THE IMPACT OF COMPUTER-BASED PROGRAMS ON MIDDLE SCHOOL MATH ACHIEVEMENT

By

Kenyatta Gilmore

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the requirements for the Degree

Doctor of Education

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ABSTRACT

The purpose of this correlation research study was to investigate the impact of computer-based learning on middle school math achievement of at-risk students. The participants for this study were drawn from a convenience sample of 83 middle school students located in southeastern Georgia. At-risk middle school students were achieving below their grade equivalent and failing to meet local and state proficiency standards. Computer-based instruction was implemented as an intervention to increase student achievement in mathematics. The study used a pretest-posttest control group design and used SPSS software to conduct the statistical analyses using an ANCOVA and *t*-test. The results indicated that the use of Math 180 did not result in a statistically significant increase in achievement of at-risk students. However, the observed power for each null hypothesis was very low, indicating the likelihood of a Type II error. Therefore, there may have been an effect of Math 180 on student achievement, but the sample sizes were too small to detect it. This type of intervention may be recommended for continued use; however, future research on other computer-based programs would be beneficial.

Keywords: at-risk, computer-based instruction, mathematics, Math 180

Dedication

This dissertation is dedicated to my family, who has supported and encouraged me along this journey. To my husband, Von, thank you for the love and patience, and for believing in me through this entire process. To my children, Bailey and Blake, thanks for your resilience and willingness to share your mom during this time. To my mom, your girl did it, again. To Moffett, thanks for always being there.

This dissertation is dedicated to my chair, Dr. Fouche, for her support, advice, guidance, and encouragement through this entire process. Immeasurable appreciation and gratitude are extended for the unwavering confidence you maintained in my ability to succeed. To my committee members, Dr. Tremble and Dr. Evans, thanks for your support and shared ideas.

Finally, this dissertation is dedicated to my grandmother, Pattie Sue, who genuinely believed her “Angel Child” could do anything. May the work I’ve done speak for me.

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CHAPTER ONE: INTRODUCTION

Overview

Chapter One contains a brief explanation of the problem, purpose, and significance of this study, which investigates the impact of computer-based programs on middle school math achievement. It also details the research questions, hypotheses for the study, and definitions of items pertaining to the study.

Background

As students advance from grade to grade, they may tend to disengage from math and lose interest in the subject (Attard, 2010). Much of their success in mathematics relies on the fact that they must be able to comprehend mathematical concepts, as well as calculate effectively (Stickney, Sharp, and Kenyon, 2012). The lack of basic skills that are needed to be successful in middle and high school mathematics courses may become a major issue for those who are recognized as at-risk students. Robertson (1997) suggested that problems are more likely to occur during a transitional year such as moving from elementary to middle school or from middle school to high school. During the transition from primary to secondary school, many students experience significant changes in the physical structure, teaching and learning practices, and expectations of school (Attard, 2010). In addition, they must face the stresses of entering a new school climate when entering secondary school. This change puts pressure on these students, and their math performance may suffer. Therefore, it is essential to ensure that highly effective math strategies are used with at-risk students. For this study, the term “at-risk” refers to students who have failed the state’s standardized test in mathematics or are performing two grade levels below in mathematics. These students are at-risk of failing mathematics, and may even drop out of school as a result. This study will focus on the various strategies that could continue to be used to improve middle school at-risk students' academic achievement in mathematics.

The reauthorization of the Elementary and Secondary Education Act in 2001, now known as the No Child Left Behind (NCLB) Act of 2001, set standards for improved student performance nationwide. Although challenging, especially for states that have not developed an accountability system, the often-controversial act has been considered the federal government's most far-reaching education bill in nearly four decades since the first Elementary and Secondary Education Act was drafted and authorized during the Johnson administration.

With the reauthorization of the NCLB Act of 2001, promotion for various grade levels depends on the students' ability to pass standardized tests in mathematics that can be identified as high-stakes tests. Across the nation, school districts are struggling to meet these requirements and are also striving to make sure all students acquire the necessary skills to achieve in mathematics. Students who are already performing poorly or failing in school are at-risk because they have not been successful with regular school mathematics curricula and will likely fall farther behind or drop out (Hixson & Tinzmann, 1990).

Although controversial, this legislation provided a framework for increasing student achievement and parent involvement and has forced educators to consider subgroups of students whose needs were not being met in the classroom. It has also highlighted the need for quality teachers and instituted reporting procedures to help the public and parents understand how their schools are performing. Across the nation, all states, school districts, and schools were being urged to review their use of high-stakes testing, and, thus, increase accountability. The primary goals of test-based educational accountability systems are to increase student achievement and to increase equity in performance among racial-ethnic subpopulations and between students who are poor and their more affluent peers (Pelliger, 2014).

For Georgia middle school students, the states' Criterion Reference Competency Test (CRCT) became an integral tool that weighed heavily in terms of making decisions for student achievement such as promotion or retention (Georgia Student Assessment Handbook, 2013). Although in effect for several years, only a minimum competency level was needed to move on to the next grade. In 2015, the state chose to increase the rigor and expectations for Georgia's students and adopted a new student assessment, the Georgia Milestones Assessment System (GMAS) to provide a more realistic picture of academic progress and increase college and career readiness (Georgia Department of Education, 2015). With academic demands continuing to increase, it is essential that at-risk math students are receiving quality instruction, which leads to content mastery.

The term *at-risk* first appeared in education literature following the publication of the federal report, *A Nation at Risk* (National Commission on Excellence in Education, 1983). The National Commission of Excellence on Education argued that poor student achievement was putting the country at economic risk; as a result, reforms called for increased requirements, higher standardized test scores for promotion, and more testing overall for students. Many young adolescents struggle with at-risk conditions such as low achievement, and school programs have used various approaches to address at-risk conditions (Lee, 1993).

The number of students being identified as at-risk has increased (Balfanz & Byrnes, 2005); these students have not seen improvement in the area of mathematics. Many students enter middle school lacking the basic skills to achieve academically in mathematics (Attard, 2010). Unfortunately, at-risk students may not focus on how important, useful, and enjoyable mathematics can be.

The main theoretical framework for this study is Knowledge Space Theory. This theory enables the creation of computer algorithms for the construction and application of discipline-specific knowledge structures known as knowledge spaces. Knowledge space theory can determine a student's knowledge state in approximately 25-30 questions. Knowledge Space Theory is based on two concepts which include the knowledge state that identifies a particular set of problems or skills that an individual is capable of solving correctly, and the knowledge structure which is a collection of these knowledge states (Conlan, O'Keefe, Hampson, & Heller, 2006). ALEKS, the computer program that will be used for this research, employs Knowledge Space Theory as the basis of the program.

Problem Statement

The problem addressed in this study is that at-risk Georgia middle school students are achieving far below their grade equivalent (GE) in mathematics and failing to meet the proficiency standards for the state's standardized high-stakes test. In society, a student can be labeled as being at-risk at any given time based on a variety of situations. Students who are identified as at risk often have not mastered the necessary skills for achievement in order to meet the required standards and may have displayed negative behaviors that may hinder them from learning in general. According to Robertson (1997), indicators of at-risk adolescents are attention problems, grade retention, poor grades, absenteeism, behavior problems, lack of confidence, and limited connection to school life. Vaughn, Boss, and Schumm (2000) identified four factors associated with at-risk students: (a) remediation, (b) retention, (c) dropping out, and (d) substandard basic skills. All of these factors place students in a category of at risk that increases as they reach high school. Although any one factor or even several factors do not necessarily place students at risk, combinations of circumstances identify the potential to drop out (Frymier & Gansneder, 1999). For students who are motivated by technology, computer based instruction may assist at-risk students in improving math achievement.

Computer-based instruction produces positive changes in student attitudes toward learning, and it reduces the amount of time needed for instruction (Kulik, 1991). Computer-based instruction is used to teach a variety of skills and subjects within the school setting. Although students are using devices, a gap in the literature still exists to determine how computer-based learning impacts student achievement in mathematics. More students are using computers but little is known about the impact of computer-based instruction on student attitudes and student learning in mathematics. Effective methods are sought to change attitudes and motivate students about achievement in mathematics.

Suh, Suh, and Houston (2007) also identified a variety of circumstances that often place students at risk: individual, family, school, and community factors. Factors that have been identified for students in these circumstances include low expectations, lack of adequate counseling, negative school climate, lack of relevant curriculum, passive instructional strategies, inappropriate use of technology, disregard of student learning styles, retentions, suspensions, and conflict between home and school (Suh, Suh, & Houston, 2007).

The experiences of at-risk students will vary; however, most of these students probably will experience the problem of academic failure because of learning deficiencies. Thus, all constituents in the education arena must be made aware of this problem and seek interventions to identify at-risk students as early as possible. According to Pinata and Walsh (1996), at-risk students should to be identified as early as possible and regularly reevaluated because their family status and living situations can change. Solutions may include making provisions for continual support and implementing programs that will assist at-risk students to achieve academically.

Purpose Statement

The purpose of this study is to investigate the impact of computer-based learning on middle school math achievement of at-risk students. According to Mertens and Anfara (2006), student achievement is academic achievement as measured by standardized test scores such as state assessments like the Criterion-referenced Competency Test (CRCT) and Georgia Milestone Assessment System (GMAS). Across the state of Georgia, school districts have been experiencing problems with student achievement in mathematics (Georgia Department of Education, 2014). On the GMAS 37.5 percent of 8^{th} grade students, 37.3% of 7^{th} graders, and 21.5% of sixth graders in the county's middle school math scored at or above proficiency levels (GAPSC, 2016). When students enter elementary school, emphasis should be placed on teaching the students to solve basic mathematics problems. With that being said, such problems would less likely be carried over into the middle school or even the high school.

The need to differentiate instruction in mathematics is necessary to ensure the needs of all students are being met. Practice makes permanent, and the more practice, support, and guidance students receive in these areas, the greater the likelihood of increase in achievement. With all stakeholders working collaboratively and addressing the existing problems concerning achievement in and mathematics for at-risk students, a deeper understanding can be gained.

Significance of the Study

The NCLB Act of 2001 and its high expectations have caused school districts and educators nationwide to focus on accountability and student achievement. One of the major areas of emphasis is mathematics. Realizing that at-risk students already lack the ability to deal effectively with the components of the cognitive processes in order to be successful in mathematics, the researcher will focus on strategies of individualized instruction to help these students improve their academic success in mathematics.

Middle school students have difficulty in achieving proficiency in the area of mathematics as measured by their performances on the state's CRCT (Georgia Department of Education, 2014). The at-risk population is steadily increasing, and providing strategies to assist these students in becoming successful is long overdue. Education reform has brought many changes for the education system, and something has to be done to accommodate the increasing number of students who were being identified as at risk.

In the educational arena, accountability has increased and caused assessment to be more important than ever before. Assessments can be used as tools for determining the abilities of students in their classrooms and to see the effects from the teaching and learning process. Administrators depend on assessment tools for the purpose of making decisions about education for the school districts and schools. Consequently, states depend on federal funds as the main source for maintaining their school districts, and assessment is a tool that they depend on for obtaining those funds.

The intent of most states utilizing high-stakes testing for accountability purposes is admirable, but the negative consequences may outweigh the potential benefits. In terms of positives, high-stakes testing helps schools set performance goals, provides a focus for the curriculum, reveals academic progress to the public, and potentially provides additional funding support through federal programs (Faulker & Cook, 2006). Due to the pressures of educational reform and high-stakes assessment, a major focus of the Georgia CRCT is on mathematics. This focus comes from the NCLB Act of 2001 that requires schools, school districts, and the state to be held accountable for the academic performance of all students.

In order for middle school students to pass the mathematics standardized test and to satisfy promotion requirements, effective instructional strategies must be implemented the first year the students enter middle school. A priority has to be placed on improving the students' academic performances during their middle school years. According to Balfanz and Byrnes (2005), student achievement has risen slightly, but the academic growth that students show over the course of a school year has slowed, particularly for some minority groups.

The use of computer-based instruction and technology has become very popular for enhancing at-risk student achievement. Because computer-based instruction can be utilized in various ways to enhance student achievement, it becomes necessary to decide which method would best meet student needs. Integrating learning systems such as Math 180 may assist in managing individualized instruction and increasing math skills. Basic skills lend themselves to drill-and-practice activities, and computer-based instruction, with its ability to generate exercises is well suited to providing extensive practice.

Computer-based instruction has been identified as an effective strategy to improve the achievement of at-risk students (U.S. Department of Education, 2003). With the advancement of technology, the use of computers in schools has increased rapidly over the last 20 years. By 1996, fully 70% of 4th graders and 50% of 8th and 11th graders were using computers at school at least once a week, whereas less than 20% did so in 1982 (U.S. Department of Education, 2003).

Computer-based instruction improves instruction for at-risk students because the students receive immediate feedback and do not continue to wrongly practice skills. Because such programs are interactive, they capture the students' attention and engage the students in a spirit of competitiveness to increase their scores. Due to the increased use of computers in general education classrooms and the increased availability of instructional materials in digital formats, computer-based approaches have become more flexible and, therefore, are able to address more learning needs of at-risk students (National Center for Education Statistics, 2014). Thus far, traditional classroom instruction and technology-based instruction have a tendency to complement each other while affording at-risk students the opportunity to enhance their academic performances. In this study, the researcher will investigate the impact of computer-based learning on middle school math achievement on the STAR Math assessment.

