DIFFERENCES IN MATH ACHIEVEMENT: UTILIZING SUPPLEMENTAL

COMPUTER-BASED INSTRUCTION AND TRADITIONAL INSTRUCTION

by

Todd Christopher Clark

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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APPROVED BY:

Nathan Putney, Ph.D., Chair

Lisa Schlabra, Ph.D., Committee

Jeanne Fanning, Ed.D., Committee

Scott B. Watson, Ph.D., Associate Dean of Advanced Programs

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ABSTRACT

Mathematics achievement has become vitally important in public education, obligating

students to meet and exceed higher standards in spite of ability and knowledge level.

This causal-comparative study sought to establish the achievement of the Classworks®

supplemental math program with seventh grade students from two public schools in

Georgia. The national Criterion-Referenced Competency Test (CRCT) scores in math

were used to compare 129 seventh grade students (control group) who used traditional

instruction and 129 students (experimental group) who used traditional instruction along

with the supplemental Classworks® software program. In addition, the study analyzed

the relationships between *gender*, *ethnicity*, and *socioeconomic status*.   The CRCT-Math

mean scores of 2009 were used as the covariate, and were compared to the CRCT-Math

mean scores of 2010 between the control and experimental groups. The results showed a

statistically significant difference between the control and experimental groups, between

the ethnic groups in the experimental group, and between the *socioeconomic status* and

ethnicity in the experimental group. However, there was no statistically significant

difference among *gender* alone and *ethnicity* alone in the experimental group. The

findings revealed that the Classworks® math program helped improve student

achievement on the CRCT-Math assessment. Consequently, additional research on the

Classworks® program is highly recommended.

Keywords: computer-based instruction (CBI), Classworks®, Criterion-Referenced

Competency Test (CRCT), active learning, adaptive learning, research-based, pedagogy

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Adequate Yearly Progress (AYP)

Analysis of Covariance (ANCOVA)

Analysis of Variance (ANOVA)

Computer-assisted Instruction (CAI)

Computer-based Instruction (CBI)

Common Core Georgia Performance Standards (CCGPS, CCSS)

Criterion Referenced Competency Test (CRCT)

Georgia Department of Education (GDOE)

Georgia Performance Standards (GPS)

Individuals with Disabilities Education Act (IDEA)

Learning Management System (LMS)

Mathematical Association of America (MAA)

Measures of Academic Progress (MAP)

No Child Left Behind (NCLB)

Standard Deviation (SD)

Statistical Package for the Social Sciences (SPSS)

Student Information System (SIS)

Trends in Mathematics and Science Study (TIMSS)

DEDICATION

God has revealed Himself through His Word and "is a lamp unto my feet, and a light unto my path" (Psalm 119:105). This journey has brought into focus the people who are the most important in my life. This manuscript is dedicated to my wife Kyong and my daughter Allison. I cannot thank my wife enough for her sacrifice, support, and encouragement. She has grown to fulfill the sacred proverb of the virtuous woman with grace and strength. Proverbs 31:10-31 "Who can find a virtuous woman? for her price is far above rubies. The heart of her husband doth safely trust in her, so that he shall have no need of spoil. She will do him good and not evil all the days of her life . . . Her children arise up, and call her blessed; her husband also, and he praiseth her." May God bless you beyond measure. To Allison, thank you for your sacrifice, support, and encouragement. You are the greatest blessing Mom and I could ever imagine. Your love of God is prized, your character is revered, and your love for others is inspiring.

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CHAPTER ONE: INTRODUCTION

Today's technology is ubiquitous in the classroom; however, the evidence of academic success is not reflecting the advancements. Approximately 99% of school systems have Internet access (NCES, 2006). Schools are using technology for various purposes including presentations, lectures, visuals, and many other uses. Unfortunately, technology is not being utilized to its fullest potential to maximize achievement. For instance, K-12 teachers and students were surveyed and reported that only 23% use technology for assignments on a weekly basis (Stetter & Hughes, 2010). In the past two decades, computers have been used primarily for drill and practice, movies, fun activities, tutoring, and assessments; consequently, computer integration was not significant for learning (Kulik & Kulik, 1991; Sarama, 2004). Unfortunately, many technologies lack current research-based strategies that are pedagogically sound (Winters, Greene, & Costich, 2008).

