Gay (2002). A description of the textbook and software can be viewed on the Prentice Hall website at http://www.prenhall.com/interactive_math. On the website it states that the software was designed to incorporate various learning styles. Students who learned best verbally could benefit most from the “read section” of the software, and students who were visual learners could gain

from the video clips. The discovery learners could profit from the interactive questions and learning activities to increase comprehension of the learning objectives. The Prentice Hall software allows a student to progress at his or her own pace. However, to make certain that a student was exposed to the most useful form of instruction all students were required to complete all three parts before they attempted the assessment part of the software. Students were required to make at least a 70% on the assessment before they could move to the next objective (Martin-Gay, 2002).

The students using the lecture-based approach were taught out of the textbook entitled Developmental Mathematics 5th Edition by Bittinger and Beecher (1999). This textbook is in a workbook format which gives students worked out examples along with similar problems that are located in the margin of the textbook. In this instructional approach, the teacher verbally explains the steps to working a problem, along with writing the steps on the board. The students are observing and taking notes during this process. After the teacher demonstrates how to work a problem, then the students may be given opportunities to work problems from the margin exercises in their textbooks. The students are then assigned homework problems that are located at the end of each section. The primary resources that are used in this classroom setting are paper and pencil along with the textbook.

The CSTCC Elementary Algebra Final Exam with a score of seventy or above, which counts as passing, was used to determine achievement rates.

Elementary Algebra students in both groups were tested at the end of the semester using the same final exam.

Data Analysis

The two groups consisted of students taught with either the computer-based instructional approach or the lecture-based approach. Both samples were larger than 30 and independent of each other. The samples were representational of past developmental mathematics students at CSTCC and future developmental mathematics students at CSTCC. The students self selected the courses in which they enrolled.

The two methods of instruction, computer-based and lecture-based, were compared using the following four factors: 1) the final exam test score and the final course grade were used to determine achievement, 2) retention rates were determined by enrollment in mathematics during the spring 2002 semester, 3) persistence rates were determined by enrollment in mathematics over a three-semester period, and 4) success rates were determined by successfully completing a college level course by the end of the third semester with a grade of A, B, or C.

Upon completion of data gathering, the data were analyzed using various statistical measures to accurately compare the two groups of students. Different statistical tests were used to analyze each question that was posed in Chapter I of this study. A summary of these statistical measures follows in this document.

A committee of developmental mathematics instructors from CSTCC worked together to develop the final exam that was used to test the Elementary Algebra students. The exam incorporated the objectives that were taught in the Elementary Algebra course. The CSTCC Elementary Algebra Final Exam is considered a valid instrument because it was developed by a group of professional mathematics educators.

The Kuder-Richardson (K-R 20) was used to determine the internal reliability of the CSTCC Elementary Algebra Final Exam that was used to determine achievement rates. This final exam was administered to all of the subjects during the fall 2002 semester. The researcher gathered the final exams and marked each question as correct or incorrect. The table used to gather the information can be viewed in Appendix B.

The following research questions were examined using various forms of data analysis.

Question 1: How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The final exam test scores and the final course grades were used to determine achievement. To examine the final exam test scores, a boxplot along with a histogram was constructed for each group. These graphical representations were used for comparison of distributions of the final exam test scores. The mean, variance, and standard deviation for the final exam test

scores were calculated for each group. The following hypotheses statements were tested:

H_0 : The population variance of the CSTCC final exam test scores of the students taught using the lecture method will equal the population variance of the CSTCC final exam test scores of the students taught using computerized instruction.

H_0 : The population mean of the CSTCC final exam test scores of the students taught using the lecture method will equal the population mean of the CSTCC final exam test scores of the students taught using computerized instruction.

An F-ratio test was used as the statistic to test for the homogeneity of variance. This test was used in order to test the null hypothesis and draw a conclusion. A 0.10 level of significance was used in this test.

A z test was used as the statistic for the difference of two means in order to test the null hypothesis and draw a conclusion. A 0.05 level of significance was used in this test.

Letter grades were also used to determine achievement. The final letter grades were gathered for each student. Students who made a grade of A, B, or C were considered passing. Students who made a grade of F, E, or I were failing. A proportion for each group was calculated. The following hypothesis statement was tested:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the

students passing with a grade of A, B, or C taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated and a z test for proportions was used to test the hypothesis statement and draw a conclusion.

A 0.05 level of significance was used in this test.

Question 2: How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The percentage of students that enrolled in a mathematics course during the spring 2003 semester was calculated for each group. The information was used to test the following hypothesis statement:

H_0 : There is no difference in the retention rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

Question 3: How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The percentage of students that enrolled in a mathematics course during the summer and fall 2003 semester was calculated for each group. The information was used to test the following hypothesis statement:

H_0 : There is no difference in the persistence rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

Question 4: How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?

The percentage of students that passed a college level mathematics course with a grade of A, B, or C during the summer and fall 2003 semester was calculated for each group along with the percentage that did not pass. The information was used to test the following hypothesis statement:

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

Question 5: How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?

The researcher examined each college level course individually. The percentage of students that passed College Algebra with a grade of A, B, or C during the summer and fall 2003 semester was calculated for each group along with the percentage that did not pass. This information was also calculated for the Introductory Statistics courses and for the Contemporary Mathematics courses. The information was used to test the following hypotheses statements:

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the College Algebra course.

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the Introductory Statistics course.

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the Contemporary Mathematics course.

A pooled estimate of the proportions was calculated and a z test for proportions was used to test the hypotheses statements and draw a conclusion. A 0.05 level of significance was used in this test.

Question 6: How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The percentage of successful students was calculated for the group taught with computers and the group taught using traditional instruction in each category: 17 years old or less, 18 to 20 years old, 21 to 24 years old, 25 to 34 years old, 35 to 64 years old, and over 64 years of age. The information was used to test the following hypothesis statement:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each category: 17 years old or less, 18 to 20 years old, 21 to 24 years old, 25 to 34 years old, 35 to 64 years old, and over 64 years of age.

A chi - square test was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

The percentage of successful males and females in the group taught with computers and the group taught using traditional approach was determined. The information was used to test the following hypothesis statement:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the

students passing with a grade of A, B, or C taught using a computerized instructional approach in males and females.

A pooled estimate of the proportions was calculated and a z test for proportions was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

The researcher calculated the percentage of successful students in each ethnic group for the students taught with computers and the students taught using traditional instruction. The following five categories for student ethnicity were used: Black, White, Hispanic, Asian, and other. The categories used in this research coincide with the categories that are currently used by Institutional Research at CSTCC. The information was used to test the following hypothesis statement:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each ethnic category: Black, White, Hispanic, Asian, and other.

A chi - square test was used to test the hypothesis statement and draw a conclusion. A 0.05 level of significance was used in this test.

CHAPTER IV

PRESENTATION OF THE FINDINGS

The purpose of this study was to examine the effects of incorporating computerized instruction into developmental mathematics courses. The study examined achievement, retention, persistence, and success of students who began in Elementary Algebra, progressed into Intermediate Algebra, and subsequently obtained their goal of completing an initial college-level mathematics course. The college-level courses consist of College Algebra, Introductory Statistics, and Contemporary Mathematics. This study tried to answer the following research questions based on a sample of community college students enrolled in elementary algebra courses at Chattanooga State Technical Community College (CSTCC).

1. How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
2. How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
3. How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
4. How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?

5. How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?
6. How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

This chapter presents the data and the findings of this study as related to the questions that were presented in the study. The collected data can be viewed in Appendix C and Appendix D. Throughout this paper, an alpha level of 0.05 was used for all z tests and an alpha level of 0.10 was used for the F-ratio test. The following research questions were examined using various forms of data analysis.

Question 1: How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The final exam test scores and the final course grades of elementary algebra students during fall 2002 semester were used to determine achievement. The final exam scores for the lecture and computer classes can be viewed in Appendix E. The final overall course letter grades for the lecture and computer classes can be viewed in Appendix F. A committee of developmental mathematics instructors from CSTCC worked together to develop the final exam that was used to test the Elementary Algebra students. The exam incorporated

the objectives that were taught in the Elementary Algebra course. The CSTCC Elementary Algebra Final Exam is considered a valid instrument because it was developed by a group of professional mathematics educators.

The Kuder-Richardson (K-R 20) was used to determine the internal reliability of the CSTCC Elementary Algebra Final Exam that was used to determine achievement rates. Two different forms of the final exam were administered to all of the subjects during the fall 2002 semester. Form A produced a reliability coefficient of alpha 0.8526 and Form B produced a reliability coefficient of alpha 0.8411. Table 2 and Table 3 show the results of the reliability test for Form A and Form B. The results of the Kuder-Richardson showed both forms of the final exam were reliable.