Research Questions

RQ1: : Does computer-based instruction (Math 180) increase math achievement on the STAR Math assessment of middle school students while controlling for the math pretest?

RQ2: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by gender, while controlling for the previous math achievement?

RQ3: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by race/ethnicity?

Null Hypotheses

$H_0$1: While controlling for the math pretest, there will be no statistically significant difference in middle school students' STAR Math assessment when participating in computer-based instruction (Math 180) compared to traditional math instruction.

$H_0$2: There will be no statistically significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not, while controlling for the previous math achievement.

$H_0$3: There will be no statistically significant difference in STAR math achievement by race of students receiving computer-based instruction (Math 180) and students who do not.

Definitions

The following list of operational definitions assists in the understanding of key terms used in this study:

1. At-risk student -A student who faces school failure or has the potential to leave school early due to low educational achievement (Taite, 1990) and is at risk of becoming a dropout because educational needs are not being met (Frymier, 1997). For this study, at-risk students are those who failed the state's standardized test in mathematics, failed one or more grades, or demonstrated academic performance below grade level in mathematics.
2. Computer-based instruction- The use of computers to present instruction and for students to interact directly with the computer to learn basic skills. Computer-based instruction is designed to help students learn new material or enhance their knowledge of materials

previously learned. For this study, basic skills instruction will focus on mathematics using the Math 180 program.

3. Traditional instruction- The use of direct instruction delivered by a classroom teacher dispensing knowledge and demonstrating skills using lectures, discussions, and group work.
4. Mathematics achievement - A student's performance determined by demonstrating competency by applying mathematics concepts and understanding basic operations and procedures in order to achieve the level of being proficient. For this study, mathematics achievement will be measured by the STAR math pretests and posttests.
5. Math 180– The artificial intelligent assessment and learning system, which uses adaptive questioning to quickly and accurately determine student math knowledge.
6. STAR Math – The standardized math assessment that provides information about student growth and achievement. It is given several times a year to measure growth in mathematics.
7. CRCT- The Criterion Referenced Competency Test was Georgia's standardized test prior to 2015.
8. GMAS- The Georgia Milestones Assessment of Skills is Georgia's current standardized high-stakes assessment. The first assessment reports were made available October 2015.
9. SPSS- Statistical Package for Social Science is the software application for performing statistical calculations in this study.

CHAPTER TWO: REVIEW OF LITERATURE

Overview

Chapter Two contains an in-depth review of the literature, which investigates the impact of computer-based programs on middle school math achievement. It details the theoretical framework, related literature, and a summary of the literature.

Introduction

In classrooms around the United States, there sits children wondering when the school day will end so the disappointment of school can come to a close. These children are numerous, and many find educational information, specifically mathematics, difficult to grasp. Fortunately, while the interest in math instruction may be virtually non-existent in the world of a child, the cyber-world is provoking problem-solving skills, reasoning skills, and making inferences. One promising new way to teach higher order thinking and problem solving skills is through web-based or computer-based techniques.

Many studies across the country and around the world are available on the advantages of a web-based learning environment. However, researchers have failed to fully assess the impact on those who are significantly behind in mathematics and are likely to not meet academic standards. This omission leaves a gap in the literature and calls for subsequent study in this area. Learning and achievement in math have been on the downward spiral across the board, but in math classes, this affect may be increased exponentially. According to the Entertainment Software Association (ESA), 2015, 68% of American households now play video games. More than 150 Americans play video games and 42% of them play at least three hours per week.

Currently, more than 200 colleges, universities, and technical schools offer video game courses and degree programs. With so many children using computer-based games, implementing them in schools serves as a constructive way to keep students engaged. Computer games assist with planning and problem solving. Since students are already using these devices, it seems appropriate to add math instruction to this toolbox. The impact of computer-based instruction on math achievement needs additional research that could make positive contributions to education. The study will focus on determining how computer-based instruction impacts struggling math students.

This literature review will address math achievement issues, the theoretical framework for which this study is based, the effectiveness of computer-based instruction, assessment, STAR math, and Math 180.

Theoretical Framework

Three learning theories closely relate to this research study: knowledge space theory, behaviorism, and social constructivism.

Knowledge Space Theory

The first framework for this study is Knowledge Space Theory (KST). This theory was developed in 1985 by Falmagne, Cosyn, Doignon, and Thiery. Knowledge Space Theory is a theory of knowledge representation and is based on precedence relation (Falmagne et al., 2004). It is logical, especially in mathematics, that some levels of knowledge normally precede other levels because of prerequisite requirements and logical steps. According to Falmagne et al. (2004), precedence relation may be used to design effective and efficient assessment mechanics.

There are three assumptions associated with precedence relations. First, from mastery of one problem, the mastery of other problems is assumed. Second, there are dependency relationships, which exist between problems of a set. And third, if a learner is capable of mastering a set, then he or she will be capable of mastering problems that are parts of the set.

In order to discover a student's knowledge state, the student takes an individualized assessment that increases or decreases the rigor of the questions in response to the student's answers. This computerized assessment is able to identify the student's knowledge state using less than 30 math problems. All problems are open-ended, so there is no probability that the student will guess into an incorrect knowledge state.

Behaviorism

Behavioral learning theory is a concept that computer-based instruction is based. Edward Thorndike inferred that behavior was a result of two factors, frequency and pleasurable results (Catania, 1999). Students continue a behavior if positive feedback is shown. Thorndike called this the "law of effect." If behavior is reinforced, then that behavior will increase (Rouse, 2007). With computerized instruction, students receive immediate feedback while working on programs. This feedback paired with positive feedback from teachers may increase the amount of time students spend on computer-based instruction. B.F. Skinner concluded that if the consequences were good, the actions would be more probable (Boylan & Saxon, 2015). The use of tests to measure observable learning behaviors, consequences in our school systems, and the breaking down of instruction are all examples of the behaviorist's influence. The focus of behaviorism is on observable human behavior.

Social Constructivism

The ideas of Jean Piaget and Liv Vygotsky help us understand this learning theory. Constructivism focuses on a learner's ability to mentally construct meaning of their own environment and to create their own learning. As a teaching practice, it is associated with different degrees of non-directed learning. Constructivists believe that all humans have the ability to construct knowledge in their own minds through a process of discovery and problem solving. When students work independently on iPads to complete tasks and gain further understanding of concepts, this learning theory is being implemented. Students use background knowledge as well as skills learned from the teacher to discover new information. Constructivism infers that students should be more responsible in the learning process and that they learn through interactions between their experiences and ideas. Social constructivism extended the focus of learning to address social aspects of learning. Social constructivism acknowledges the uniqueness and complexity of the learner and actually encourages, utilizes, and rewards it as an integral part of the learning process (Wertsch 1997). With computer-based instruction, students receive individualized instruction and rewards that assist in motivating the learner to achieve more.

Related Literature

Gordon Pask and O.M. Moore introduced computer-based instruction during the 1950s. These researchers worked to develop a learning theory that focused on artificial intelligence, logic, and linguistics. Pask and Moore were primarily concerned with information, feedback, identity, and purpose. As computer technology advanced in the 1960s, computer-based instruction began to evolve. The most common uses for computer-based instruction were for simulations of real situations and processes, tutorials, practice which increases fluency in new skills, instructional games, and problem solving. These uses may be advantageous for middle school math students.

There are numerous advantages of computer-based instruction if done effectively. It can motivate learners and provide immediate feedback. It can store the performance of the learner for future use or further fine-tuning. Computer-based instruction can be adjusted depending on the level of the learner. It is usually a highly interactive method of learning.

Depending on the program, computer-based instruction does have some limitations. Equipment and software can be costly and difficult to acquire. Not all subjects can be supported efficiently by computer-based instruction. Also, choosing the appropriate program is essential as to not waste instructional time by just playing on the computer.

The use of computer-based instruction and technology has become very popular for enhancing at-risk student achievement. According to a report on technology and education reform (U.S. Department of Education, 1993), some of the first computer-based instruction programs were developed set standards for subsequent instructional software. After systematically analyzing courses in mathematics and other subjects, Suppes (U.S. Department of Education, 1993) designed highly structured computer systems that featured learner feedback, lesson branching, and student record keeping.

Because computer-based instruction can be utilized in various ways to enhance student achievement, it, then, becomes the responsibility of the teacher to decide which method would be appropriate for all students. The uses can be whole-class group, small group, or individual. Basic skills lend themselves to drill-and-practice activities. Computer-based instruction, with its ability to generate exercises, is well suited to providing extensive drill and practice in basic skills. Students at risk of failing mathematics may lack basic skills and be unprepared to acquire advanced-thinking skills. Thus, at-risk students become logical candidates for computer-based drill-and-practice instruction (U.S. Department of Education, 1993).

With the advancement of technology, the use of computers in schools has increased rapidly over the last 30 years. By 1996, 70% of 4th graders and 50% of 8th and 11th graders were using computers at school at least once a week, whereas less than 20% did so in 1982 (U.S. Department of Education, 2014). In 2014, 98% of students were using computers in school daily. Use of technology to improve student learning has become one of the major components in today's education reform.

Computer-based instruction is among the range of strategies being used to improve student achievement in school subjects, including mathematics. Programs for computer-based instruction have come a very long way since they were first developed. These programs tutor and drill students, diagnose problems, keep records of student progress, and present material in print and other manifestations. It is believed that they reflect what good teachers do in the classroom (Soe et al., 2000).

Computer use in schools has become widespread from primary education through the university level and even in some preschool programs. Instructional computers are basically used in one of two ways: they provide a straightforward presentation of data, or they fill a tutorial role in which the student is tested on comprehension. Computer-based instruction provides one-to-one interaction with a student as well as an instantaneous response to the answers elicited. Computer-bases instruction programs allow students to proceed at their own pace. By using such programs diagnostically, students' problems can be identified, and a focus can be placed on the problem area. Because of the privacy and individual attention afforded through computer-based instruction, some students are relieved of the embarrassment of giving the incorrect answer publicly or of going more slowly through lessons than their classmates.

Personalizing information allows computer-based instruction to increase learner interest in the given tasks and to increase the internal logic and organization of the material. The animation of objects involved in the explanation of a particular concept increases learning by decreasing the cognitive load on the learner's memory, thereby, allowing the learner to perform search and recognition processes and to make more informational relationships (Traynor, 2003).

Computer-based instruction improves instruction for at-risk students, including those with disabilities, because the students receive immediate feedback and do not continue to practice the wrong skills. Because such programs are interactive, they capture the students' attention and engage the students in a spirit of competitiveness to increase their scores. Due to the increased use of computers in general education classrooms and the increased availability of instructional materials in digital formats, computer-based approaches have become more flexible and are able to address more learning needs of students with disabilities (National Center for Education Statistics, 2004). Traditional classroom instruction and technology-based instruction have a tendency to complement each other while affording at-risk students the opportunity to enhance their academic performances.

A significant finding in the research literature is that the use of computer-based instruction as a supplement to traditional, teacher-directed instruction produces achievement effects superior to those obtained with traditional instruction alone. Generally speaking, this finding holds true for students of different ages and abilities and for learning in different curricular areas.

At-Risk Students

Problems that contribute to students being labeled at risk may relate to poverty, crime, school, drinking, and various family problems. Many students in this category may feel left out and spend less time engaging in their academic. As a result, many fall behind in their schoolwork. This can contribute to the at-risk student becoming frustrated due to not understanding the course work and, therefore, failing to master the necessary skills to be successful in school. Such students must receive guidance and encouragement to do their best in school.

When students experience low achievement, they often fall into a rut and fail if preventive measures are not put into place. Lee (1993) noted that effective programs have high expectations for at-risk students, regardless of the at-risk condition. At-risk programs for low achievers often fail to demand excellence from learners due to low expectations. Rather than allowing or even promoting mediocrity, at-risk programs should be challenging and rigorous and should have high expectations.

For many at-risk students, their self-concept and sense of confidence derive largely from their relationships with others. Parents and school staff are primary sources through which students make judgments about themselves as learners and about their potential to be successful in educational environments (Hixson & Tinzmann, 1990). It is important for at-risk students to possess positive attitudes and high self-concepts in order to achieve academically.

With the implementation of the NCLB Act of 2001, all states were required to ensure that all students become proficient in and mathematics. However, American students score below average on international tests of mathematical knowledge and skills (Loveless, 2011), and nearly two-thirds of our nation's eighth graders do not meet current mathematics standards (National Center for Education Statistics, 2015). The school district of the current study, just like many others, seemed to be pressured by accountability and by attempts to make sure students attain proficiency on Georgia's standards-based achievement tests in mathematics.

It is very important for all students to acquire the necessary skills that will enable them to increase their achievement to progress from level to level in terms of grade placement.

Although several computer-based programs have been implemented to help students become successful, it is imperative that they be thoroughly researched to determine their effectiveness with at-risk students. These students tend to need extra help and special attention in order to remain in school. Early interventions enable at-risk students who are more likely to drop out of school to remain in school. The school system's high school graduation rate in 2015 was 77% for students in Grades 9–12. One goal of the middle schools is to help prepare students for high school to help students become college and career ready.

Effectiveness of Computer-Based Instruction

Computer-based instruction is the use of computers or hand-held devices to deliver educational content to students. Computer programs or applications offer a one-to-one learning ratio and allows students to actively engage in the learning process. Computer-based instruction gives immediate feedback and promotes positive interactions.

Computer-based instruction is strongly associated with e-learning, a term that has been broadly used in education since the 1990s (Witte, Haelermans, & Rogge, 2014). It is the process for teaching and learning initiatives that delivers content through the use of technology innovations. Researchers at the University of Memphis conducted a study to determine the effectiveness of ALEKS to close the racial score gaps in an undergraduate behavioral statistics course (Hu, Luellen, Okwumabua, Xu, & Mo, 2008). The study used 548 undergraduate students who took the course online and in a traditional classroom setting. The researchers compared the progress of the 137 students who took the course online versus the 411 students who took the course face-to-face. Results from the study determined that ALEKS helped close the racial gap by decreasing the initial difference in between groups by one letter grade.

With most states adopting the Common Core Standards, educators are continually searching for ways to increase student engagement. Mobile devices, such as iPads, have been used for drill and practice in mathematics. However, these devices would be more useful when research-based mathematics instruction is utilized. Countless math applications have been created for the iPad. Technology integration enhances teaching, learning, and student engagement (Wright & Wilson, 2011). As students spend more time using these devices, they will become active learners and more motivated to learn and produce high-quality work (Franklin, 2011).

Due to an increased need to increase achievement in Title I public schools, a four year study of students in grades kindergarten through eighth grade was conducted to assess the effectiveness of a supplementary computer-based instruction program in math and language arts on underachieving low socioeconomic students (Suppes, Liang, Macken, & Flickinger, 2014). Students participated in computer-based courses where the program offered immediate individualized feedback. Since the program was individualized, students were able to move on when ready if they mastered material. Individual remediation was a built-in component for students having trouble mastering material. Results indicated that online computer-based instruction was an effective way to improve achievement score for at-risk elementary and middle school students with low socioeconomic statuses. These findings are significant due to the large number of students involved in this study and the significant gains of the at-risk students.

Students are exposed to technology at home and school for entertainment, communication, and other reasons. The relationship between students' exposure to technology and their math and science achievement was examined (Delen & Bulut, 2011). Nearly 5000 students from 170 schools in Turkey were surveyed about technology use and accessibility. Results indicated that the greater the exposure to computers, the larger impact it had on their math and science achievement. This adds to previous evidence that computer usage can be beneficial to student achievement in mathematics.

Another country, Italy, has low math achievement and looks for ways to increase student achievement in this area. They too are searching for instructional practices and interventions to increase student achievement, specifically in mathematics. Through a large trial involving 175 middle schools, researchers assessed the effects of the M@t.abel teacher training program had on students; math performance and on teachers' behavior and instructional practices (Argentin et. al, 2014). Information about teacher and student engagement, attitude, and achievement were collected through questionnaires and national standardized test data. Results indicated that students of teachers who have completed the training program had more positive attitudes and a greater feeling of responsibility for their own learning. These teachers began to try more innovative ways to engage students in learning. Although teachers did not specifically use technology as a sole source of intervention, it was determined that teachers who used more innovative practices increase the opportunities for students to increase math achievement.

A study on personal devices such as iPads indicated that students with mobile devices prefer computer-based instruction to traditional teaching (Crighton, et al, 2012). Students were allowed to utilize iPads during the school day; however, they were not as likely to complete written homework assignments.

A controlled study of fifth grade students focused on the challenging topic of fractions. Although fractions are introduced as early as second grade, middle school and high school students generally experience difficulty when working with fractional numbers. In this study, students used a math app designed to help them strengthen their relationship between fractions, proportions, and percentages on the number line (Riconscente, 2013). Baseline data was gathered on two groups that were tested using released state assessment items. Results revealed a significant increase in fraction knowledge in students who played

For years, whenever students struggled with a concept, administrators and teachers have quickly added additional time in that area. Although this strategy works well with reading, a study generated by Florida's Miami-Dade County Schools reveals that additional time in math will not help struggling students retain math skills needed to be successful. The study determined that math scores did increase during the initial implementation; however, students' scores decreased when they returned to their regular schedules (Schaffhauser, 2014). Teacher and student anticipation and excitement of a new strategy may be the cause of the short-lived increase. However, it is constant student engagement that delivers more long-term results. Students are able to retain information better when it peaks their interests'. This is the type of engagement computer-based instruction delivers for students.

Evidence from a high-school study to determine if the use of a computer-based learning system impacts standardized Algebra scores indicated significant improvements in achievement scores. The study consisted of a pretest before nine months of intervention. Progress monitoring was completed each month. When results from the state standardized test were released, it was found that students who used the online program for at least two class periods per week showed a much larger gain on the state test compared to the national average (LaVergne, 2007).

In an article on mathematics web-based instruction, researchers analyzed how use of computer instruction in mathematics improved student motivation and parental communication (Al-A'ali, 2008). By using a web-based program, teachers were able to document an increase in students' attitudes towards tackling math problems. Students were more willing to engage and felt less threatened when using computers versus participating in daily teacher-led direct instruction.

When student's interests and engagement increases, they are motivated to continue working and complete more assignments. This was evidenced in a second grade teacher's class she taught a lesson involving money related math skills. Students were actively engaged and did not want to put the devices down at the end of the lesson. Students worked in groups of two or three to answer questions with visual representations (Bennett, 2011). After using iPads for five months, the second grade teacher saw an increase in student motivation, attitudes, and overall math grades.

Since the addition of iPads at Northdale Middle School, students are more engaged, and these devices have become motivators for students to complete assignments (Baca, 2012). The largest impact that teachers initially noted was the decrease in negative classroom behaviors.

This decrease had a positive impact on the students' math achievement. Teachers also noted that students were able to self-pace and required less prompting. If our students are going to be competitive after graduation, they must be intrinsically motivated and able to think without constant direction from teachers.

Impact on Student Achievement

The influence of hand-held devices on third grade student achievement was studied using a nine-week computer-based learning intervention (Kiger, Herro, & Prunty, 2012). Two classes were taught using traditional flashcards and direct instruction methods. Two other classes used a computer program called Everyday Math that focused on web applications as the primary method of instruction. Students using web applications retained more information and outperformed the other group on a multiplication posttest.

Students involved in study at a Nebraska elementary school used hand-held devices during math instruction. According to standardized test results, the students performed significantly below grade level. After using computer-based instruction three days a week for six weeks, these three participants improved their subtraction scores by an average of 17% (Nordness, Haverkost, & Volberding, 2011). This study suggests that continued use of mobile devices will impact math achievement.

According to "Computer games for the math achievement of diverse students" (Kim & Chang, 2010), researchers examined the effects of math computer games on 4th-graders. Students completed survey questionnaires to get their insight on how they feel about math computer games. Students responded that math computer games were fun and they spent more time solving math problems when working on computers. Students felt that they were able to learn more when using computer games.

Studies have been published on the use of computer-based math programs at various levels. A 2007 study was done because of the large number of Algebra 1 students struggling to achieve in a traditional classroom setting using a traditional math text. The researcher wanted to determine if an online intervention in addition to the traditional teaching would positively affect the standardized math scores of Algebra 1 students (LaVergne, 2007).

The study involved 98 participants, who used the computer program between 30 and 90 minutes per week. Standardized test results revealed the students using the program had an average improvement of 2.7 points while students who did not use the program showed only a one-point growth in the same district. The national average of growth that same year was 1.6 points. This growth was assessed after a pretest, nine months of twice per week use, and the stated assessment. Evidence from this study suggests that computer-based instruction slightly increased Algebra 1 math scores.

According to X. Hu (2009), Tennessee County Schools tracked the progress of 200 sixth graders during and after school program. Students performing in the bottom 40% of the Tennessee Comprehensive Assessment were randomly assigned to work in a computer-based setting or a study hall (with teacher assistance) serving as a quiet place to complete extra math practice.

When researching the impact of technology-based mathematics, Craig, Hu, Graesser, & Bargagliotti (2013) implemented a computer-based program for 25 weeks as an afterschool math intervention. Students were compared to a control group who were taught by a classroom teacher. Researchers wanted to compare math performance, behavior, and the need for assistance in completing tasks. The study revealed that students in the computer program performed as well as or better than the control group on the Tennessee state assessment. There was no statistically difference in math achievement. However, there was a decrease in the amount of assistance needed by the students who worked on the computer versus the students who were taught by a classroom teacher. From this article, it can be inferred that effective use of computer-based math interventions may lead to improved math achievement.

Although previous studies mentioned in this literature review occurred in the United States, Longfield Academy in Kent, England incorporated a high level of technology integration in the curriculum (Walsh, 2012). Students in the school had or were issued iPads to use daily. Three of the top ways students used the iPads were for online research, creating presentations, and group work. This study used surveys to assess the impact of iPad use on motivation, quality of work, achievement, collaboration, and other factors. Teachers reported the quality and standard of quality of pupil work and progress began rising. Findings of the study included the following: 77% of faculty respondents felt that student achievement appeared to have risen since the introduction of the iPad, 73% of students and 67% of staff felt that the iPad helped students improve the quality of their work, 69% of students that completed the survey felt that using the iPad was motivating and that they worked better with it than without it, and 60% of faculty thought that students were more motivated by lessons that incorporate the iPad than those that did not (Walsh, 2012).

Assessment and Learning in Knowledge Spaces (ALEKS) is a web-based, artificially intelligent assessment and learning system, which uses adaptive questioning to quickly and accurately determine exactly what a student knows and doesn't know in a course (ALEKS, 2010). ALEKS then instructs the student on the topics she is most ready to learn. As a student works through a course, ALEKS periodically reassesses the student to ensure that topics learned are also retained. ALEKS courses are very complete in their topic coverage and have a reliability of .984. Because of the artificial intelligence in ALEKS, students are almost always successful at learning the material ALEKS offers them. The level of instructor involvement doesn't affect this. The program gained notoriety in 1994 after numerous studies were reviewed, and it was determined that mathematics test scores increased significantly when students used an integrated learning system such as ALEKS.

The learning system is easy to use. Students begin with a tutorial, which shows them how to use the program’s tools. Then, an initial assessment is done to determine the students’ strengths and weakness. ALEKS will then create an individualized pie chart representing the student’s knowledge and skills. For middle school mathematics, the concepts covered are aligned with the Common Core Standards. Beginning in May 2012, ALEKS added a new component that reports detailed student performance data to support the creation of Individualized Education Plans. (ALEKS, 2012) This report may be beneficial in lesson planning, differentiation of instruction, and saving time by quickly identifying present levels of performance. In 2010, an RtI component was introduced to detect, prevent, and support schools in assisting struggling math students. This RtI component addresses all three tiers of the RtI process. ALEKS provides progress monitoring, individualized instruction, and detailed reporting of student mastery.

In 2013, Utah’s STEM Action Center was launched to help ensure middle school and high school students are properly equipped in the areas of science, technology, engineering, and mathematics. ALEKS was chosen as the math curriculum for this initiative. All middle and high school students had access to ALEKS to engage in individualized student instruction.

In order to improve students' initial math course placement, the University of Wisconsin-Milwaukee created a bridge program, which focused on increasing math performance with the use of the ALEKS program (Reisel, Jablonski, & Munson, 2012). Participants in the study were incoming students who failed to place into Calculus 1 on the university's placement exam. For four weeks, these students used the individualized instruction of the ALEKS program to improve their mastery of material required for them to be successful in college-level math courses. It was determined that the ALEKS program was an effective tool for quickly advancing mathematical skills. Although the participants in this study may have been motivated to place into Calculus 1, middle school students may be as motivated to do well due to Georgia's high-stakes testing in middle school mathematics.

Equipped with the research and knowledge of how computer-based instruction has impacted multiple schools, middles schools associated with this research study researched, and adopted the ALEKS program as its math intervention in 2011. Although the ALEKS program seemed to help some students, because of funding and inconsistency in teacher implementation, the school district opted to not renew the ALEKS contract. This left the district still in need of a research-based math intervention that was more cost-effective and was able to make an immediate impact with struggling middle school math students.

STAR Math

STAR Math is a computer-adaptive assessment designed to give accurate, reliable, and valid data about students' math abilities (Renaissance Learning, 2010). It is designed for students in grades 1-12. STAR Math is the most widely used math assessment in K12 schools. The test consists of 24 questions. The software uses student responses to adjust the levels of difficulty. After calculating a score for each student, a grade equivalency is determined. Schools tend to issue the STAR Math test several times a year to determine the trend in academic achievement for individual students.

Teachers may use results from the STAR Math assessment to individual instruction and identify students in need of remediation and enrichment. Measuring student growth is essential to understanding the effects of instruction.

Math 180

Math 180 is a math intervention program specifically designed for middle school students who struggle with math concepts and skills. Math 180 was developed by a team of expert mathematicians with input from key advisors. This team consisted of top university professors: Dr. Deborah Ball (University of Michigan), Dr. Ted Hasselbring (Vanderbilt University), Dr. Sybilla Beckmann (University of Georgia), and Dr. David Dockterman (Harvard University). Math 180 is structured to produce confidence in mathematics by allowing students to master content at their individualized paces. These math skills are necessary in order to meet the demands of rigorous standardized assessments. Middle school students are expected to be proficient in algebra readiness and problem-solving skills. Math 180 targets the development of strong mathematical skills and practices. It uses real-world situations to learn key concepts needed to be prepared for life after secondary school.