To examine the final exam test scores, a boxplot along with a histogram was constructed for each group. These can be viewed in Table 4 and Figure 1 along with Table 5 and Figure 2. These graphical representations were used for a comparison of distributions of the final exam test scores. The tables show the 5 - number summaries, along with the inter-quartile ranges (IQR) and outliers for the lecture classes and the computer classes. The figures show the boxplots that were constructed from the 5 - number summaries. The lecture classes had a minimum score of 30 on the final exam with a maximum score of 104. The computer classes had a minimum score of 24 on the final exam with a maximum score of 100. An extra credit problem was placed on both forms of the final exams, which accounted for the 104 score. The lecture classes had a score of 72.75 at quartile 1 and a 90 at quartile 3. The median of the final exam scores

Table 2 Reliability of the Elementary Algebra Final Exam Form A

Reliability of Final Exam Form A							
	Number of Cases	Mean	Variance	Standard Deviation	Number of Variables	Alpha	Standard Item Alpha
Statistics for Scale	70.0	20.1857	33.5157	5.7893	31	0.8526	0.8368

Table 3 Reliability of the Elementary Algebra Final Exam Form B

Reliability of Final Exam Form B							
	Number of Cases	Mean	Variance	Standard. Deviation	Number of Variables	Alpha	Standard Item Alpha
Statistics for Scale	80.0	20.1750	29.0323	5.3882	31	0.8411	0.8195

Table 4 Five Number Summary with the Inter-Quartile Range and Outliers
for the Elementary Algebra Final Exams of the Lecture Classes

Number Summary for Lecture Classes' Final Exams, Fall 2002
Minimum = 30
Q1 = 72.75
Median = 81
Q3 = 90
Maximum = 104
IQR = 17.25
Outliers: 46, 43, 42, 40, 31, 30

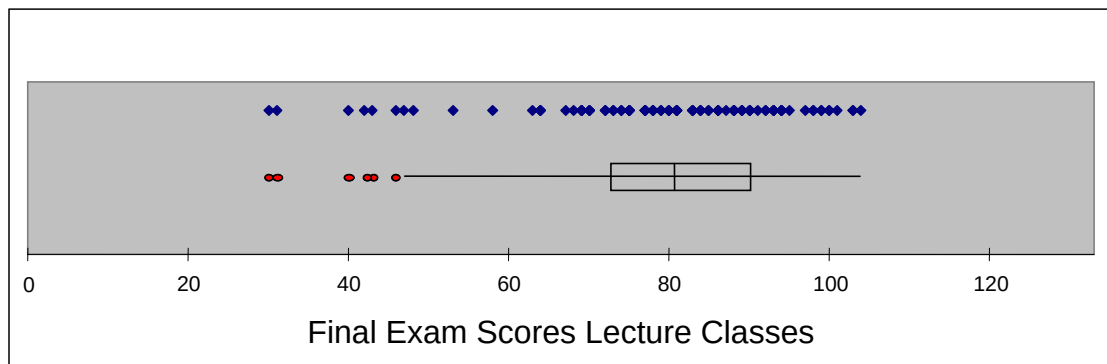


Figure 1 Boxplot for the Elementary Algebra Final Exams of the Lecture
Classes, Fall 2002

Table 5 Five Number Summary with the Inter-Quartile Range and Outliers
for the Elementary Algebra Final Exams of the Computer Classes

Number Summary for Computer Classes' Final Exams, Fall 2002	
Minimum =	24
Q1 =	65
Median =	77
Q3 =	85
Maximum =	100
IQR =	20
Outliers:	24

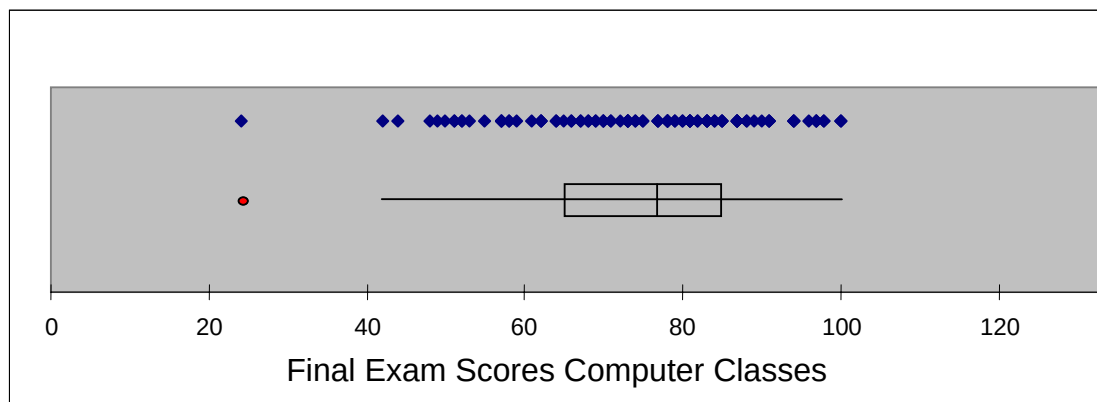


Figure 2 Boxplot for the Elementary Algebra Final Exams of the Computer
Classes, Fall 2002

was 81. The computer classes had a score of 65 at quartile 1 and an 85 at quartile 3. The median for the final exam scores was 77. The lecture classes' final exam scores were slightly higher in all three categories. The inter-quartile range for the lecture classes was 17.25 and 20 for the computer classes. The scores in the computer classes were more dispersed than the scores in the lecture classes between the 75th percentile and the 25th percentile. The lecture classes had several outlying scores 46, 43, 42, 40, 31 and 30 where the computer classes had a low outlier of 24. Overall, the students in the lecture classes scored higher on the final exam than the students in the computer classes.

Table 6 and Figure 3 along with Table 7 and Figure 4 show the frequency tables and the histograms that were used to compare the final exam test scores for the lecture classes and the computer classes. The frequency tables along with the histograms show that the majority of the lecture students and the computer students scored from 80 to 89 on the final exam. Upon examination of the histograms and the boxplots, both sets of scores are skewed negatively in their distributions. The lecture classes' scores have more outliers than the computer classes; therefore, the lecture classes' scores are slightly more skewed than the computer classes' scores.

The descriptive statistics for the final exam test scores were calculated for the lecture classes and the computer classes and can be viewed in Table 8 and Table 9. The lecture classes had a mean final exam score of 79, with a variance

Table 6 Frequency Distribution of the Elementary Algebra Final Exam
Scores for the Lecture Classes, Fall 2002

Frequency Distribution of	
Final Exam Scores for the Lecture Classes	
Final Exam Grades	Frequency
20-29	0
30-39	2
40-49	6
50-59	2
60-69	10
70-79	25
80-89	30
90-99	21
100-109	6

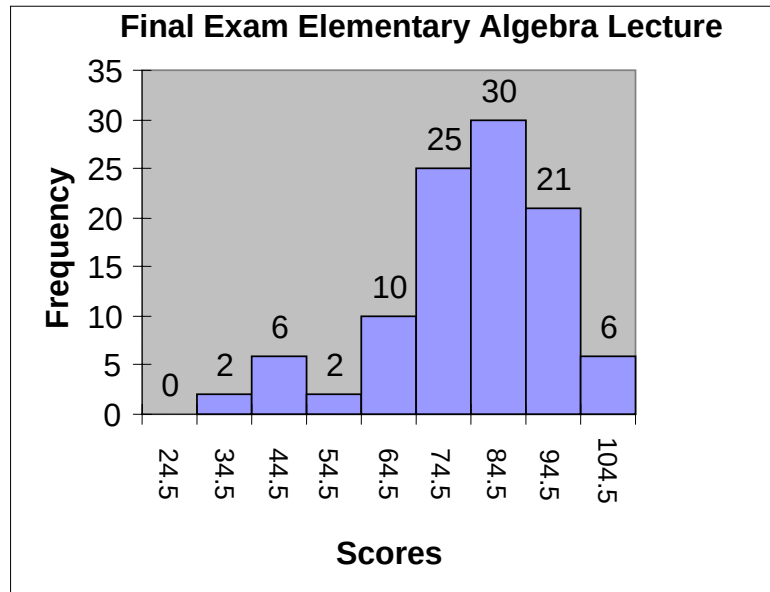


Figure 3 Histogram for the Elementary Algebra Final Exam Scores for
Lecture Classes, Fall 2002

Table 7 Frequency Distribution of the Elementary Algebra Final Exam
Scores for the Computer Classes, Fall 2002

Frequency Distribution of Final Exam Scores for the Computer Classes	
Final Exam Grades	Frequency
20-29	1
30-39	0
40-49	4
50-59	13
60-69	15
70-79	25
80-89	26
90-99	13
100-109	2

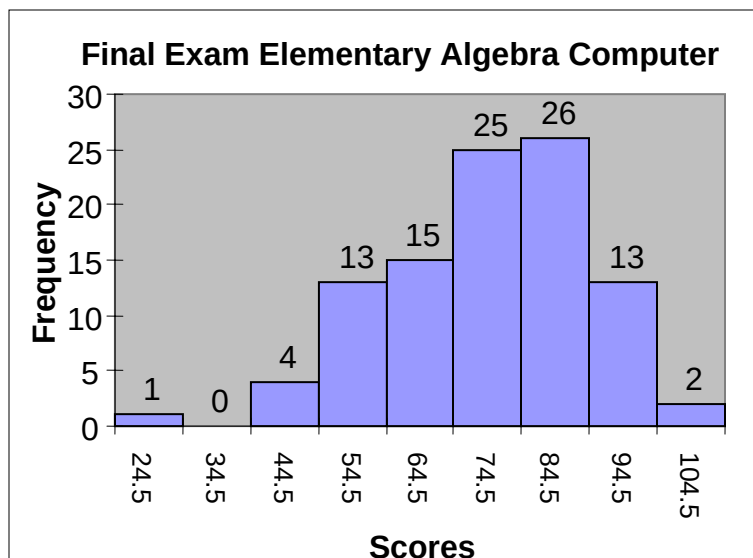


Figure 4 Histogram for the Elementary Algebra Final Exam Scores for
Computer Classes, Fall 2002

Table 8 Descriptive Statistics for the Elementary Algebra Final Exams of the
Lecture Classes, Fall 2002

Descriptive Statistics	
Lecture Final Exam	
Mean	79.3235
Standard Error	1.5358
Median	81
Mode	75
Standard	
Deviation	15.5106
Sample Variance	240.5775
Kurtosis	1.3707
Skewness	-1.0873
Range	74
Minimum	30
Maximum	104
Sum	8091
Count	102

Table 9 Descriptive Statistics for the Elementary Algebra Final Exams of the
Computer Classes, Fall 2002

Descriptive Statistics	
Computer Final Exam	
Mean	74.4950
Standard Error	1.5012
Median	77
Mode	73
Standard Deviation	14.9369
Sample Variance	223.1097
Kurtosis	0.2546
Skewness	-0.5616
Range	76
Minimum	24
Maximum	100
Sum	7375
Count	99

of 241 and a standard deviation of 16. The computer classes had a mean final exam score of 74, a variance of 223 and a standard deviation of 15. The skewness of the final exam in the lecture classes was -1.0873 where the computer classes' final exam had a skewness of -0.5616.

The following hypotheses statements were tested:

H_0 : The population variance of the CSTCC final exam test scores of the students taught using the lecture method will equal the population variance of the CSTCC final exam test scores of the students taught using computerized instruction.

H_1 : The population variance of the CSTCC final exam test scores of the students taught using the lecture method will differ from the population variance of the CSTCC final exam test scores of the students taught using computerized instruction.