The goal of the founders of Math 180 was to develop a math intervention that equipped struggling middle school math students with knowledge, confidence, and motivation to excel in high school mathematics and become college and career ready. This math program is based on three research-based principles: focus on what matter most, force multiplier for teaching, and have a growth mindset.

Math 180 focuses on specific sets of concepts and mathematical practices. It uses the eight standards for mathematical practice to accelerate learning and develop deep conceptual understanding. The concentration is on concepts along the progression to algebra. Students begin to understand how math is interdependent and cumulative in nature. The rigor is increased with opportunities for mathematical reasoning and higher-order thinking. Students learn to communicate mathematically with a richer math vocabulary. Older students who have not been successful in mathematics are able to focus on what matters most and build foundations in order to improve math competency. They learn to make connections and apply their understanding into new contexts.

Math 180 uses technology to provide data-powered differentiation. This enables the accommodation of students with a variety of abilities, interests, and learning needs. Students with special needs may receive supports in Math 180 that they may be unable to receive in a traditional classroom setting. Students are provided ongoing formative assessments and progress monitoring. Teachers receive interactive reports with recommendations, resources, and lesson plans to enhance student learning. These reports allow teachers to see growth and progress towards mastery.

Math 180 encourages a growth mindset by improving student attitudes towards mathematics. Students receive positive praise for working hard and persevering through the program. They learn that making a mistake is a natural part of learning. Through Math 180, students develop a mindset that over time their math abilities will improve through effort and dedication. Math 180 presents concepts in ways that give purpose and value to mathematics. Students experience success by mastering concepts through practice.

Math 180 is a comprehensive personalized learning system of curriculum, instruction, and assessment tailored to engage and motivate middle school students through the use of technology. Students are not only motivated, but they play an integral part by taking ownership of their own learning. Prior research suggests that Math 180 may increase student achievement in mathematics.

A two-year study was conducted in a large California school district was completed to determine the impact of the Math 180 program on student math achievement. Math 180 was used as the principal math intervention for the district's middle schools. The Modesto City School District, a Title 1 district, has approximately 82% of its students eligible for free or reduced-priced lunches. Math 180 was used for 55 minutes each day as an intervention tool for students who consistently performed poorly in their math classes, as well as state assessments. Results from the first year of Math 180 implementation revealed that students' math achievement increased by an average of 137 points. In the second year of the study, participants' achievement scored increased an average of 144 points. Modesto City Schools experienced significant gains in math achievement. Data from participant use revealed a positive correlation between the amount of time students used Math 180 and higher academic gains.

Six middle schools in Hillsborough County Public Schools (Florida) participated in a study to compare math intervention methods. Three of the schools used traditional teaching, and the other three used Math 180 as their remediation tool. Students were assigned to a control group or a treatment group. Math 180 served as the math intervention program for the treatment group. All participants in the study continued in their regular sixth grade math course during the study. Results of the study indicated that students who used Math 180 as an intervention showed greater gains on the post assessments. Through student interviews, students who used Math 180 reported they were more confident with mathematics after the intervention.

Clark County School District in Las Vegas, Nevada examined the effectiveness of the first of two courses in Math 180. This course focuses on the foundational skills of mathematics. Ninety-seven middle school students used Math 180 as their math intervention for approximately one school year. These students completed a pretest and posttest to determine the impact of Math 180. Students in the control and treatment group had similar pretest scores. The posttest scores revealed that students in the treatment group experience greater growth results on the posttest.

Math Achievement Issues

Technology has continuously become incorporated into U.S. school systems. Computers have become a pervasive tool toward optimizing student learning. Traynor (2003) identified five mechanisms by which computer programs facilitate learning: (a) personalizing information, (b) animating objects on the screen, (c) providing practice activities that incorporate challenges and curiosity, (d) providing a fantasy context, and (e) providing a learner with choice over his or her own learning. When students receive appropriate instruction and technology instruction as support, the end result should be significant gains in academic achievement.

Math fact fluency continues to be an important prerequisite for math achievement. A study was conducted to examine how technology-enhanced fluency assessments affect achievement patterns of low and typically achieving students (Stickney, Sharp, and Kenyon, 2012). It was found that although most students in the study did not meet grade level expectations for fact mastery, the higher the fluency level, the more likely students were to achieve mathematically. Students in early elementary grades used the STAR math test as a pretest. Students were then placed in groups according to their performances. After computerized practice, low-achieving students showed significant gains in math achievement. These results indicated that extra practice time with math fluency should be built into the math curriculum. This is not always done in middle grades where more emphasis is place on grade-level content mastery. The use of technology was advantageous, as students preferred to study math facts in this manner rather than flash cards.

According to Lee and Smith (2006), one of the first studies concerning the implementation of middle school components and student achievement defined academic achievement as a composite score combining reading and mathematics. In order for at-risk students to be successful in school, they should be encouraged to stay in school and strive for success by achieving in these areas. Educators must seek means of addressing the needs of at-risk students and implement programs and strategies that will assist them.

National and international comparisons have found that the mathematics achievement levels of students in the United States fall far behind those of other developed nations, and within the US itself, the students who are falling behind come predominantly from high poverty and high minority areas (Balfanz & Byrnes, 2005). Now, several years later, while U.S. students are scoring higher on national math assessments than they did twenty years ago, they still rank around the middle of the pack in international comparisons, and behind many other advanced industrial nations (Desilver, 2015). There are several factors that help contribute to the middle school math achievement gap. Achievement tests have been used to determine the capabilities of what students learn, know, or can do in various core content areas. The information gathered from such tests provides information for stakeholders to view concerning the outcomes of student learning. The NCLB Act of 2001 caused the use of testing to expand in more ways than one while focusing on student achievement. As a result, the NCLB Act of 2001 required all states to develop standards for their curriculum and state assessments for Grades 3-8. In order for students to achieve, an accountability system was put in place that would affect the lives of many in the arena. From that, evaluations would be done as a means of measuring student achievement by holding teachers, schools, and school districts accountable for achievement gains or losses. This requirement stretched out to include the achievement of different subgroups of students.

According to Desilver (2015), an overwhelming number of middle school students are not proficient in mathematics. In 2013, only 34% of eighth graders scored at or above the proficient level in mathematics, which was an improvement over previous years (National Center for Education Statistics, 2014). Students are still not achieving the most basic level of mathematics skills, and the gap between low and higher performers has persisted (National Center for Education Statistics, 2014). As long as the at-risk students are not meeting the proficient level, this gap will continue to increase because that group of students will fall further behind each year. School improvement plans set goals and guidelines to improve academic achievement. If schools are to meet these guidelines, they must strive to close the achievement gap to assure that all students achieve academic proficiency.

Smith and Geller (2004) reported the need for every student to master challenging mathematics, including the foundations of algebra and geometry. This basic goal for mathematics by the end of eighth grade is essential and is also reflected in the objectives and academic standards being set throughout the U. S. at state and local levels. Unfortunately, many students, particularly those with learning disabilities, and other processing problems such as being at risk, may not be able to meet the standards necessary because teachers lack or do not implement effective strategies to foster understanding of basic concepts of algebra (Smith & Geller, 2004). This need is evidenced by the poor performance of students on standardized mathematics tests that, eventually, may prevent these students from receiving a regular diploma.

According to the U.S. Department of Education (2013), U.S. schools are not producing the mathematics excellence required for global economic leadership and homeland security in the 21st century, and, as a result, educators must ensure that schools use scientifically based methods with long-term records of success to teach mathematics and measure student progress. Mathematics is a critical subject, and educators must improve achievement to maintain U.S. economic leadership. Stagnant mathematics performance in schools diminishes students' abilities to compete globally and endangers U.S. prosperity and security.

The National Council of Teachers of Mathematics (1989) produced standards for school mathematics and developed five goals for students that reflect the importance of mathematical literacy. These goals would enable students to learn to value mathematics, become confident in their own ability, become mathematical problem solvers, learn to communicate mathematically, and learn to reason mathematically.

In order for mathematics assessment to be effective, educators must make sure that the assessments are aligned with the goals of the curriculum. The guidelines that have been set by the NCLB Act of 2001 require states to set standards, and these standards should be aligned with the curriculum and related to high-stakes testing and assessment. The results of the test will be used to measure student achievement progress and how they compare to state standards. Mathematics achievement is improving slightly, but more work must be done to ensure that U.S. students receive a sound background in mathematics.

The United States must research the best way to teach mathematics and measure students' progress in mathematics. Researchers must scientifically prove the best ways to teach mathematics by using research-based teaching methods and rejecting unproven fads. Mathematics achievement scores in southern states showed that 37% of eighth graders did not possess mathematics skills at a basic level; more students failed to learn mathematics in these states than nationally (US Department of Education, 2013). Poverty has been identified as an indicator of students being at risk.

Houghton Mifflin Harcourt conducted a study that revealed that an algebra iPad app dramatically improved student math achievement (Houghton Mifflin, 2012). A school district in Riverside, California piloted the use of HMH Fuse, a Houghton Mifflin math application. Students participated in a one-year study where they were randomly assigned to use the app in comparison with those using only a textbook. An increase was found in test scores among students taught with the Houghton Mifflin algebra app compared to their peers. Results revealed that students who used HMH Fuse were more motivated, more attentive in class, and more engaged with Algebra content (Houghton Mifflin, 2012). Findings from the study indicated that students who used the application had more positive attitudes toward math, and those students achieved higher scores on the California Standards Test.

When examining the influence of iPads on math achievement (Kiger, Herro, & Prunty, 2012), third grade students at a Park Elementary School participated in a nine-week mobile learning intervention. Two classrooms used Everyday Math and daily practice using flashcards, math games, and number sequences to learn multiplication. Two other classrooms used Everyday Math and web applications for the iPad for daily practice. Students using the iPads outperformed the other group. On average students using iPads answered more items correctly on the post-intervention multiplication test.

A study was conducted on the comparison of the effects of a worksheet versus an iPad on math fluency and active academic engagement during a high school math class in an alternative school setting (Haydon, Hawkins, Denune, Kimener, & McCoy, 2012). Participants engaged in independent seatwork by either completing problems on a worksheet or completing problems presented on an iPad. Based on visual analyses, students solved more math problems correctly in less time and demonstrated higher levels of active engagement on the iPad as compared to the worksheet. This study implies that the use of iPad technology over a period of time will prove effective in increasing math skills for students with emotional disturbance (ED). The research revealed that students with ED make limited progress in mathematics. Academic instruction can be supplemented by the use of iPads to increase the use of effective independent seatwork time by promoting extended practice opportunities.

“Less than a class set,” (Bennett, 2011) involves utilizing iPads in a second grade math class. The teacher used the iPad to support her teaching of money. The teacher used the iPads in several ways. Learning centers were set up with different tasks for students to complete. Students were able to complete math related scavenger hunts. Partners or trios were given a math task to answer specific questions with visual representations.

After using computer-based instruction for a semester, the teacher found that by designing lesson plans around a hand-held tool, she could solve the toughest of student problems with one device. When students' interest and engagement increased, the overall math grades increased.

The addition of iPads to the special education toolbox raised the bar for achievement at Northdale Middle School (Baca, 2012). In the third year of use there, iPads have led to increased engagement among some of the most severely disabled students and have accelerated their learning. Students use the devices as both learning tools and as motivators for students to complete other assignments. Teachers conducted a study of their students with and without the iPads and found the devices generally increased engagement and learning, but decreased negative behaviors. They also noticed that students were able to work independently without constant prompting.

Data from the one to one use of mobile devices clearly demonstrates that when students use their devices as essential tools for learning and use a broad range of apps for fifty to seventy-five percent of the day, then student achievement increases (Norris & Soloway, 2012). This increase is not as significant when the iPads were used only as supplemental devices.

The use of hand-held devices has been examined during instruction (Nordness, Haverkost, & Volberding, 2011) with second grade students (two boys and one girl) with learning and behavioral disabilities. The girl and one of the boys received special education services for learning disabilities, while the second boy received services due to attention deficit hyperactivity disorder. All three students were performing significantly below school criteria for subtraction mastery on the Nebraska Abilities Math Test. Users were able to customize the difficulty level and set the maximum number of problems the students needed to complete within a specific time frame. A multiple baseline across students' research design was implemented to determine the effect of 10 minutes of practice, three times a week, on zero to 20 two-digit subtraction problems on the software application. All participants improved their subtraction scores by an average of 17 percent. The results of this study suggest that practice on a mobile computing device with a mathematic flashcard application can improve subtraction skills in second grade students with disabilities.

Summary

In closing, this review of literature discussed the theoretical framework and literature related to computer-based instruction and Math 180. It is already known that the web offers countless opportunities to connect with those outside our homes, towns, and nations. With computer-based learning in classrooms, these connections could literally be at students' fingertips. In the classroom, teachers could replace visual aids or presentation handouts with documents accessible on each student's computer or mobile device. Because an iPad or iPod can be used anywhere, students are likely to engage more often with their academics. Students can study and work together just about anywhere. The more time students spend focused on hand held devices, the more they are capable of learning. Student achievement is measured by what students can do independently. What better way to prepare students with knowledge and self-assurance than to guide them in the direction of a student-centered curriculum? Increased academic achievement is the overall result teachers, parents, and administrators are looking for. Since research shows that computer-based learning is effective in increasing academic achievement, schools should focus on securing funding to put more of them into classrooms. Math achievement should be top priority in working with these devices.

Students play video games and access social media on a daily basis. Most middle school students have cellular phones or some sort of gaming device. These students use these devices daily for entertainment purposes. Use of these devices in school could be the breakthrough that low-performing students need to increase math ability. They are comfortable using them and they can learn at their own paces.

An impressive number of studies on this subject have returned a wealth of information on the positive effects of technology-based environment. However, the research literature on the subject leaves an entire sub-group of the population unaccounted for. Based on that conclusion, further research should focus on how the proven benefits of computer-based learning relates to or may benefit middle school math achievement.

CHAPTER THREE: METHODS

Overview

Computer-based instruction produces positive changes in student attitudes (Gilbert, Hawthorne, & Henley, 2014) toward learning, and it reduces the amount of time needed for instruction (Kulik, 1991). Computer-based instruction is used to teach a variety of skills and subjects within the school setting. Although students are using devices, a gap still exists to determine how computer-based learning impacts student engagement and math achievement. The purpose of this research study is to investigate the impact of computer-based instruction on middle school math achievement. This chapter presents the methodology of this study: research design, research questions and hypotheses, participants and setting, instrumentation, procedures, and data analysis.

Design

This correlation research study used a pretest-posttest control group design. This study also used ex-post facto information to determine the impact of computer-based instruction, as measured by the STAR assessment, on middle school math achievement. Correlation research designs are used to discover relationships between variables through the use of correlational statistics (Gall, Gall, & Borg, 2007). This method of design involves collecting data on two or more variables for each individual in a sample and then computing a correlation coefficient. This is the best research design for this study because the goal of a control-group design is to keep the experiences of the experimental and control groups as identical as possible, except when the experimental group is exposed to the treatment (Gall, Gall, & Borg, 2007).

Research Questions

RQ1: : Does computer-based instruction (Math 180) increase math achievement on the STAR Math assessment of middle school students while controlling for the math pretest?

RQ2: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by gender, while controlling for the previous math achievement?

RQ3: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by race/ethnicity?

Null Hypotheses

$H_0$1: While controlling for the math pretest, there will be no statistically significant difference in middle school students' STAR Math assessment when participating in computer-based instruction (Math 180) compared to traditional math instruction.

$H_0$2: There will be no statistically significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not, while controlling for the previous math achievement.

$H_0$3: There will be no statistically significant difference in STAR math achievement by race of students receiving computer-based instruction (Math 180) and students who do not.

Participants and Setting

The participants for this study were drawn from a convenience sample of middle school students located in southeastern Georgia during the 2015-2016 school year. The school district has fourteen school sites and serves nearly 10,000 students. The school system has a 1:1 iPad initiative, and technology is plentiful throughout the district. Physical textbooks are few as most texts are downloaded onto student iPads. All students are accustomed to testing and completing assignments via an iPad or computer as students are assigned an individual device in early elementary school. Two of the district's three middle schools will be chosen as the sites for this research. These schools will be chosen based on their differences in remediation methods. School A will use the Math 180 program for math remediation, and School B will use a traditional teacher for math remediation. Each school has a student population of approximately 700 students.

School A has 705 students and approximately 50 teachers. The teacher-student ratio is 14:1. School A is a Title 1 school with 66% of its students receiving free or reduced lunch.

School B has 725 students and approximately 48 teachers. The teacher student ratio is 15:1. School B is a Title 1 school with 70% of its students receiving free or reduced lunch.

For this study, the number of middle school students sampled was 83. This sample size was used for a medium effect size with a statistical power of .8 at the .05 alpha level. This sample size exceeds 30 participants, which is the minimum number of participants desired for correlational research. Participants were selected by convenience sampling. The students were performing at least two grade levels behind in mathematics achievement as measured by the STAR Math pre-assessment. Participants ranged from 11 to 14 years old. There were approximately 46 male students and 37 female students included in the study in both the treatment and control groups combined.

The control group consisted of three class sections that received traditional math instruction. Students worked independently and through collaborative efforts for approximately

50 minutes each school day. The treatment group consisted of three sections of students who received Math 180 math instruction for approximately 50 minutes a day. Both school sites employed certified math teachers in the remedial classes. All participants in this study received daily math instruction taught by certified math teachers with several years of teaching experience.

Instrumentation

STAR Math was used as a pre and post assessment for all students involved in this study. STAR Math is a computer-adaptive assessment designed to give accurate, reliable, and valid data quickly so that informed decisions can be made about instruction and intervention. STAR math is the most widely used math assessment in K12 schools (Renaissance Learning, 2011). STAR has a pretest and posttest, which will consist of 24 questions across eight mathematical strands. This test was given to each participant to determine performance levels. It was able to measure each student's math skills in about 20 minutes and provide complete, valid, and reliable results. The STAR Math report generates scaled scores, percentile rankings, and grade level equivalents. Cronbach's alpha for this instrument, determined in 2013, is .90 (renlearn.com, 2013).

Assessment and Learning in Knowledge Spaces (ALEKS) is an artificially intelligent learning system, which uses adaptive questioning to quickly and accurately determine what a student knows (ALEKS, 2013). This intelligence system develops an individualized plan for each student. The plan is represented by a colorful pie chart that is easily readable and understood by students, parents, and teachers. The program then instructs the students in areas where deficits are found until mastery of skills is obtained. ALEKS provides one-on-one math instruction. Students work at their own paces to acquire math skills and are provided with continuous positive feedback. ALEKS monitors students' usage and progress and produces individual reports of student progress. ALEKS is highly reliable with a Cronbach alpha of .984. This instrument has been used in numerous studies (ALEKS, 2013).

Procedures

Prior to conducting this research, approval was granted from Liberty University's Institutional Review Board. Next, approval was gained from the local school district. Consent forms did not need to be sent home with students to obtain parental consent due to anonymous ex post facto information being used. Middle school students were given the STAR Math assessment during their traditional math classes. The assessment took approximately 20 minutes for each student to complete, and results from this pre-assessment were instantly available. The researcher selected 83 students who, according to the pretest, were performing at least two grade levels behind. Half of these students were assigned to the control group and the other half of these students were placed in the treatment group.

The independent variables in this study are participation in Math 180, gender, and race. The dependent variable will be student achievement as measured by the STAR Math posttest.

The remedial math teacher was responsible for enrolling participants in the treatment group in the Math 180 computer program. Students used their school-issued iPads to access the Math 180 curriculum. Students were asked to be actively engaged in this program for a minimum of 30 minutes per school day for approximately 18 weeks. Students completed the treatment with supervision of a remedial math teacher. Her role was to primarily facilitate learning and ensure students are on task in an organized learning environment.

At the end of the treatment, students in the control and treatment groups were administered the STAR Math posttest during their traditional math classes. All participants used their iPads to take the posttest. The researcher used Math 180's internal monitoring software to access data about the amount of time each student in the treatment group was actively engaged in the treatment during remedial math. All data was compiled in a spreadsheet in order to analyze. Scatterplots and tables were used to determine relationships.

Data Analysis

STAR Math pretest and posttest data was reviewed. An analysis of covariance (ANCOVA) was used be used to answer research questions one and two. Research question one asked if the computer-based program (Math 180) increased math achievement of middle school students performing at least two years below grade level. Research question two asked if the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by gender, while controlling for the previous math achievement. An ANCOVA was the most appropriate statistical test to use in answering these research questions because the researcher wanted to statistically control for the possible effects of a confounding variable. In this case, the researcher wanted to control for the STAR Math pretest scores; therefore, an ANCOVA was used in lieu of an ANOVA or *t*-test. There was a need to control for the pretest scores since the effect of previous achievement could influence an exam or test performance to some degree.

An independent *t*-test was conducted to evaluate whether middle school students participating in computer-based instruction significantly differed in their math achievement based on their race. While an ANCOVA would have been the preferred analysis choice, it was not possible to conduct an ANCOVA given the small number of White students (n = 7) in the treatment group. The majority of the students in the treatment group classified themselves as Black (n = 37). Thus, an independent *t*-test was conducted. An independent *t*-test (also known as independent sample *t*-tests) is the most appropriate analysis procedure as it is used when a researcher wants to compare the mean scores of two different groups (Warner, 2013). This analysis was used because it "involves comparison of mean scores on a quantitative Y outcome between two groups" (Warner, 2013, p. 185). A *t*-test is used when the goal is to compare the means of a normally, distributed, interval-dependent variable for two independent groups. A *t*-test is used to determine whether there are any significant differences between the means of two or more groups (Green & Salkind, 2011). The pretest served as the covariate, with the participation in Math 180 being the independent variable, and student achievement/growth on the posttest being the dependent variable. A *t*-test will be used to determine if there was a significant difference in math achievement by race of students receiving computer-based instruction. The *t*-test is the best statistical test for research question three because only two groups are being compared, and this test simply looks at differences between two groups on a variable of interest.

SPSS was used to run the following assumption tests: Levene's test for homogeneity of variances, homoscedasticity by plotting a scatterplot of scores against predicted values, homogeneity of regression slopes, and assumption of independence of the covariate and treatment. The effect size was calculated using Cohen's *d*. This method estimates the average variability by taking the square root of MS' error from the analysis of covariance, which would standardize the mean difference in the metric of the adjusted scores (Green & Salkind, 2011).

CHAPTER FOUR: FINDINGS

Overview

Chapter Four contains a detailed data analysis for this study, as well as a restatement of the purpose, research questions, and hypotheses. The purpose of this study was to investigate the impact of computer-based learning on middle school math achievement of at-risk students. This correlation research study used a pretest-posttest control group design. This study used ex-post facto information to determine the impact of computer-based instruction, as measured by the STAR Math assessment, on middle school math achievement. The independent variables in this study were participation in a remedial math course (Math 180), gender, and race/ethnicity. The dependent variable was student achievement as measured by the STAR Math posttest. The research questions and hypotheses for this study are identified below:

Research Questions

RQ1: Does computer-based instruction (Math 180) increase math achievement on the STAR Math assessment of middle school students while controlling for the math pretest?

RQ2: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by gender, while controlling for the previous math achievement?

RQ3: Do the STAR math achievement scores of students using computer-based instruction (Math 180) differ significantly by race?

Null Hypotheses

$H_0$1: While controlling for the math pretest, there will be no statistically significant difference in middle school students' STAR Math assessment when participating in computer-based instruction (Math 180) compared to traditional math instruction.

$H_0$2: There will be no statistically significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not, while controlling for the previous math achievement.

$H_0$3: There will be no statistically significant difference in STAR math achievement by race of students receiving computer-based instruction (Math 180) and students who do not.

Descriptive Statistics

There were 83 participants in this study. The sample consisted of 45% female and 55% male participants. Of this sample, 25% of the participants were reported as being white, and 75% of the participants were reported as black. For hypothesis one, 44 students were in the treatment group, and 39 students were in the control group. For hypothesis two, there were 29 male participants and 15 female participants in the treatment group. Hypothesis three included 37 participants who identified as being black and seven participants who identified as being white in the treatment group.

In August 2016, all participants in this study were administered the initial STAR Math assessment. All of the students in both the treatment group and the control group scored Below Basic and were identified as needing math remediation at two grade levels below where they should have been. Participants were administered the STAR Math posttest in May 2017. In School A, students received remediation using Math 180, a computer-based math program. Students in School B received traditional math remediation with only teacher-directed instruction.

Results

Null Hypothesis One. The null hypothesis states that there will be no statistically significant difference in math achievement on the Star Math assessment between students receiving computer-based instruction (Math 180) and students who do not. An analysis of covariance (ANCOVA) was conducted to determine if there was a statistically significant difference in the math achievement of middle school students based on the type of instruction in which they participated (computer-based instruction (Math 180) vs. traditional), while controlling for previous math achievement test scores. The descriptive statistics disaggregated the computer-based classroom and traditional instruction groups are outlined in Table 1, including the mean, standard deviation, adjusted mean score, and standard error of the mean for each variable.

Table 1 Descriptive Statistics

Dependent Variable: Posttest

Group	Mean	Std. Deviation	N
A	685.45	89.617	44
B	670.74	102.025	39
Total	678.54	95.341	83

Table 2 Estimates of Descriptive Statistics

Dependent Variable: Posttest

			95% Confidence Interval	
Group	Mean	Std. Error	Lower Bound	Upper Bound
A	682.527[a]	9.323	663.972	701.081
B	674.047[a]	9.904	654.338	693.756

a. Covariates appearing in the model are evaluated at the following values: Pretest = 628.53.

Assumption Testing

Prior to conducting the ANCOVA, assumption testing was completed. Via visual inspection of scatterplots (See Figure A), it was determined that there was a linear relationship between the math achievement before (pretest) and after (posttest) the instruction was employed.