H_0 : The population mean of the CSTCC final exam test scores of the students taught using the lecture method will equal the population mean of the CSTCC final exam test scores of the students taught using computerized instruction.

H_1 : The population mean of the CSTCC final exam test scores of the students taught using the lecture-based method will be greater than the population mean of the CSTCC final exam test scores of the students taught using the computerized instructional approach.

The results of the F-ratio test, which can be viewed in Table 10, showed there was no significant difference between the variance of the final exam scores for the students taught elementary algebra using the lecture method and the ones

Table 10 F-Ratio Test for the Homogeneity of Variance

F-Test Two-Sample for Variances		
	Elementary Algebra Exam Grades Lecture	Elementary Algebra Exam Grades Computer
Mean	79.32352941	74.49494949
Variance	240.5774607	223.1096681
Observations	102	99
Df	101	98
F	1.078292405	
P(F<=f) one-tail	0.354261831	
F Critical one-tail	1.294799186	

taught with computerized instruction, $F(101,98) = 1.08$, $p = 0.354$.

However, there was a significant difference in the elementary algebra final exam test scores between the lecture based students who had a mean score of 79 (SD = 15.5), and the students taught elementary algebra using the computerized instructional method who had a mean score of 74 (SD = 14.9), $z = 2.25$, $*p = 0.012$. The results of this test can be viewed in Table 11.

Letter grades in the course were also used to determine achievement. The final letter grades were gathered for each student. Students who made a grade of A, B, or C were considered passing. Students who made a grade of F, E, I or W were considered failing. A proportion for each group was calculated. The following hypotheses statements were tested:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach.

H_1 : The population proportion of the students passing with a grade of A, B, or C taught using the lecture method will be greater than the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated and a z test for proportions was used to test the hypotheses statements and draw a conclusion. The results of this test, which can be viewed in Table 12, showed there was a

Table 11 Z test for the Means of the Elementary Algebra Final Exams of the Lecture Classes and Computer Classes, Fall 2002

Z test: Two Sample for Means		
	Elementary Algebra Final Exam Grade for Lecture	Elementary Algebra Final Exam Grade for Computer
Mean	79.3235	74.4950
Known Variance	240.5775	223.1097
Observations	102	99
Z	2.2483	
P(z<=z) one-tail	0.0123	

Table 12 Two Sample Z test, Comparing Proportions of Achievement in the
Lecture Classes and the Computer Classes in Elementary Algebra Fall 2002

Achievement Rate Comparison		
Lecture Classes		<u>Calculated Values</u> z = 4.486 Pooled P- value = 0.4752 P Value = 0.00000363
Sample Size	175	
Number that Passed with A, B or C	105	
Achievement Rate	0.60	
Computer Classes		
Sample Size	208	
Number that Passed with A, B or C	77	
Achievement Rate	0.3702	

significant difference between the proportion of the students passing with a grade of A, B, or C, taught elementary algebra using the lecture method and the proportion of the students passing elementary algebra with a grade of A, B, or C taught using a computerized instructional approach, $z = 4.486$, $*p < 0.001$.

Question 2: How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

To answer this question, the retention rate of students that enrolled in a mathematics course during the following spring 2003 semester was calculated for each group. The information was used to test the following hypotheses statements:

H_0 : There is no difference in the retention rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

H_1 : The retention rates of all students taught using the lecture method is greater than the retention rate of all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypotheses statements. The results of this test, which can be viewed in Table 13, showed there was no significant difference in the retention rates of students taught elementary algebra using the lecture method and students taught using a computerized instructional approach, $z = 1.227$, $p = 0.11$.

Table 13 Two Sample Z test, Comparing Proportions of Retention of Elementary Algebra Lecture Classes and Elementary Algebra Computer Classes who Enrolled in a Mathematics Course in Spring 2003

Retention Rate Comparison		
Lecture Classes		<u>Calculated Values</u> z = 1.227 Pooled P- value = 0.6240 P value = 0.1098
Sample Size	175	
Number Enrolled in a Math Course Spring 2003	115	
Retention Rate	0.6571	
Computer Classes		
Sample Size	208	
Number Enrolled in a Math Course Spring 2003	124	
Retention Rate	0.5962	

Question 3: How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The persistence rates of students that enrolled in a mathematics course, developmental or college level, during the summer or fall 2003 semester was calculated for the groups taking elementary algebra using each approach. The information was used to test the following hypotheses statements:

H_0 : There is no difference in the persistence rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

H_1 : The persistence rates of all students taught using the lecture method is greater than the persistence rate of all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypotheses statements. The results of this test, which can be viewed in Table 14, showed there was no difference in the persistence rates of students taught elementary algebra using the lecture method and students taught elementary algebra using a computerized instructional approach, $z = 1.371$, $p = 0.09$.

Question 4: How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?

The success rate of students in the study that passed a college level

Table 14 Two Sample Z test, Comparing Proportions of Persistence of
Elementary Algebra Lecture Classes and Elementary Algebra Computer Classes
Who Enrolled in a Mathematics Course in Summer or Fall 2003

Persistence Rate Comparison		
Lecture Classes		<u>Calculated Values</u> z = 1.371 Pooled P - value = 0.4648 P-value = 0.0851
Sample Size	175	
Number Enrolled in a Math Course Summer or Fall 2003	88	
Persistence Rate	0.5029	
Computer Classes		
Sample Size	208	
Number Enrolled in a Math Course Summer or Fall 2003	90	
Persistence Rate	0.4327	

mathematics course with a grade of A, B, or C during the summer or fall 2003 semester was calculated for each group. The information was used to test the following hypotheses statements:

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach.

H_1 : The success rates of all students taught using the lecture method is less than the success rates of all students taught using a computerized instructional approach.

A pooled estimate of the proportions was calculated, and a z test for proportions was used to test the hypotheses statements. The results of this test, which can be viewed in Table 15, showed there was no difference in the success rates in a subsequent mathematics class of students taught elementary algebra using the lecture method and students taught elementary algebra using a computerized instructional approach, $z = -0.20$, $p = 0.42$.

Question 5: How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?

The researcher examined each college level course individually in order to answer this question. The success rate of students that passed College Algebra

Table 15 Two Sample Z -test, Comparing Proportions of Success in
Subsequent College Level Courses in Summer or Fall 2003 for Those Students
Who Took Elementary Algebra Using Two Different Methods of Instruction

Success Rate Comparison		
Lecture Classes		<u>Calculated Values</u> z = -.2020 Pooled P- value = 0.4839 P-value = 0.4200
Sample Size	38	
Number that Passed a College Level Math Course with A, B or C	18	
Success Rate	0.4737	
Computer Classes		
Sample Size	24	
Number that Passed a College Level Math Course with A, B or C	12	
Success Rate	0.5000	

with a grade of A, B, or C during the summer or fall 2003 semester was calculated for each group. This information was calculated for the Introductory Statistics course and for the Contemporary Mathematics course. Two other college level courses were included after examining the data: Statistics I and Structures of the Number System. In the third semester of the study very few students were able to take a college level course. A summary of the number of students that enrolled in a college level course during the summer or fall 2003 semester, along with the number that passed the college level courses and their success rate can be viewed in Table 16 and Table 17.

After sorting the data into the tables the researcher discovered that the data were not robust enough to test the following hypotheses statements:

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the College Algebra course.

H_1 : The success rates of all students taught using the lecture method is less than the success rates of all students taught using a computerized instructional approach in the College Algebra course.

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the Introductory Statistics course.

Table 16 Number and Percentage of Students Succeeding in a College Level Mathematics Course after Taking Elementary Algebra Using Lecture Based Instruction

Comparison of Success Rates in Various College Level Courses (Lecture)			
Courses	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
College Algebra	29	12	0.4138
Introductory Statistics	4	2	0.5000
Contemporary Mathematics	2	2	1.0000
Statistics I	2	1	0.5000
Structures of the Number System	1	1	1.0000

Table 17 Number and Percentage of Students Succeeding in a College Level Mathematics Course after Taking Elementary Algebra Using Computer Based Instruction

Comparison of Success Rates in Various College Level Courses (Computer)			
Courses	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
College Algebra	16	7	0.4375
Introductory Statistics	3	1	0.3333
Contemporary Mathematics	5	4	0.8000

H_1 : The success rates of all students taught using the lecture method is less than the success rates of all students taught using a computerized instructional approach in the Introductory Statistics course.

H_0 : There is no difference in the success rates of all students taught using the lecture method and all students taught using a computerized instructional approach in the Contemporary Mathematics course.

H_1 : The success rates of all students taught using the lecture method is less than the success rates of all students taught using a computerized instructional approach in the Contemporary Mathematics course.

Question 6: How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

To answer Question 6, the success rate of students in elementary algebra was calculated for the group taught using the lecture method and the group taught using computerized instruction in each category: 17 years old or less, 18 to 20 years old, 21 to 24 years old, 25 to 34 years old, 35 to 64 years old, and over 64 years of age. Tables 18 and 19 show the ages, the number of students that enrolled in a college level mathematics course during the summer or fall 2003 semester and the number that passed the college level courses and their success rate. The data were not strong enough to test the following hypotheses statements:

Table 18 Success of Students that Enrolled in a Subsequent College Level
Course following Elementary Algebra Taught Using Lecture Based Instruction
Grouped by Age

Comparison of Success Rates by Age (Lecture)			
Age	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
17 or less	0	0	0.0000
18 to 20	11	6	0.5455
21 to 24	14	3	0.2143
25 to 34	11	7	0.6364
35 to 64	2	2	1.0000
Over 64	0	0	0.0000

Table 19 Success of Students that Enrolled in a Subsequent College Level
Course following Elementary Algebra Taught Using Computer Based Instruction
Grouped by Age

Comparison of Success Rates by Age (Computer)			
Age	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
17 or less	0	0	0.0000
18 to 20	12	8	0.7000
21 to 24	8	1	0.1250
25 to 34	4	3	0.7500
35 to 64	0	0	0.0000
Over 64	0	0	0.0000

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each category: 17 years old or less, 18 to 20 years old, 21 to 24 years old, 25 to 34 years old, 35 to 64 years old, and over 64 years of age.