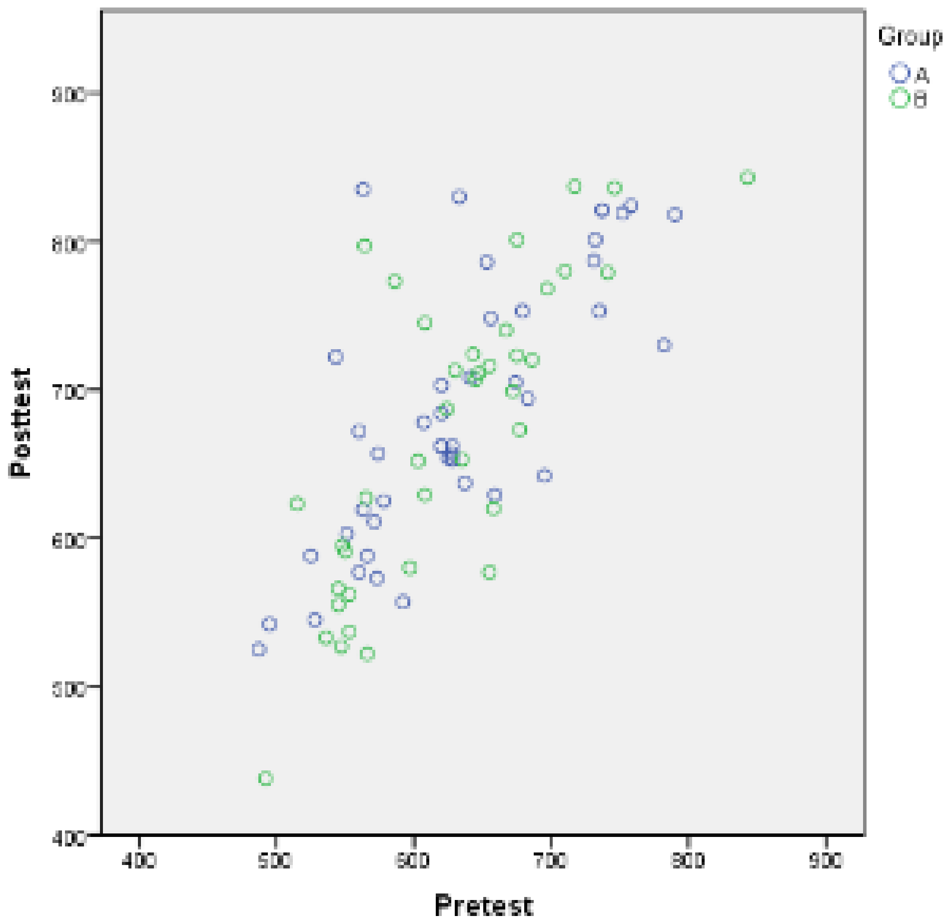

Figure A Pretest/Posttest Scatterplot

The assumption of the homogeneity of regression slopes was not violated as the interaction term was not statistically significant, $F(1, 79) = 1.43$, $p = .24$. The dependent variable was normally distributed for across both the traditional and intervention groups, as assessed by Shapiro-Wilks test ($p > .05$). Via inspection of the boxplots (see Figure B), there were no outliers in the data.

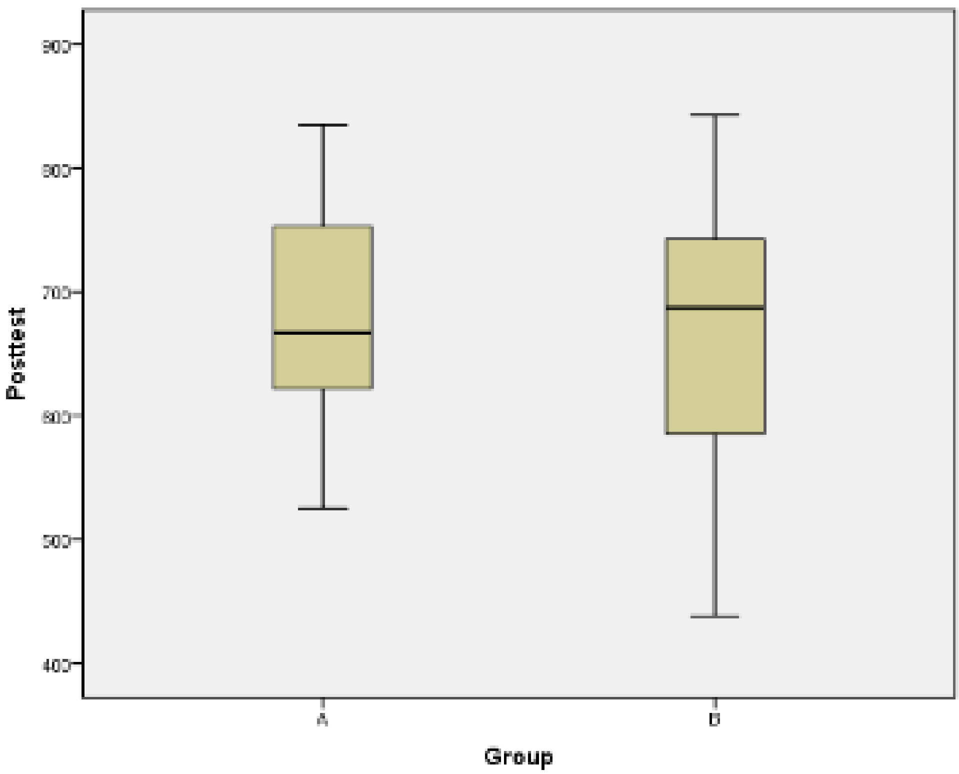

Figure B Posttest Boxplot

Examining Levene's test for equality of variances ($p = .46$), the assumption of homogeneity of variances was not violated. Visual inspection of the scatterplots of the standardized residuals plotted against the predicted values (see Figure C) indicated that the assumption of homoscedasticity could be assumed.

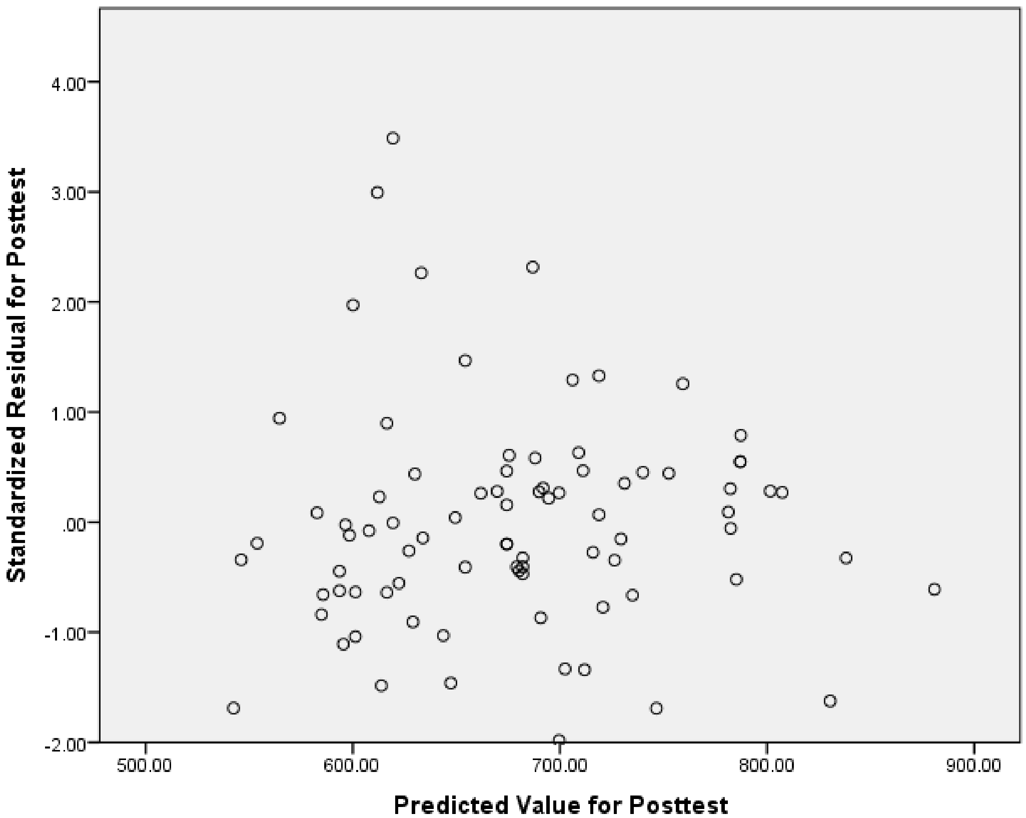

Figure C Predicted Values Scatterplot

While middle school students participating in the computer-based instruction (Math 180) scored higher on average on the STAR Math assessment than students participating in traditional math instruction (see Table 2), the difference was not statically significant. After adjusting for pretest math achievement scores, there was no statistically significant difference in posttest scores between the two types of instruction, $F(1, 80) = .39$, $p < .54$, partial η2 = .005. Effect size, based on Cohen (1988), was small, $\eta^2 = .005$. The strength of relationship between type of instruction and the exam scores was very small, accounting for .5% of the variance of the dependent variable. Therefore, there is significant evidence to fail to reject the null hypothesis and conclude that there is not a significant difference in math achievement on the Star Math assessment between students receiving computer-based instruction (Math 180) and students who do not. The observed power was .28; therefore, the results should be interpreted with caution.

Null Hypothesis Two. The null hypothesis states that there will be no statistically significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not.   An analysis of covariance (ANCOVA) was conducted to determine if there was a statistically significant difference in the math achievement of middle school students based on their sex (i.e., male and female), while controlling for previous math achievement test scores. The descriptive statistics disaggregated sex are outlined in Table 3, including the mean, standard deviation, adjusted mean score, and standard error of the mean for each variable.

Table 3 Disaggregated Descriptive Statistics

Dependent Variable: Posttest

Gender	Mean	Std. Deviation	N
F	662.87	101.513	15
M	697.14	82.259	29
Total	685.45	89.617	44

Table 4 Gender Group Statistics

Dependent Variable: Posttest

			95% Confidence Interval	
Gender	Mean	Std. Error	Lower Bound	Upper Bound
F	671.784[a]	15.449	640.585	702.983
M	692.526[a]	11.094	670.122	714.930

a. Covariates appearing in the model are evaluated at the following values: Pretest = 631.57.

Prior to conducting the ANCOVA assumption testing was completed. Via visual inspection of scatterplot (See Figures D), it was determined that there was a linear relationship between the math achievement before (pretest) and after (posttest) the computer based instruction was employed.

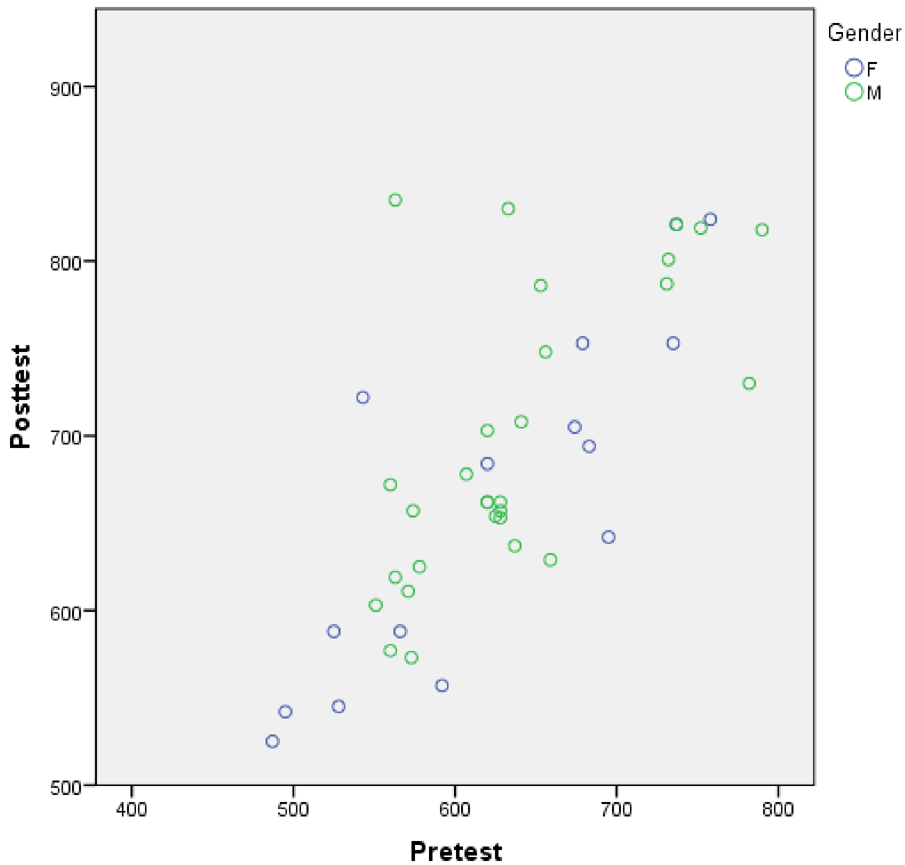

Figure D Gender Scatterplot

The assumption of the homogeneity of regression slopes was not violated as the interaction term was not statistically significant, $F(1,40) = .30$, $p = .59$. The dependent variable was normally distributed in the female group, as assessed by Shapiro-Wilks test (p = .24). However, the independent variable was not normally distributed for males, as assessed by Shapiro-Wilks test (p = .16). Via inspection of the boxplots (see Figure E, boxplots), there were no outliers in the data. As Warner (2013) suggested the ANCOVA is robust against minor violations in normality, the decision was made to continue with the ANCOVA.