H_1 : The population proportion of the students passing with a grade of A, B, or C taught using the lecture method will be less than the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each category: 17 years old or less, 18 to 20 years old, 21 to 24 years old, 25 to 34 years old, 35 to 64 years old, and over 64 years of age.

The success rate of males and females in the group taught using a lecture approach and the group taught using a computerized approach was determined. A summary based on gender, the number of students that enrolled in a college level course during the summer or fall 2003 semester, along with the number that passed the college level courses and their success rates can be viewed in Table 20 and Table 21. The data were not strong enough to test the following hypotheses statements:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the

Table 20 Success by Gender of Students that Enrolled in a Subsequent
College Level Mathematics Course Following Elementary Algebra Taught Using
Lecture Based Instruction

Comparison of Success Rates by Gender (Lecture)			
Gender	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
Male	8	2	0.2500
Female	30	16	0.5333

Table 21 Success by Gender of Students that Enrolled in a Subsequent
College Level Mathematics Course Following Elementary Algebra Taught Using
Computer Based Instruction

Comparison of Success Rates by Gender (Computer)			
Gender	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
Male	11	3	0.2727
Female	13	9	0.6923

students passing with a grade of A, B, or C taught using a computerized instructional approach in males and females.

H_1 : The population proportion of the students passing with a grade of A, B, or C taught using the lecture method will be less than the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in males and females.

Finally, the researcher calculated the success rate of students in each ethnic group, for the group taught elementary algebra using a lecture method and the group taught using computerized instruction. The following five categories for student ethnicity were used: Black, White, Hispanic, Asian and other. The categories used in this research coincide with the categories that are currently used by Institutional Research at CSTCC. Tables 22 and 23 summarize the number of students based on ethnicity that enrolled in a college level course during the summer or fall 2003 semester, along with the number that passed the college level courses and their success rate.

The data were not robust enough to test the following hypotheses statements:

H_0 : The population proportion of the students passing with a grade of A, B, or C, taught using the lecture method will equal the population proportion of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each ethnic category: Black, White, Hispanic, Asian, and other.

H_1 : The population proportion of the students passing with a grade of A, B, or C taught using the lecture method will be less than the population proportion

Table 22 Success of Students that Enrolled in a Subsequent College Level
Mathematics Course by Ethnicity Following Elementary Algebra Taught Using
Lecture Based Instruction

Comparison of Success Rates by Ethnicity (Lecture)			
Ethnicity	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
Black	14	5	0.3571
White	24	13	0.5417
Hispanic	0	0	0.0000
Asian (Oriental)	0	0	0.0000
Other	0	0	0.0000

Table 23 Success of Students that Enrolled in a Subsequent College Level
Mathematics Course by Ethnicity Following Elementary Algebra Taught Using
Computer Based Instruction

Comparison of Success Rates by Ethnicity (Computer)			
Ethnicity	Total that Enrolled during the Summer or Fall 2003 Semesters	Number that Passed	Success Rate
Black	5	3	0.6000
White	18	8	0.4444
Hispanic	0	0	0.0000
Asian (Oriental)	1	1	1.0000
Other	0	0	0.0000

of the students passing with a grade of A, B, or C taught using a computerized instructional approach in each ethnic category: Black, White, Hispanic, Asian, and other.

Summary

The six questions of this study were used to develop hypotheses statements that were tested at a 0.05 level of significance except the homogeneity of variance which was tested at a 0.10 level of significance.

Question 1: How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The final exam test scores and the final course grades for elementary algebra during fall 2002 semester were used to determine achievement. The results of the Kuder-Richardson (K-R 20) showed that the CSTCC Elementary Algebra Final Exam was a reliable test instrument, and the results of the F-ratio test showed that the final exam was a valid test instrument.

Boxplots, histograms and descriptive statistics were constructed using the results of the final exam test scores. All of these were used to determine that the lecture classes' final exam scores were slightly higher than the computer classes' final exam scores.

A z test was used and the results showed there was a significant difference in the final exam test scores between the lecture based students and the students taught elementary algebra using the computerized instructional method.

A z -test was used and the results showed there was a significant difference between the proportion of the students passing elementary algebra with a grade of A, B, or C taught using the lecture method and the proportion of the students passing elementary algebra with a grade of A, B, or C taught using a computerized instructional approach.

These results indicate that the achievement rates of elementary algebra students enrolled in a lecture-based instructional approach is significantly higher than the achievement rates of elementary algebra students enrolled in a computer-based instructional approach in elementary algebra.

In this study, persistence and retention are based on students' enrollment in mathematics courses following the fall 2002 semester. Students who successfully complete the elementary algebra course during the fall 2002 next enroll in the intermediate algebra course. After successful completion of the developmental sequence, students may take one of several college level courses in subsequent semesters. Questions 2 and 3 address persistence and retention.

Question 2: How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The retention rate of students that enrolled in another mathematics course during the spring 2003 semester was calculated for each group. The students either registered for intermediate algebra or they registered to retake elementary algebra. A z test was used as the test statistic and the results showed there was no significant difference in the retention rates of students who were taught elementary algebra using the lecture method and students who were taught elementary algebra using a computerized instructional approach.

Question 3: How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?

The persistence rate of students that enrolled in another mathematics course, developmental or college level, during the summer or fall 2003 semester was calculated for each group. A z test was used and the results showed there was no significant difference in the persistence rate of students who were taught elementary algebra using the lecture method and students who were taught elementary algebra using a computerized instructional approach.

Question 4: How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?

The success rate of students that passed a college level mathematics course with a grade of A, B, or C during the summer or fall 2003 semester was calculated for each group. A z- test for proportions was used and the results

showed there was no difference in the success rates in a subsequent college level mathematics course of students taught elementary algebra using the lecture method and students taught elementary algebra using a computerized instructional approach

Question 5: How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?

Question 6: How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

Questions 5 and 6 could not be answered because the data were not robust enough to run a test for significant difference.

When examining the questions that were posed in this study, one can see that the only significant difference observed was in the achievement rate of the students taught elementary algebra using the lecture-based instructional approach as compared to the students taught elementary algebra using the computer-based instructional approach. There was no significant difference between the two groups when examining retention, persistence and success.

Chapter V

SUMMARY, DISCUSSION AND RECOMMENDATIONS

This chapter presents a summary of the findings of this study. The study attempted to answer six research questions based on data that was collected from Chattanooga State Technical Community College elementary algebra students that began their courses in the fall 2002 semester and they were tracked until the fall 2003 semester.

1. How do the achievement rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
2. How do the retention rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
3. How do the persistence rates of students compare using a lecture-based instructional approach versus a computer-based instructional approach?
4. How do the success rates of students in college level mathematics compare using a lecture-based instructional approach versus a computer-based instructional approach?
5. How do the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?
6. How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?

Limitations of the study are also described along with recommendations for further research.

Summary of the Results

This study examined achievement, retention, persistence, and success of elementary algebra students who complete a lecture-based instructional approach versus a computer-based instructional approach. The two groups that were used in the study were very similar in nature. The lecture group consisted of 116 females (66.3%) and 59 males (33.7%), which made 175 students. The computer group consisted of 97 females (46.6%) and 111 males (53.4%), which made 208 students. The lecture group had a mean age of 25 with a minimum age of 18 and a maximum age of 51. The computer group had a mean age of 24 with a minimum age of 18 and a maximum age of 58. The ethnicity of the lecture group consisted of 47 Blacks (26.9%), 3 Hispanics (1.7%), 2 Asians (Oriental) (1.1%), 122 Whites (69.7%) and 1 other (0.6%). The ethnicity of the computer group consisted of 56 Blacks (26.9%), 4 Hispanics (1.9%), 3 Asians (Oriental) (1.4%), 144 Whites (69.2%) and 1 other (0.5%). A summary of gender, ages and ethnicity of the two elementary algebra groups can be viewed in Appendix G.

Achievement was studied using elementary algebra final exam grades and overall course grades from students who were enrolled in elementary algebra during the fall 2002 semester. Using various statistical measures it was determined that the lecture students' achievement rates were significantly higher than the students who received computerized instruction.

Retention was studied using students who began in the fall 2002 semester in elementary algebra, tracking them, to see if they enrolled in a mathematics course during the spring 2003 semester. It was discovered that there was no significant difference in the retention rates of students who were taught elementary algebra using the lecture method and students who were taught the subject using a computerized instructional approach.

Persistence was studied using students who began elementary algebra in the fall 2002 semester, enrolled in a mathematics course during the spring 2003 semester and persisted with their mathematics by registering for a mathematics course in the summer 2003 semester or the fall 2003 semester. The results showed there was no significant difference in the persistence rates of students who were taught elementary algebra using the lecture method and students who were taught elementary algebra using a computerized instructional approach.

Student success was studied using students who began in the elementary algebra course in the fall 2002 semester and successfully completed a college mathematics course by the fall 2003 semester. Success was determined by the number of students who made a letter grade of an A, B or C in any college level mathematics course. The results of this study showed there was no difference in the success rates of students taught elementary algebra using the lecture method and students taught the subject using a computerized instructional approach.

When examining achievement, retention, persistence and success, the only area in this study that showed a significant difference was among the

achievement rates. The lecture students' achievement rates were significantly higher than the students who received computerized instruction. Retention, persistence and success did not show any significant difference between the two groups.

Due to certain limitations in this study, this research should not be taken as an indictment that mathematics software programs should not be used in developmental mathematics. This study should be used as a starting point in order to continue research in the area of developmental mathematics, and explore other mathematics software programs that may be used to help improve overall student success in mathematics.

Limitations

Two questions were posed by the researcher that could not be answered in this study with the data that was collected. One question was "How does the success rates in College Algebra, Introductory Statistics, and Contemporary Mathematics compare between students who complete a lecture-based instructional approach versus a computer-based instructional approach?" The other question was "How do the age, gender, and ethnicity of successful students compare using a lecture-based instructional approach versus a computer-based instructional approach?" These questions could not be answered because the data were not robust enough to run a test for significant difference.

Discussion

Technology continues to play a crucial role in the teaching and learning of mathematics. In 2005 the National Council of Teachers of Mathematics (NCTM) composed a yearbook entitled Technology-Supported Mathematics Learning Environments: Sixty-Seventh Yearbook. This yearbook addressed how technology is currently being used in the classroom and how it can successfully be implemented in the future (NCTM, 2005).

The NCTM (2005) embraces the position that technology is a necessary instrument for teaching and learning mathematics successfully. Technology helps to extend the mathematics that can be taught and enhances students' learning. This position places a great burden on mathematics educators to find the most effective ways to use technology to enhance teaching, learning and assessment in the mathematics classroom. Teachers have to make daily decisions of when to incorporate technology and how students will use technology most effectively. In today's society and in future societies, technology is not going away. Technology in the mathematics classroom will provide more opportunities for learning, more opportunities for real-world problem solving and help students to adapt to what awaits them in the future (NCTM, 2005).

Choosing the correct software can be a key element in the success of the mathematics student. The student has to eventually be able to use the software program independently. Mathematical software programs need to be developed so that they can be used to enhance the learning of the student and empower students to meet specific educational goals and objectives. Software should

incorporate drill and practice and games, help to develop mathematical skills, provide computer manipulative and tools to promote problem solving, and help promote higher order thinking skills (NCTM, 2005).

For mathematics students to be successful when using technology there must be someone present who can supervise students and instruct them in how to use computer programs to learn. Computer work should be introduced at a gradual pace to allow students to learn to be independent in the learning process. Once students learn to work independently, then the teacher should be in the classroom to offer guidance when necessary. The role of the teacher should now be one of a facilitator of learning. Guidance does not always have to come from the teacher; it can come from other students. When students are allowed to communicate with other students about mathematics, it helps them to internalize the mathematics that they are learning (NCTM, 2005).

Effective use of computers in the classroom involves teacher planning, participation and support. During the learning process the teacher needs to lead whole-group discussions that give students opportunities to discuss and reflect on what they have learned. The teacher can use a single computer with a large screen projection during the discussion. This can be used to help direct the discussion that is taking place among the class as a whole (NCTM, 2005).

To incorporate technology into the classroom, a teacher must start slowly and think realistically. Teachers must be able to assess the tools that are available to them and discuss with other teachers how they use technology in their classrooms. Teachers must learn various ways that computers can be used

in the learning process. Computers can be used in the mathematics classroom as reference devices where students research certain facts about mathematical problems being considered in the class and then report to the students in the class what they have discovered. Computers can be used for data collection, and they can be used to introduce new concepts or reinforce concepts. Technology should be used to help develop students' understanding of mathematics and should play a major role in classroom instruction. Technology should be used to help students focus on decision making, reflection, reasoning and problem solving (NCTM, 2005).

Based on the technology that is available to teachers, teachers have to decide how the technology can be used most effectively in their individual classrooms. To move successfully toward implementing technology into the classroom, teachers have to develop, practice, and implement new ways to instruct and assess mathematics students. Many new mathematics software programs have been developed to help teachers with this process. These programs have been developed to help familiarize students with technology applications in the field of mathematics. These programs can be used to help facilitate student learning of basic skills, data collection and analysis, and conceptualization of mathematics. Before implementing these technologies in the classroom, teachers have to be given opportunities to see the new technologies, learn, and experiment with ways to successfully integrated them into the classroom (NCTM, 2005).

Teachers have to develop well structured lesson plans to properly integrate technology into the classroom. The lessons must encourage students to develop problem solving skills and reasoning skills. They must be able to make connections between concepts and representations and be able to communicate their ideas to others. Teachers must incorporate time into the lessons to listen and respond to students' ideas and take the time to assess students' learning as they work (NCTM, 2005).

For technology to be successfully implemented into the mathematics classroom, teachers and students have to be willing to use the technology that is available to them. Jim Fey, a mathematics and curriculum instructor at the University of Maryland, suggests that technology is not the only part in the learning process that makes a difference in teaching and learning. Technology does not make the difference; rather, how technology is used and by whom makes the difference. Teachers have to be willing to develop a curriculum where technology can successfully be implemented. Students have to develop an understanding of the technology and learn its capabilities (NCTM, 2005).

After many interviews with individuals who are known for their expertise in the use of technology in the mathematics classroom, Kathleen Heid constructed a summary of ideas about what will be needed to integrate technology successfully into future mathematics classrooms. To successfully incorporate technology into future mathematics classrooms, teachers must make the best use of the technologies and tools that they currently have available to them. Teachers must be willing to take advantage of any professional development that

comes available to them. Technology must be made available to all students and the curriculum must be adjusted to allow students to explore and pursue problems that interest them. Teachers must be committed to using technology on a regular basis in order to develop and enhance mathematical understanding of students, and educators must realize that technology is just an instrument in the learning process (NCTM, 2005).

This discussion suggests that implementing technology into the mathematics classroom is a continuous learning process for both teachers and students. The teachers have to learn how to implement technology, working with other teachers who have successfully accomplished this process. Professional development in this type of learning is a must for teachers. Appropriate software has to be chosen that is suitable for the learning needs of the individual students. Since the process of using a computer software program to learn mathematics is a new experience for some students, students have to be eased into the process of learning mathematics (NCTM, 2005).

Recommendations for Future Research

Based on the results of this study and the previous discussion, the following recommendations are suggested for further research:

1. This study should be replicated in order to better understand overall student success in college level mathematics courses by extending the number of semesters that the students are tracked.

2. The fall 2002 semester was the first time that instructors at Chattanooga State Technical Community College (CSTCC) taught using a computer software program as their main method of instruction. A study should be conducted to see how instructors' students' success rates improve over time as the teachers become more confident with the new method of instruction.
3. The mathematics courses at CSTCC were only taught for one year using Prentice Hall Interactive Math Software Package. A new software package was implemented during the fall 2003 semester and continues to be used until the present. This same study should be replicated with a new group of elementary algebra students who were taught using a different software package to see if there are any differences in the studies.
4. Since research suggests that professional development plays a crucial role in helping teachers to successfully implement computer software programs into the learning process, a study should be conducted to see what professional development is being provided and how much effect the professional development has in the utilization of computer based instruction.
5. A study should be conducted that examines the various roles that teachers play in the instructional process in classes taught using a computer based instruction and classes taught using a lecture based approach.

Conclusion

This study was initiated because students who take developmental mathematics courses generally have overall low achievement, retention, persistence and success rates in community colleges. This study was used to see if using a computer software program in mathematics could help improve these areas. The literature seemed to suggest that this implementation of computer software is a continual learning process for the teacher and the student. Teachers play a crucial role in taking the initiative to learn to effectively implement computer software programs into their curriculum.

The Review of Literature in this study showed that there were very few research studies conducted on using computer software programs in developmental algebra classes in community colleges. The literature suggested that continued research needs to be conducted in order to see what is working and what is not working when using computer software programs in the mathematics classrooms.

This study examined the first year that this process was attempted at Chattanooga State Technical Community College. Based on this study and the literature, one can see that changes need to be implemented into the instructional process and research needs to be an on going practice. This research study should be used as a starting point for future research in implementing computer software into the curriculum of the developmental mathematics classroom. This study can give future researchers incentives to

continue to search for ways to improve the implementation of software programs in mathematics.

REFERENCES

REFERENCES

- American Mathematics Association of Two-Year Colleges (AMATYC). (1995). Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus. Upper Saddle River, NJ: Prentice Hall.
- Applebome, P. (1996). Americans straddle average mark in mathematics and science. The New York Times: Themes of the Times. Upper Saddle River, NJ: Prentice Hall.
- Baharvand, M. (2001). A comparison of the effectiveness of computer assisted instruction versus traditional approach to teaching geometry. MAI 40(03), 552.
- Bers, T.H. & Smith, K.E. (1990). Assessing assessment programs: The theory and practice of examining reliability and validity of a writing placement test. Community College Review, 18(3), 17-27.
- Bittinger, M.L. & Beecher, J.A. (1999). Developmental Mathematics 5th Edition. Boston, MA: Addison-Wesley.
- Boss, S.J. (2002). Community colleges face doing more with less. Christian Science Monitor 94(192), 18.
- Braxton, J.M. (2002). Reworking the Student Departure Puzzle. Nashville, TN: Vanderbilt University Press.
- Brier, E. (1984). Bridging the academic gap: An historical view. Journal of Developmetal Education, 8(1), 2-5.

Casazza, M.E. & Silverman, S. (1996). Learning Assistance and Developmental Education. San Francisco, CA: Jossey-Bass.

Casazza, M. E. (2000). Who are we and where did we come from. Harvard Symposium2000: Developmental Education [On-line]. Available: http://www.ced.appstate.edu/centers/ncde/reserve_reading/V23-1casazza_who.htm.

Clark, R.E. (1983). Reconsidering research on learning from media. Review of Educational Research 53(4), 445-459.

D'Ignazio, F. (1993). Electronic highways and classrooms of the future. In the Technology Age Classroom [On-line]. Available: http://www.etc.bc.ca/lists/nuggets/EdTech_report.html

Ebeling, J.R. & Middlesworth, C.V. (2002). Placement, success and persistence of first-time student developmental cohorts: Spring 1997, Fall 1997, spring 1998 and fall 1998. Office of Research, Evaluation and Assessment. Kansas City, MO: Metropolitan Community Colleges [On-line]. Available: http://www.kcmetro.cc.mo.us/research/Developmental_Student_Report_2002.pdf

Economist. (2002). Screen it out; Teaching with computers. The Economist (US) 365 (8296), NA.

Edwards, C. E. (2002). Reflections on a framework for quality in educational technology programs. Educational Technology: The Magazine for Managers of Change in Education 42(3), 29-32 .