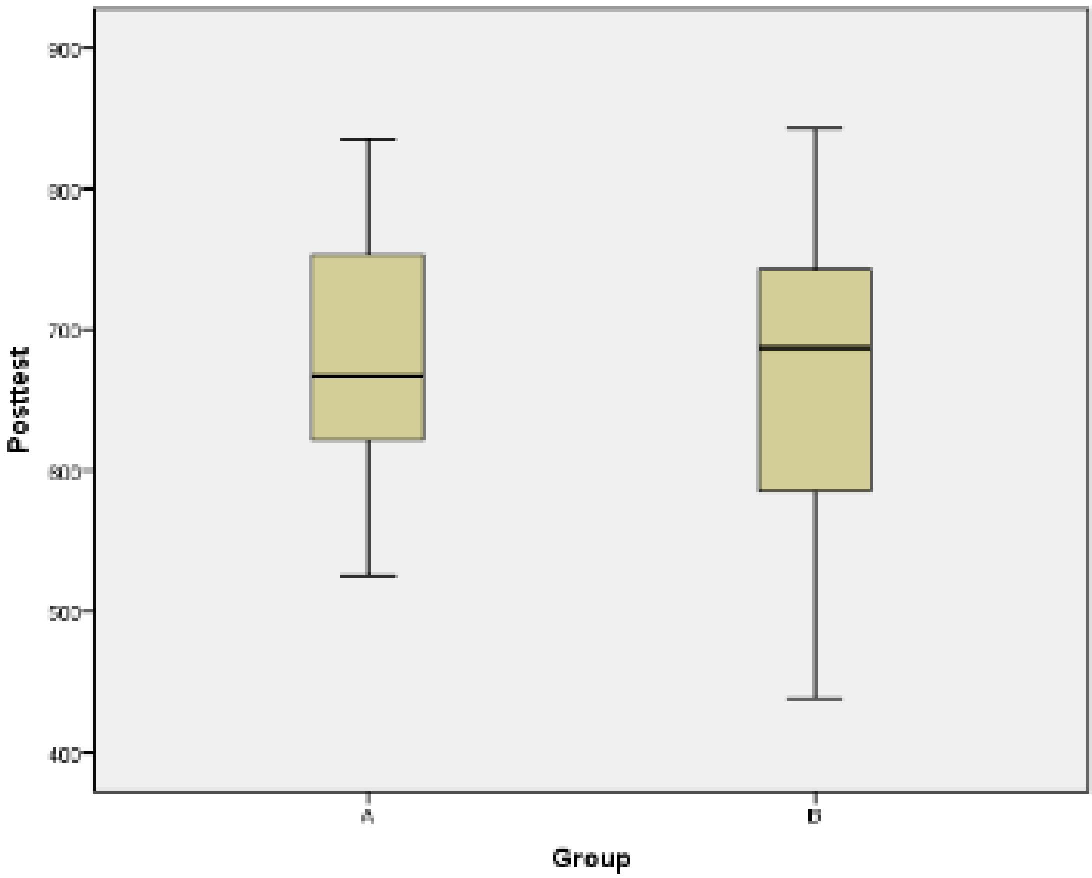

Figure E Gender Boxplot

Examining Levene's test for equality of variances (p = .78), the assumption of homogeneity of variances was not violated. Visual inspection of the scatterplots of the standardized residuals plotted against the predicted values (see Figure E) indicated that the assumption of homoscedasticity could be assumed.

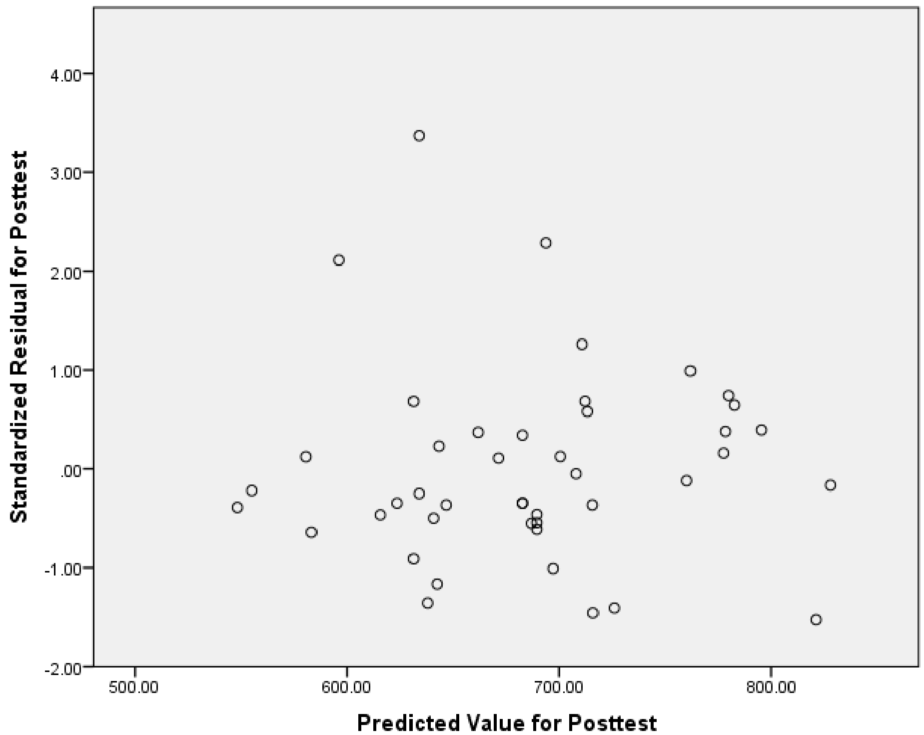

Figure F Posttest Scatterplot

The male middle school students participating in the computer-based instruction (Math 180) scored higher on average on the STAR Math assessment than females (see Table 3); however, the difference was not statically significant. After adjusting for pretest math achievement scores, there was no statistically significant difference in posttest scores between males and females, $F(1, 41) = 1.18$, $p < .28$, partial η2 = .028. Effect size, based on Cohen (1988), was small, $\eta^2 = .028$. The strength of relationship between gender/sex and the exam scores was very small, accounting for 2.8 % of the variance of the dependent variable.

Therefore, there is significant evidence to fail to reject the null hypothesis and conclude that there is not a significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not. The observed power was .18; therefore, the results should be interpreted with extreme caution.

Null Hypothesis Three. The null hypothesis states that there will be no statistically significant difference in STAR math achievement by race/ethnicity of students receiving computer-based instruction (Math 180) and students who do not. An independent *t*-test was conducted to evaluate whether middle school students participating in computer-based instruction significantly different in their math achievement based on their race. Prior to conducting the analysis, assumption testing was completed. The assumption of normality was evaluated using Shapiro-Wilks tests. The assumption of normality for both groups was not found tenable at the .05 alpha level. Visual inspection of boxplots demonstrated that the data set had no extreme outliers (see Figure F).

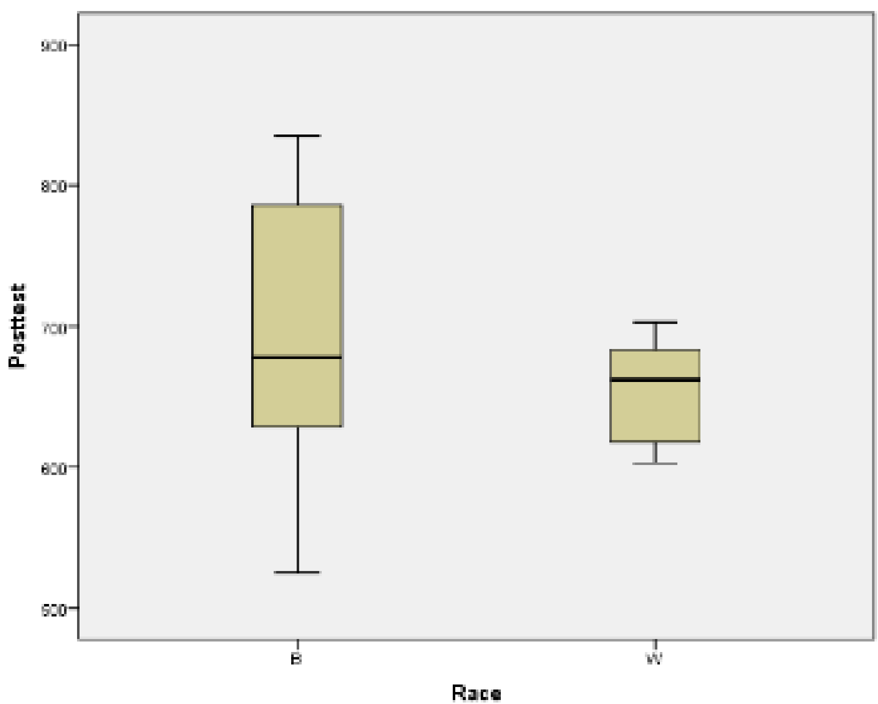

Figure G Race Boxplot

The Levene's test was used to evaluate the assumption of homogeneity of variance. The results of Levene's test, $F = 6.53$, $p = .01$, indicated that the variances of the two groups could not be assumed to be equal. Thus, *t*-test results in which equal equivalence is not assumed were used.

The high *F* score and significant *p* value (below .05) requires an “equal variances not assumed” *t*-test, utilizing a more conservative approach with smaller degrees of freedom (Warner, 2013). The results of the independent *t*-test that does not assume equal variance were not significant. The result of the *t*-test indicated that there was not a significant difference in math achievement scores based on race, $t\ (21.52) = -1.77$, $p = .09$, Cohen’s d = .53. Effect size, based on Cohen (1988), was moderate. Black students ($M = 691.62$, $SD = 95.28$, $n = 37$), while scoring higher on average, did not statistically significant differ in their average math achievement compared with white students ($M = 652.86$, $SD = 40.15$, $n = 7$) (or See Table 5 and Figure G). Given the small number of white students, the observed power was .33; therefore, these results should be applied cautiously.

Table 5 Race Group Statistics

	Race	N	Mean	Std. Deviation	Std. Error Mean
Posttest	W	7	652.86	40.147	15.174
	B	37	691.62	95.281	15.664

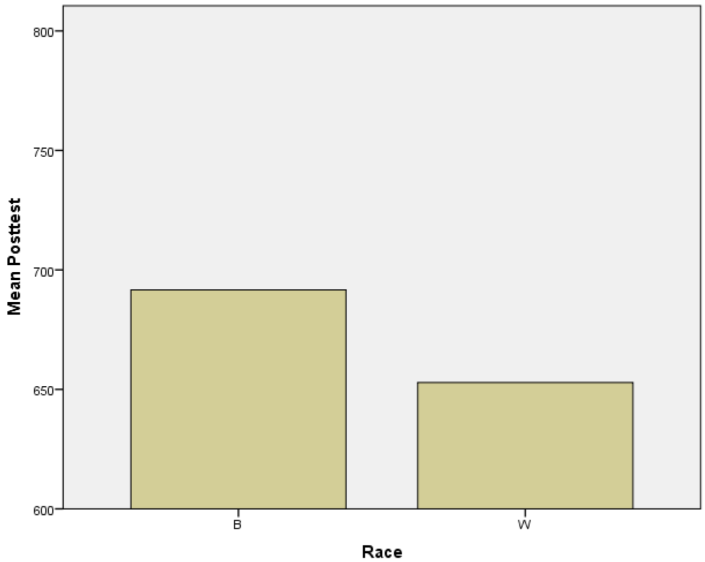

Figure H Race Bar Graph

Therefore, there is not significant evidence to reject the null hypothesis and conclude that there is a significant difference in STAR math achievement by race of students receiving computer-based instruction (Math 180) and students who do not.

Summary

Chapter Four provided a detailed data analysis for this study. The data were analyzed using SPSS to perform an ANCOVA for hypotheses one (intervention versus control group) and two (gender). A *t*-test was performed for hypothesis three (race). Each of the three null hypotheses could not be rejected in this study. However, the observed power for each null hypothesis was very low, indicating the likelihood of a Type II error. Therefore, there may have been an effect of Math 180 on student achievement, but the sample sizes were too small to detect it.

CHAPTER FIVE: CONCLUSION

Overview

The main focus for this research study was to investigate the use of computer-based instruction to increase mathematics achievement in at-risk, middle school students utilizing the computer-based program, Math 180. This chapter provides a concise summary of the findings, as well as a discussion, implications, limitations, recommendations for future research, and summary of the study.

Discussion

The purpose of this study was to investigate the impact of computer-based learning on middle school math achievement of at-risk students. When used effectively, computer-based instruction is an intervention that may be instrumental in helping at-risk students improve their achievement in mathematics.

Three learning theories closely relate to this research study: knowledge space theory, behaviorism, and social constructivism.

Knowledge Space Theory

Knowledge Space Theory is a theory of knowledge representation and is based on precedence relation (Falmagne et al., 2004). It is logical, especially in mathematics, that some levels of knowledge normally precede other levels because of prerequisite requirements and logical steps. In order to discover a student's knowledge state, the student takes an individualized assessment that increases or decreases the rigor of the questions in response to the student's answers. This computerized assessment is able to identify the student's knowledge state using less than 30 math problems. All problems are open-ended, so there is no probability that the student will guess into an incorrect knowledge state.

This theory explicitly explains what occurred with the intervention students completing Math 180. These students continued to receive work at the appropriate frustration level. Students were able to see success that they may not have experienced if not in a computer-based program.

Behaviorism

Behavioral learning theory is a concept that computer-based instruction is based. Edward Thorndike inferred that behavior was a result of two factors, frequency and pleasurable results (Catania, 1999). Students continue a behavior if positive feedback is shown. With computerized instruction, students receive immediate feedback while working on programs. This feedback paired with positive feedback from teachers may increase the amount of time students spend on computer-based instruction.