- Fulton, K. & Honey, M. (2002). Emerging technologies in education. Educational Technology: The Magazine for Managers of Change in Education 42(4), 6-8.
- Garet, M.S. & Mills, V.L. (1995). Changes in teaching practices: The effects of the curriculum and evaluation standards. The Mathematics Teacher 88(5), 380-389.
- Hamtini, T.M. (2000). A comparison study of computer-facilitated instruction versus non-computer facilitated instruction in developmental mathematics at a university: Student's attitudes and achievement. DAI 61(04A), 1368.
- Higbee, J.L & Dwinell, P.L. (1997) Do developmental education programs really enhance retention? A commentary [On-Line]. Available:
<http://www.nade.net/documents/Mono97/mono97.6.pdf>
- Honey, M., Culp, K. M. & Spielvogel, R. (1999). Critical issue: Using technology to improve student achievement. North Central Regional Educational Laboratory (NCREL) [On-line]. Available:
<http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te800.htm>
- Ikenberry, S. O. (1999). The truth about remedial education. Community College Journal: Remedial Education, 69(50), 8.
- Johnston, H. J. (1996). Technology: Bringing our present and future into the classroom. Schools in the Middle: Theory into Practice. 27-32.
- Kinnaman, D.E. (1990). What is the research telling us? Classroom Computer Learning 10(6), 31-39.

Kinnaman, D.E. (2001). A look back, a look ahead. Curriculum Administrator 37(7), 64.

Kozma, R.B. (1994). Will media influence learning? Reframing the debate. Educational Technology Research and Development 42(2), 7-19.

Martin-Gay, K. E. (2002). Introductory and Intermediate Algebra: Review, Reference, and Practice. Upper Saddle River, NJ: Prentice Hall.

Martin-Gay, K. E. (2002). Prentice Hall Interactive Math Introductory and Intermediate Algebra Student Package. Upper Saddle River, NJ: Prentice Hall.

McCabe, R. H. (1999). Can community colleges rescue America? Community College Journal: Remedial Education, 69(50), 20-23.

McKenzie, J. (1994). From technology refusal to technology acceptance: A reprise. From Now On: The Educational Technology Journal [On-line]. Available: <http://www.fromnowon.org/fnomay94.html>

McKenzie, J. (1993). Staff development for new technologies. From Now On: The Educational Technology Journal. [On-line]. Available: <http://www.fromnowon.org/staffd.html>

McKinney, K. (1996). Technology in community colleges. (ERIC Document Reproduction Service Number ED399992).

Means, B. (2002). Evaluating learning technologies: Comments on a framework for quality in educational technology programs by Confrey, Sabelli, and Sheingold. Educational Technology: The Magazine for Managers of Change in Education 42(3),37-40.

- Mellon, C. A. (1999). Technology and the great pendulum of education. Journal of Research on Computing in Education 32(1), 28-35.
- Muse, V. U. (1999). Quotable quotes. Community College Journal: Remedial Education, 69(50), 48.
- National Council of Teachers of Mathematics. (1989). Commission on standards for school mathematics. Curriculum and Evaluation Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.
- National Council of Teachers of Mathematics (1991). Professional Standards for Teaching Mathematics. Reston, VA: National Council of Teachers of Mathematics.
- National Council of Teachers of Mathematics (1995). Assessment Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.
- National Council of Teachers of Mathematics (2000). Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.
- National Council of Teachers of Mathematics (2005). Technology-Supported Mathematics Learning Environments: Sixty-Seventh Yearbook. Reston, VA: National Council of Teachers of Mathematics.
- Parker, C.E. (1998). Cultivate academic persistence now. Black Issues in Higher Education 14(26), 104-110.

Pathways Task Force, (2000). Pathways through Algebra, Funded by the National Science Foundation and the Lumina Foundation [On-line]. Available: <http://www.algebrapathways.org/>.

Perin, D. (2002). The location of developmental education in community colleges: a discussion of the merits of mainstreaming vs. centralization.

Community College Review.

Reigeluth, C.M. & Joseph, R. (2002). Beyond technology integration: The case for technology transformation. Educational Technology: The Magazine for Managers of Change in Education 42(4), 9-13.

Ronan, B. & Kur, S. (2001). Community colleges and social capital: 21st century economic development. Community College Journal 71(6), 34-36.

Roueche, J. E. & Roueche, S. D. (1999). High Stakes, High Performance: Making Remedial Education Work. Washington, DC: Community College Press.

Roueche, J. E. & Roueche, S. D. (1999). Keeping the promise: Remedial education revisited. Community College Journal: Remedial Education, 69(50), 12-18.

Smith, M.S. & Casserly, C.M. (2002) The expert panel's framework for assessing the quality of educational technology programs. Educational Technology: The Magazine for Managers of Change in Education 42(3), 33-36.

Thorpe, R. (2002). How should we think about educational technology programs. Educational Technology: The Magazine for Managers of Change in Education 42(3), 21-24.

Tinto, V. (1993). Leaving College: Rethinking the Causes and Cures of Student Attrition. Chicago, IL: The University of Chicago Press.

Transue, P.J. (2001). Recognizing the role of community colleges. Community College Journal, 71(6),3.

Weidner, H.Z. (1990). Back to the Future. Paper presented at the annual meeting of the Conference on College Composition and Communication, Chicago, IL (ERIC Document Reproduction Service Number 319045).

Wyatt, M. (1992). The past, present and future need for college reading courses in the U.S. Journal of Reading, 36(1), 10-20.

Zeisuss, T. (1999). Being prepared. Community College Journal: Remedial Education, 69(50), 7.

Zeitlin, A.N. & Markus, T.C. (1996). Should remediation be mandatory in the community college? Community Review, 14, 27-40.

Zumwalt, D.B. (2001). The effectiveness of computer-aided instruction in eighth grade pre-algebra classrooms in Idaho. DAI 62(11A), 3655.

APPENDICES

Appendix A
Data Gathering Chart

Data Gathering Chart

Student ID	Age	Gender	Ethnicity	Grade in Elementary Algebra Fall 2002	Score on Elementary Algebra Final Exam	Spring 2003 Enroll	Grade in Intermediate Algebra	Enrolled Summer 2003 or Fall 2003	Grade in College-Level Course

Appendix B

Example of the Table Used to Test Reliability of the Final Exam

Example of the Table Used to Test

Reliability of the Final Exam

1 = correct and 0 = incorrect

Test Questions	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
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28								
29								
30								
31								

Appendix C

Data from Lecture Classes

Data from Lecture Classes

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
23	F	H	IF	X	DSPM0850	W	MATH1510	A	MATH1710	D
40	F	W	B	86	DSPM0850	A				
30	M	W	B	79	DSPM0850	W				
25	F	W	W	X						
26	F	W	A	89	DSPM0850	W				
24	M	W	F	X						
20	F	B	B	88	DSPM0850	B				
24	M	W	B							
20	M	W	B	89	DSPM0850	C				
20	M	W	W	X						
30	M	X	W	X					DSPM0800 MATH1010	B A
21	M	W	F	X						
34	F	W	C	78	DSPM0850	C			DSPM0850 DSPM0850	F F
34	F	B	W	X						
20	F	B	C	70	DSPM0850	F			DSPM0850 DSPM0850	F F
20	M	W	C	75	DSPM0850	F				
21	M	W	B	75	DSPM0850	W			DSPM0850 DSPM0850	F F
20	F	W	A	101	DSPM0850	B				
21	F	B	C	73	DSPM0850	C			DSPM0850 DSPM0850	F F
20	M	W	F	X	DSPM0800	F				
27	F	W	F	X					DSPM0800	F
34	F	B	F	X						
20	M	W	A	90	DSPM0850	A			DSPM0850	F
23	M	W	C	69						
23	M	W	C	64					DSPM0850 MATH1710	F A
21	F	O	C	70	DSPM0850	B				
27	F	W	A	104	DSPM0850	A				
22	M	B	W	X						

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
27	M	H	C	53	DSPM0850	F	DSPM0850	F		
22	F	W	A	90	DSPM0850	B			MATH1710	W
22	F	B	C	77	DSPM0850	C			MATH1710	F
20	F	W	C		DSPM0850	F			DSPM0850	W
20	F	B	F	69	DSPM0800	F				
20	M	O	B	81	DSPM0850	W			DSPM0850	C
20	F	W	W	x					DSPM0800	C
25	F	W	A	88	DSPM0850	B			MATH1010	B
19	F	B	C	81	DSPM0850	C				
31	F	W	C		DSPM0850	B				
27	F	W	F	x						
29	F	W	F	x	DSPM0800	W			DSPM0800	B
20	F	B	C	77	DSPM0850	C	MATH1710	C		
20	F	W	B		DSPM0850	F				
21	F	W	A	90	DSPM0850	B			MATH1710	W
31	F	W	A	90	DSPM0850	W				
36	F	W	B		DSPM0850	C				
28	F	W	C	79					DSPM0850	W
28	F	W	A	93	DSPM0850	A			MATH1710	C
24	M	W	C	63	DSPM0850	F			DSPM0850	I
22	M	W	C	64	DSPM0850	W	DSPM0850	C	MATH1710	W
21	M	B	F	x			DSPM0800	F	DSPM0800	F
34	F	B	B	86	DSPM0850	W			DSPM0850	B
20	F	W	B	86	DSPM0850	B			MATH1710	F
50	F	W	B	83						
20	M	W	F	40	DSPM0800	F			DSPM0800	F
27	F	B	E	75						
38	F	W	A	103	DSPM0850	A			MATH1710	A
28	F	W	B		DSPM0850	F				
26	F	W	F	x						
21	M	B	C	74	DSPM0850	C			MATH1530	W
21	F	W	B	83	DSPM0850	C	MATH1710	B		

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
49	F	W	C	72	DSPM0850	F			DSPM0850	C
22	F	W	W	x						
20	M	B	C	75	DSPM0850	W			DSPM0850	F
20	F	W	F	47					DSPM0800	C
20	F	W	B	77	DSPM0850	B			MATH1710	F
26	F	W	B	88					DSPM0850	C
21	M	W	B	84	DSPM0850	W			DSPM0850	F
20	F	W	C	77	DSPM0850	F			DSPM0850	C
22	F	W	F	x						
30	F	W	B	81	DSPM0850	B				
27	F	W	A	103	DSPM0850	A				
24	F	W	C		DSPM0850	C			MATH1530	W
25	M	W	C	73	DSPM0850	B			MATH1710	D
22	F	B	F	x						
21	M	W	F	x						
23	F	B	C	70	DSPM0850	F				
35	F	W	F	43	DSPM0800	C	DSPM0850	W	DSPM0850	F
21	F	W	A	92	DSPM0850	B				
22	M	W	F		DSPM0800	C	DSPM0850	F	DSPM0850	F
18	F	W	B	85						
23	M	W	A	94	DSPM0850	W				
20	M	W	A	91	DSPM0850	B				
20	F	W	C	69	DSPM0850	B	MATH1710	C		
27	F	W	F	x					DSPM0800	B
20	F	W	F		DSPM0800	C			DSPM0850	W
40	M	B	F	x			DSPM0800	W		
21	F	W	W	x						
30	F	W	F	x						
24	M	W	F		DSPM0800	F				
22	F	B	C	72	DSPM0850	C			MATH1710	F
22	F	B	F	42	DSPM0800	F				
20	M	B	F	x						

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
20	M	B	C	64	DSPM0850	F	DSPM0850	A	DSPM0800 MATH1710	W F
28	F	W	A	100						
26	M	B	F	x	DSPM0800	W				
23	M	B	A	92	DSPM0850	B				
20	M	W	W	x						
21	F	W	B	80	DSPM0850	C				
20	F	W	A	93	DSPM0850	C				
20	M	W	B		DSPM0850	F				
20	F	W	A	94	DSPM0850	B				
27	M	B	F	x	DSPM0850	F				
20	M	W	C	74	DSPM0850	E	MATH1710	B	MATH0990 MATH1720	C W
18	F	W	B	81	DSPM0850	C				
22	M	W	A		DSPM0850	C				
20	F	W	B		DSPM0850	C				
24	F	H	F							
21	F	W	F	x	DSPM0800	E				
21	M	W	F	x						
20	M	W	C		DSPM0850	C				
20	F	W	A	97	DSPM0850	A				
31	F	W	F	x	DSPM0800	C				
33	M	W	C	84	DSPM0850	C	DSPM0850	W	MATH1710 DSPM0850	A F
37	F	B	W	x						
20	F	W	A	93	DSPM0850	B				
21	M	W	F	58	DSPM0800	F				
33	F	B	F	x						
20	F	W	B	81	DSPM0850	B				
20	M	W	B	78	DSPM0850	C				
24	F	W	A	94						
23	F	W	F	x						
20	M	W	F	x	DSPM0800	C				
30	F	W	A	93	DSPM0850	C			DSPM0850	F
30	F	B	F	x	DSPM0800	E				
									DSPM0800	F

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
23	F	B	A	77	DSPM0850	F				
30	F	W	W	x						
20	F	B	B	88	DSPM0850	A	MATH1710	B	MATH1830	C
20	F	W	B	80						
32	F	W	B	84	DSPM0850	C	MATH1710	W	MATH1710	W
28	M	W	E	48	DSPM0800	C			DSPM0850	B
22	F	B	A	89	DSPM0850	B			MATH1510	F
20	F	W	B	85	DSPM0850	W			DSPM0850	W
21	M	W	F						DSPM0800	F
27	F	W	B		DSPM0850	W			DSPM0850	C
21	M	W	C	75	DSPM0850	W			DSPM0850	B
23	M	W	F	31						
23	M	B	A	98						
36	F	B	W	x					DSPM0800	W
20	F	W	F		DSPM0800	C				
29	F	W	A	100					DSPM0850	A
28	M	B	B	87	DSPM0850	B	MATH1710	C		
20	F	W	B	75	DSPM0850	F	DSPM0850	W		
18	F	W	E		DSPM0800	F	DSPM0800	F	DSPM0800	F
22	F	W	A	98	DSPM0850	B				
33	F	W	A	99	DSPM0850	A				
22	M	W	W	x						
21	F	B	W	x						
25	F	B	A	99	DSPM0850	A			MATH1710	B
21	F	W	E	46	DSPM0800	F			DSPM0800	C
20	M	B	C	67	DSPM0850	F				
23	F	B	C	68	DSPM0850	F	DSPM0850	C	MATH1710	W
33	F	W	F	30	DSPM0800	F				
21	F	B	F	x	DSPM0800	C			DSPM0850	W
20	F	B	C	69	DSPM0850	C			MATH1710	W
21	M	W	B	80					DSPM0850	W
38	F	W	F	x						

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
20	F	W	B	83	DSPM0850	F			DSPM0850	B
22	M	W	B	81					DSPM0850	W
33	F	W	A	94	DSPM0850	A			MATH1710	F
25	F	W	F							
20	M	B	F	x						
21	F	B	B	88	DSPM0850	C			MATH1710	C
24	F	W	C	78						
20	F	W	W	x			DSPM0800	B	DSPM0850	F
20	M	W	B	83	DSPM0850	C			MATH1710	D
21	F	B	W	x	DSPM0800	F				
36	F	W	W	x						
20	F	B	F		DSPM0800	E			DSPM0800	W
31	F	B	F	x						
28	F	W	F	x						
34	F	W	A		DSPM0850	A			MATH1530	A
20	F	W	A	95	DSPM0850	C				
27	M	B	A				DSPM0850	C	MATH1710	W
51	M	B	W	x	DSPM0800	F			DSPM0800	F

Appendix D
Data from Computer Classes

Data from Computer Classes

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
21	M	B	F	x						
21	F	W	F	x	DSPM0800	C			DSPM0850	W
26	M	B	F	x						
43	F	W	F	58	DSPM0800	A			DSPM0850	B
22	M	B	B	85	DSPM0850	C				
22	F	W	F	x	DSPM0800	F			DSPM0800	B
20	F	W	F	x						
26	F	W	B	91	DSPM0850	E				
20	F	W	B	81	DSPM0850	F				
23	M	B	F	x	DSPM0800	F				
22	M	W	W	x						
19	M	W	F	x						
22	F	W	F	x						
20	F	W	F	x						
23	F	B	F	x						
21	M	W	W	x					DSPM0800	W
22	M	W	F	x	DSPM0800	C			DSPM0850	F
24	F	W	F	51						
20	F	W	F	x	DSPM0800	E				
19	F	W	B	83	DSPM0850	C			MATH1710	B
21	F	W	F	x	DSPM0800	IF			DSPM0800	I
20	F	W	C	73	DSPM0850	B			MATH1010	B
23	F	B	F	x	DSPM0800	W			DSPM0800	F
28	M	W	F	x						
21	F	W	F	x	DSPM0800	B				

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
22	F	B	IF	x						
39	M	W	W	x						
23	F	W	W	x						
22	M	W	F	x	DSPM0800	C				
21	M	W	F	x						
22	F	W	F	x						
20	M	B	F	x	DSPM0800	F			DSPM0800	W
20	M	W	F	x						
19	F	W	F	x					DSPM0800	C
24	F	W	A	100	DSPM0850	A				
21	M	W	B	87					DSPM0850	A
20	F	W	B	87					DSPM0850	A
20	M	B	F	x	DSPM0800	C			DSPM0850	F
22	M	W	E	52	DSPM0800	E			DSPM0800	W
24	M	W	A	87	DSPM0850	B				
21	M	W	A	97	DSPM0850	W				
20	M	W	C	62	DSPM0850	F				
20	F	W	C	73					DSPM0850	F
21	F	B	F	x	DSPM0800	F				
21	F	B	C	77						
21	M	W	F	x						
21	F	B	F	x	DSPM0800	E			DSPM0800	F
32	F	W	A	98	DSPM0850	B				
34	M	B	F	x	DSPM0800	F			DSPM0800	F
21	F	W	F	x						
21	M	B	W	x						
21	M	W	F	x	DSPM0800	W			DSPM0800	C

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
26	M	W	F	x						
20	M	W	F	42						
38	M	B	F	x	DSPM0800	C				
21	F	W	E	81	DSPM0800	C			DSPM0850	F
22	F	W	C	74						
20	F	W	E	66					DSPM0800	C
24	M	B	F	x	DSPM0800	F				
21	M	B	F	x	DSPM0800	E				
25	M	B	C	81	DSPM0850	C				
21	M	H	F	64	DSPM0800	B			DSPM0850	F
21	M	W	B	75	DSPM0850	C				
21	M	B	F	x	DSPM0800	F				
20	M	W	A	97					DSPM0850	C
22	M	W	C	65	DSPM0850	C				
20	M	W	A	96	DSPM0850	F			DSPM0850	F
20	M	W	W	x	DSPM0800	F				
20	M	W	E	57	DSPM0800	F				
22	F	W	C	68					DSPM0850	B
23	M	W	F	x						
30	F	W	W	x	DSPM0800	F				
21	M	W	C	73	DSPM0850	C			MATH1710	W
20	F	B	F	x	DSPM0800	F			DSPM0800	F
22	F	W	F	x	DSPM0800	IF			DSPM0800	F
42	M	B	E	x	DSPM0800	C	DSPM0850	F	DSPM0850	B
20	M	B	F	x					DSPM0800	W
31	F	W	B	78	DSPM0850	B				
24	M	W	B	78	DSPM0850	C				
22	M	W	A	97	DSPM0850	A	MATH1710	F	MATH0990	A

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
25	M	W	W	x	DSPM0800	B	DSPM0850	B		
23	M	W	F	x						
23	F	B	F	x						
21	F	B	F	x	DSPM0800	C			DSPM0850	F
21	M	B	W	x						
20	M	B	W	x						
22	F	W	B	89	DSPM0850	B			MATH1010	W
25	F	B	C	67	DSPM0850	F			DSPM0850	F
33	M	W	A	100	DSPM0850	A			MATH1710	W
22	M	W	F	x					DSPM0800	C
34	F	B	F	49	DSPM0800	A			DSPM0850	A
19	M	W	C	70	DSPM0850	F	DSPM0850	C		
23	F	B	W	x	DSPM0800	F				
20	F	W	A	94	DSPM0850	A			MATH1530	A
27	F	W	F	x						
20	M	W	B	84	DSPM0850	A			MATH1710	C
33	F	B	B	81			DSPM0850	A	MATH1710	B
34	M	B	F	x	DSPM0800	B			DSPM0850	B
19	F	W	B	94	DSPM0850	F			DSPM0850	F
20	F	W	B	83					DSPM0850	B
36	F	W	F	x						
22	M	W	F	x	DSPM0800	B				
22	F	W	B	87	DSPM0850	C				
20	F	B	F	62	DSPM0800	C			DSPM0850	C
23	M	B	F	61	DSPM0800	W			DSPM0800	W
20	M	W	F	x	DSPM0800	F			DSPM0800	F
28	M	B	B	85	DSPM0850	W				
26	F	W	W	x	DSPM0800	F			DSPM0800	F