Having teachers who were sincerely concerned with the increase in student achievement played an important role in this study. These teachers, as well as the intervention program, gave consistent feedback and did not allow students to become frustrated or fail.

Social Constructivism

Constructivism focuses on a learner's ability to mentally construct meaning of their own environment and to create their own learning. Constructivists believe that all humans have the ability to construct knowledge in their own minds through a process of discovery and problem solving. When students work independently on iPads to complete tasks and gain further understanding of concepts, this learning theory is being implemented. Students use background knowledge as well as skills learned from the teacher to discover new information. Social constructivism acknowledges the uniqueness and complexity of the learner and actually encourages, utilizes, and rewards it as an integral part of the learning process. With computer-based instruction, students receive individualized instruction and rewards that assist in motivating the learner to achieve more.

The investigation of this study was designed to focus on using computer-based instruction to improve mathematics achievement for at-risk, middle school students. These students were falling behind in mathematics, and an intervention was needed to assist these students. The rise of high-stakes testing since caused more emphasis to be placed on student achievement. Selected grade levels are tested annually to determine if students are proficient in the area of mathematics. Many students at the schools involved in this study were already performing below grade level, had been retained, and were not proficient in mathematics. The intent of this study was to improve test scores in mathematics for at-risk students using a computer-based math program. A correlation research design was used for this study focusing on the differences in test scores after utilizing a computer-based intervention. The results of the three research questions are summarized and discussed in this chapter.

Three research questions were used by the researcher to investigate the use of computer-based instruction to improve scores for at-risk middle school students in mathematics.

Null Hypothesis One

The null hypothesis states that there will be no statistically significant difference in math achievement on the Star Math assessment between students receiving computer-based instruction (Math 180) and students who do not. While middle school students participating in the computer-based instruction (Math 180) scored higher on average on the STAR Math assessment than students participating in traditional math instruction, the difference was not statistically significant; therefore there was evidence to fail to reject the null hypothesis.

Null Hypothesis Two

The null hypothesis states that there will be no statistically significant difference in STAR math achievement by gender of students receiving computer-based instruction (Math 180) and students who do not. After controlling for pretest math achievement scores, there was not a statistically significant difference in posttest scores between males and females; therefore, there was evidence to fail to reject the null hypothesis.

Null Hypothesis Three

The null hypothesis states that there will be no statistically significant difference in STAR math achievement by race/ethnicity of students receiving computer-based instruction (Math 180) and students who do not. The results indicated that there was not a significant difference in math achievement based on race; therefore, there was evidence to fail to reject the null hypothesis.

The implementation of instructional strategies and techniques is definitely needed to assist the students in attaining academic success. The use of technology to improve student learning has become one of the major components in today's education reform. In other studies, computer-based instruction has been identified as an effective strategy to improve the achievement of at-risk students (Baca, 2012; National Center for Education Statistics, 2004). Math 180 computer program was used as a means of providing assistance for these students to increase their GE levels in mathematics as well as overall academic grades.

Implications

Realizing that high stakes testing was a driving force for states and school districts to become more accountable for improving student achievement, the focus of this study was to improve achievement in mathematics for at-risk students. The selection of at-risk students was instrumental for the study and was done through the analysis of standardized test scores as well as math grades. The lack of statistically significant evidence indicated that at-risk students are capable of achieving academic success in mathematics from either the use of computer-based instruction or teacher-led instruction. This does not align with other studies in the literature; however, the observed power for each null hypothesis was very low, indicating the likelihood of a Type II error. Therefore, there may have been an effect of Math 180 on student achievement, but the sample sizes were too small to detect it. The current research does answer some questions about math achievement; however, many questions remain that will need to be answered to improve the math achievement of at-risk students.

Research question one focused on the investigation of computer-based effects on mathematics achievement for at-risk students comparing the results from their STAR Math pretest and posttest scores by utilizing the Math 180 computer program and traditional classroom teaching. The posttest results indicated that the treatment did not result in a statistically significant difference from the control as measured from the pretest to the posttest. Although students using Math 180 did slightly better on the posttest, there was not a significant increase caused by this computer-based program. This may have been the result of having a sample size that was too small to detect an effect as evidenced by the low observed power. This is not aligned with other related studies in the literature.

As stated in the literature review, the realm of technology has brought many changes to the education arena, especially because of the incorporation of varied technological tools for enhancing learning. As student needs continue to change, it may be necessary to integrate the use of various technological components for all learners to obtain the required skills to be competent at grade level. However, further studies will need to be done.

In today's society, mathematics achievement for students looks at real-world situations that incorporate more hands-on activities and tasks. It must also be noted that schools have created environments that incorporate technology as alternate approaches for addressing the needs of at-risk students. Students also should be able to use concrete materials for appropriate technology for computation and exploration and to assess learning as part of instruction.

The computer-based program that was used in this study was very personal, and because of the privacy and individual attention afforded through it, many students were relieved of the embarrassment of giving the incorrect answer publicly or of going more slowly through lessons than their classmates.

Research question two focused on the comparison of males and females using computer-based instruction. The analysis indicated that there was not a significant difference in posttest scores of males and females using the Math 180 intervention and the students who received remediation through a traditional classroom teacher. This may have been the result of having a sample size that was too small to detect an effect as evidenced by the low observed power.

All Math 180 activities were self-paced with visual cues for self-correction. From viewing the program, one would think that such programs were too easy for middle school students, but the students were working on instruction that had been identified as their instructional levels according to the grade level equivalent that was revealed from the individual students' pretests. The computer program was able to maintain effective records for all students each time students interactively utilized the software.

In the literature review, findings were not consistent with the findings from the research study; however, the low observed power as a result of a small sample size may have been responsible for seeing only a slight increase in achievement for those students receiving the intervention. Therefore, these results may not actually conflict with the approach State schools are taking in creating environments that incorporate technology as alternate approaches for addressing the needs of at-risk students. According to the National Center for Education Statistics (2004), the increased use of computers and the increased availability of computer-based approaches have become more flexible and are, therefore, able to address more learning needs for students to develop abilities to read and comprehend text.

Baca (2012) described technology-enriched instruction as an instructional practice that is effective for at-risk students. He also summarized and critiqued research findings on the uses and applications of computer-based instruction with at-risk students. The drill-and-practice sessions used with computer-based instruction serve as a good practice for at-risk students (U.S. Department of Education, 2014). Adequate test preparation significantly improves student performance on high-stakes tests.

Research question three addressed whether the race of the student affected the outcome of the intervention. The number of black participants was much greater than white participants, and the small sample size resulted in a low observed power; therefore, a larger population may deem better results.

With a high demand for increased student achievement, the focus on high-stakes testing has caused educators to take different approaches when trying to help students achieve academic success. The information that is received from test scores is very important; however, such information does not provide educators with the all of the necessary information for making critical decisions (Desilver, 2015). Schools across the nation are faced with the need to test students more as a way of improving academic achievement.

The participation of the educators was also extremely important for this study. Looking at the fact that students spend a large portion of their day at school with the teachers, obtaining teacher buy-in concerning achievement in mathematics for at-risk students provided the researcher a chance to hear their responses and further elaborations about the interview checklist. With reading being an essential strategy for academic success in all core areas and in education in general, the educators clearly understood the importance of the study and expressed their concerns about at-risk students' achievement in reading and mathematics. Teachers have to assess students' progress to find out if the teaching and learning process is effective. Assessments and test results can serve as factors that will enable teachers and students to determine what has been learned from teaching and what areas need more focus. Assessment can also help teachers focus on students' strengths or weaknesses for future assessment, while, at the same time, it can provide opportunities for students to develop their own perceptions about the learning process.

Knowing that these at-risk students have been experiencing low achievement in mathematics, all stakeholders will need to get involved to assure the needs of at-risk, middle school students are being met.

According to Pellegrino (2014), direct instruction is a highly structured approach designed to accelerate the learning of at-risk students. Improving students' academic achievement and increasing their grade level equivalent scores at the end of the school year was the researcher's main goal. This goal was difficult to ascertain due to the low observed power as a result of small sample sizes. The statistical analysis from the posttest scores showed a slight, but statistically insignificant, increase of grade equivalent levels for some students but not all.

Support and encouragement from parents and teachers continues to be an important factor in motivating student to excel academically. This is especially important for those students who are identified as at-risk. When the parents and teachers are working together and communicating effectively, that consistency usually helps the at-risk students cooperate and become successful.

Limitations

This dissertation was derived from the need to provide assistance to at-risk, middle school students who needed to enhance their academic achievement in reading and mathematics, not only in the classroom, but also on future standardized tests. These students also needed assistance to prevent future grade retentions. In this research study, the use of a computer-based intervention, Math 180, was inconclusive based on low observed power as a result of small sample sizes. Therefore, the small increases in pretest to posttest performance are likely due to the likelihood of a Type II error. Had sample sizes been larger, Math 180 may have proved to be beneficial in terms of providing individualized instruction for the students to enhance skills in their deficient areas through the use of repetitive practice using Math 180. However, additional studies would need to be conducted to evaluate the actual effectiveness of the treatment.

An additional limitation in the study occurred during the third month of school when an unforeseen hurricane occurred in the area that caused a complete evacuation of the county. This caused students to be displaced and resulted in the loss of instructional time from classes, as well as in the computer labs. As a result of the hurricane, students were not able to make up the time that was lost. Daily attendance was another issue that might have hindered the effect of gain for some students' GEs. Whenever students were absent, they missed valuable instructional time and were not able to retrieve any of the missed instruction. There was no penalty for lost time in remedial math; students were able to continue where they previously stopped when an absence occurred, but they would not have progressed as far in the program as students who had been present for all classes.

The generalizability of this study was limited because the sample population that was used might not have been representative of the entire school's population, and the sample sizes were small as evidenced by the low observed powers in the evaluation of each null hypothesis. Results cannot be generalized to other populations. The use of a single pretest and posttest could also be recognized as a limitation because this design is technically a pre-experimental design that makes use of only a single group of students. Gall, Gall, and Borg (2007) stated that the one-group pretest-posttest design involves three steps: (a) administration of a pretest measuring the dependent variable, (b) implementation of the experimental treatment (independent variable) for participants, and (c) administration of a posttest that measures the dependent variable again. The effects of the experimental treatment are determined by comparing the pretest and posttest scores. The pretest was used to measure the participants' achievement in mathematics before the implementation of Math 180.

Recommendations for Further Study

The posttest results revealed a minor, but statistically insignificant, gain for at-risk students in mathematics who participated in Math 180. Many of these at-risk students had passing final grades in mathematics for the school year. The students worked diligently throughout the year trying to increase their overall achievement levels. The data collected for the at-risk students from the pretest scores may be a motivational tool for the students to work hard enough to be successful in improving their math scores. It is also recommended that, in order to help increase the validity of the research data, a larger sample size should be randomly selected to determine with more certainty the potential impact of utilizing the computer-based program.

Math 180 may have provided needed practice activities that were challenging and intended to enhance student math skills. However, continuing efforts are recommended to further improve test scores and grades for at-risk students by carefully planning to increase the number of students who are included in interventions while focusing on the need to become proficient in mathematics.

Summary

By comparing the pretest and posttest scores, the information from the study revealed the achievement growth each at-risk student made during the course of the school year. Other interventions should be given some consideration to help those who are not proficient in math. The results indicated that the use of Math 180 did not result in a statistically significant increase in achievement of at-risk students. With the increased measures of high-stakes testing for student achievement, it is recommended that further research be focused on studies of this type to examine and evaluate the impact of other computer-based programs. From the study, it was revealed that the use of computer-based learning allowed students to work at their individual pace and provided immediate feedback by informing the students whether the answers were correct or incorrect. This type of intervention within itself is recommended for continued use with at-risk students for increasing academic achievement.

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APPENDIX A

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

June 8, 2017

Kenyatta Gilmore
IRB Application 2901: The Impact of Computer-Based Programs on Middle School Math Achievement

Dear Kenyatta Gilmore,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your IRB application.

Your study does not classify as human subjects research because it will not involve the collection of identifiable, private information.

Please note that this decision only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued non-human subjects research status. You may report these changes by submitting a new application to the IRB and referencing the above IRB Application number.

If you have any questions about this determination or need assistance in identifying whether possible changes to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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Liberty University | Training Champions for Christ since 1971

APPENDIX B

Lewis Frasier Middle School

910 Long-Frasier Street · Hinesville, Georgia 31313

Phone 912-877-5367 · Fax 912-877-3291

January 26, 2017

Dear Ms. Kenyatta Gilmore:

After careful review of your research proposal entitled The Impact of Computer-Based Programs on Middle School Math Achievement, I have decided to grant you permission to access our student data.

Check the following boxes, as applicable:

☑ Data will be provided to the researcher stripped of any identifying information.

☑ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

Jermaine A. Williams
Principal

APPENDIX C

Midway Middle School

425 Edgewater Drive
Midway, GA 31320
(912)884-6677
(912)884-5944 Fax

Debra B. Frazier
Principal
Dr. Sonia Bacon
Assistant Principal

January 27, 2017

Debra Frazier
Principal
Midway Middle School
425 Edgewater Drive
Midway, GA 31320

Dear Kenyatta Gilmore,

After careful review of your research proposal entitled The Impact of Computer-Based Programs on Middle School Math Achievement, I have decided to grant you permission to access our student data.

Check the following boxes, as applicable:

☑ Data will be provided to the researcher stripped of any identifying information.

☐ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

Principal
Midway Middle School