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
23	M	O	C	78						
21	M	W	B	77	DSPM0850	A			MATH1530	W
29	F	W	C	82	DSPM0850	W	DSPM0850	F	DSPM0850	F
28	F	W	W	x						
25	F	O	W	x	DSPM0800	C			DSPM0850	F
27	F	W	F	x	DSPM0800	F				
20	F	W	C	79	DSPM0850	B				
29	F	B	F	x						
21	F	W	F	x						
26	F	B	B	80	DSPM0850	B	MATH1010	B	MATH1410	C
20	F	B	F	x	DSPM0800	F				
34	M	W	W	x						
20	F	W	W	x						
19	M	W	B	79	DSPM0850	C			MATH1710	F
20	F	B	F	24	DSPM0800	E			DSPM0800	C
20	F	W	F	x	DSPM0800	F				
20	M	W	E	55	DSPM0800	E			DSPM0800	C
20	F	W	E	48	DSPM0800	C				
22	F	W	C	78	DSPM0850	B	MATH1710	W		
25	M	W	C	78	DSPM0850	B				
32	F	W	C	80	DSPM0850	B				
22	F	W	W	x						
26	F	W	C	69	DSPM0850	A			MATH1710	B
20	M	H	F	x						
21	M	W	C	71						
22	F	B	F	x						
20	F	W	B	84	DSPM0850	C			MATH1010	B
21	M	W	F	x	DSPM0800	C			DSPM0850	W

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
21	M	W	F	x	DSPM0800	F				
23	F	B	F	x						
21	M	W	F	51	DSPM0800	IF				
21	F	B	B	85	DSPM0850	F			DSPM0850	F
19	M	W	F	x	DSPM0800	E				
21	M	W	C	81	DSPM0850	W			DSPM0850	F
20	M	W	F	x						
22	M	W	C	57	DSPM0850	B				
21	M	W	B	83	DSPM0850	B			MATH1710	F
20	M	W	F	52	DSPM0800	C			DSPM0850	F
22	F	W	B	73						
20	M	B	C	91	DSPM0850	C			MATH1710	D
22	M	W	E	58						
20	M	B	C	74	DSPM0850	C				
20	M	W	F	x	DSPM0800	W			DSPM0800	C
20	M	W	F	x	DSPM0800	C			DSPM0850	W
21	M	W	F	x						
23	M	B	E	50					DSPM0800	F
20	M	B	F	x					DSPM0800	F
18	M	W	F	x						
21	M	W	F	x						
20	F	W	C	68	DSPM0850	B			MATH1530	F
20	M	W	C	88						
23	M	H	F	x						
20	M	H	F	66	DSPM0800	F			DSPM0800	C
53	F	B	F	x					DSPM0800	F
31	M	B	F	x			DSPM0800	F		

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
21	M	W	F	x	DSPM0800	W				
22	F	W	IF	x						
20	F	W	E	67						
19	F	W	C	70	DSPM0850	C			MATH1010	B
20	M	O	A		DSPM0850	A	MATH1710	A	MATH1510	B
26	F	W	B	88						
58	M	W	W	x	DSPM0800	B			DSPM0850	C
21	M	B	C	71					DSPM0850	F
35	M	W	F	x	DSPM0800	B	DSPM0850	W		
21	M	B	F	x						
24	M	W	W	x					DSPM0800	W
21	F	B	B	91	DSPM0850	B			MATH1710	B
20	F	W	F	x	DSPM0800	E			DSPM0800	A
41	F	W	F	x						
21	M	W	F	53	DSPM0800	B			DSPM0850	C
20	M	W	F	x	DSPM0800	F				
23	F	W	C	73						
22	F	B	C	75						
20	M	W	E	59	DSPM0800	F				
22	M	W	B	77	DSPM0850	C				
20	M	W	B	82						
20	F	W	F	x					DSPM0800	F
30	F	W	C	70						
21	F	W	B	64	DSPM0850	C				
22	F	W	F	x	DSPM0800	F				
49	M	W	W	x						
21	F	W	C	69	DSPM0850	B			MATH1710	W
27	F	W	F	x	DSPM0800	W				

Age	GENDER	ETHNICITY	2002F DSPM080 Grade	DSPM080 Exam Grade	2003S Math Course	2003S Math Grade	2003U Math Course	2003U Math Grade	2003F Math Course	2003F Math Grade
22	F	W	W	x						
21	F	B	C	72					DSPM0850	F
21	M	X	A		DSPM0850	W				
37	F	W	A	94	DSPM0850	A				
45	M	W	F	x						
23	M	W	F	x	DSPM0800	C			DSPM0850	W
20	F	W	B	90	DSPM0850	C				
19	F	B	F	44	DSPM0800	F				
27	M	W	B	83	DSPM0850	C				
29	F	B	F	x						
20	M	B	F	57						
21	F	W	F	x	DSPM0800	C			DSPM0850	W
20	M	W	B	87	DSPM0850	A			MATH1710	B
32	M	W	A	98	MATH1530	A				
22	M	W	F	x	DSPM0800	F			DSPM0800	F
20	M	B	C	62	DSPM0850	B			MATH1710	D
21	M	W	W	x						

Appendix E

Final Exam Scores in Elementary Algebra

Final Exam Scores in Elementary Algebra

Lecture Classes' Final Exam Scores		
104	84	69
103	84	69
103	84	69
101	83	69
100	83	68
100	83	67
99	83	64
99	81	64
98	81	64
98	81	63
97	81	58
95	81	53
94	81	48
94	80	47
94	80	46
94	80	43
93	79	42
93	79	40
93	78	31
93	78	30
92	78	
92	77	
91	77	
90	77	
90	77	
90	77	
90	75	
89	75	
89	75	
89	75	
88	75	
88	75	
88	74	
88	74	
88	73	
87	73	
86	72	
86	72	
86	70	
85	70	
85	70	

Computer Classes' Final Exam Scores		
100	78	52
100	78	51
98	78	51
98	77	50
97	77	49
97	77	48
97	75	44
96	75	42
94	74	24
94	74	
94	73	
91	73	
91	73	
91	73	
90	73	
89	72	
88	71	
88	71	
87	70	
87	70	
87	70	
87	69	
87	69	
85	68	
85	68	
85	67	
84	67	
84	66	
83	66	
83	65	
83	64	
83	64	
82	62	
82	62	
81	62	
81	61	
81	59	
81	58	
81	58	
80	57	
80	57	
79	57	
79	55	
78	53	
78	52	

Appendix F

Final Letter Grades 2002 Fall in Elementary Algebra

Final Letter Grades 2002 Fall in Elementary Algebra

Lecture Classes' Final Letter Grades			Computer Classes' Final Letter Grades	
Letter Grades	Frequencies		Letter Grades	Frequencies
A	34		A	13
B	37		B	31
C	34		C	33
F	46		F	96
I	1		I	2
E	4		E	11
W	19		W	22
Total	175			208

Appendix G

Gender, Age and Ethnicity of Elementary Algebra Students Fall 2002

2002 Gender, Age and Ethnicity of Elementary Algebra Students Fall 2002

Gender of Students Enrolled in Elementary Algebra Lecture Classes Fall 2002	Gender of Students Enrolled in Elementary Algebra Computer Classes Fall 2002
Females 116	Females 97
Males 59	Males 111
Total 175	Total 208
Percent Females 66.3%	Percent Females 46.6%
Percent Males 33.7%	Percent Males 53.4%

	Ages for Elementary Algebra Lecture Classes Fall 2002	Ages for Elementary Algebra Computer Classes Fall 2002
Mean	24.72114286	23.5856823
Standard Error	0.464666202	0.419818409
Median	22.00821918	21.35890411
Mode	19.88767123	21.32328767
Standard Deviation	6.14695606	6.054707203
Sample Variance	37.78506881	36.65947932
Kurtosis	3.644081373	9.24444935
Skewness	1.76046161	2.797411862
Range	33.53150685	39.46575342
Minimum	17.55068493	18.2739726
Maximum	51.08219178	57.73972603
Sum	4326.2	4905.821918
Count	175	208

Ethnicity of Elementary Algebra Lecture Classes Fall 2002	Ethnicity of Elementary Algebra Computer Classes Fall 2002
Black 47	Black 56
Hispanic 3	Hispanic 4
Asian (Oriental) 2	Asian (Oriental) 3
White 122	White 144
Other 1	Other 1
Total 175	Total 208
Black 26.9%	Black 26.9%
Hispanic 1.7%	Hispanic 1.9%
Asian (Oriental) 1.1%	Asian (Oriental) 1.4%
White 69.7%	White 69.2%
Other 0.6%	Other 0.5%

VITA

Tina Burrow Cannon was born in Chattanooga, Tennessee on December 15, 1964. She attended schools in the Hamilton County public school system, and she graduated from Tyner High School in June 1983. She attended the University of Tennessee at Chattanooga where she received her Bachelor of Science Degree in Secondary Education: Mathematics in April 1989. In January 1990 she began teaching at Chattanooga State Technical Community College as an adjunct instructor in the Developmental Studies Department. She also taught General Education Degree classes for Chattanooga State Technical Community College. She received a Masters of Arts degree in Education from Tusculum College in December 1993. In January 1993 she began working for Chattanooga State Technical Community College as a fulltime instructor. She went back to school in order to get 18 hours of graduate level mathematics courses from the University of Tennessee at Chattanooga, Middle Tennessee State University and Shenandoah University. In July 1998, she became an Assistant Professor of Mathematics in the Mathematics Department at Chattanooga State Technical Community College. She began work on a Doctorate of Education with a concentration in Instructional Technology and Educational Studies during the fall 1999 semester. The doctorate degree was received December 2005. She is presently working as an Associate Professor of Mathematics in the Mathematics Department at Chattanooga State Technical Community College.