Computer-based learning is an excellent form of active learning. Active learning has a theoretical basis that reaches "back 200 years beginning with Pestalozzi's Object Teaching and Froebel's Kindergarten, and more recently by Dewey's ideas of experimental learning" (Tienken & Maher, 2008, p. 4). The original use of computer instruction lacked scaffolding, pedagogical concepts, and developmental skills (Wang, Kinzie, McGuire, & Pan, 2009). The field of technology is slowly addressing these problems and utilizing scaffolding and taxonomies. Kim and Hannafin (2011) discussed scaffolding in technology rich environments in regards to problem solving. One major problem with scaffolding is the absence of domain knowledge in students. Programs can overcome domain knowledge deficiencies by way of scaffolding that incorporate

activities focused on problem identification through 'interactive cycle(s) of investigation' (Kim & Hannafin, 2011, p. 412). Rourke and Coleman (2010) conducted a case study on scaffolding with digital learning. They concluded that students who utilize the scaffolding process are more self-directed and independent through erudition, while understanding that pedagogy guides the application of technology. Chyung and Stepich (2003) incorporated Bloom's Revised Taxonomy in an online instructional course. The researchers found that Bloom's taxonomy provided an important guide for matching objectives, lessons and activities, and assessments to meaningful instruction. Taxonomies can work symbiotically with scaffolding to create authentic learning. Classworks® by Curriculum Advantage, Inc. takes advantage of this concept. New units provide facts and knowledge with added support and resources that help aid students in their understanding. As the lessons progress, the learning becomes more advanced in higher-order thinking and autonomy (Curriculum Advantage Inc., 2009).

Recent studies about technology show the potential for student success. For instance, "classroom integration of technology promotes deeper understanding of mathematical concepts, makes instruction more student-centered, provides students with realistic mathematical experiences, promotes student reflection through interactive feedback, and broadens epistemological authority in the classroom" (Ross, Sibbald, & Bruce, 2009, p. 562). This type of success is a result of a foundation in active learning strategies. Bonwell and Eison (1991) examined active learning and how these techniques improve academics. They define active learning as being engaged in higher-order thinking activities that include "visual learning, writing in class, problem solving, computer-based instruction, cooperative learning, debates, drama, role playing,

simulations, games, and peer teaching" (p. 1). Prince (2004) conducted a review of active learning in engineering and found that active learning was effective in varying degrees among various strategies.

Classworks® is a software program offered by Curriculum Advantage Inc. that supplements traditional instruction through proven strategies, including mini-lessons, practice activities, review activities, assessments, and projects (Curriculum Advantage Inc., 2007). Classworks® is a form of active learning that incorporates research-based strategies, best practices, taxonomies, scaffolding, learning styles, mastery, and aligned standards which create a learning environment that is pedagogically rigorous (Curriculum Advantage Inc., 2007). The program uses best practices to instruct students in application, discovery, and investigation that are aligned with state and national standards. The learning scaffolds from convergent knowledge to divergent thinking, which infuses the higher-order thinking skills of the Revised Bloom's Taxonomy. This study will seek to better understand if supplemental computer-based instruction that is pedagogically sound will increase student achievement, specifically in mathematics.

The No Child Left Behind Act of 2001 mandated performance outcomes for achievement and graduation rates for all students. NCLB requires performance outcomes for subgroups including gender, ethnicity, socioeconomic status (SES), disability, English-language proficiency, and immigrant status. Reznichenko (2013) proclaimed the UNESCO's "Mathematics for All" encourages equality around the world, and asserted that the "disparities in students' mathematics achievement have long been coupled with the demographic categories of race and ethnicity, culture and language, SES and social class, gender and disabilities" (p. 2). Raising outcomes on gender, ethnicity, and SES

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are vitally important for Title I schools. Unfortunately, many subgroups are not meeting expectations. Psychological literature has indicated that gender performance varies within the subject of mathematics. The females who were observed tended to be more dependent and collaborative workers, while the males tended to be more independent and problem solvers (Gentry & Buck, 2010; Reznichenko, 2013). There are stereotypes that permeate females and males, which incentivize males and discourage females. Gentry and Buck (2010) found that teachers were more inclined to encourage, correct, and be patient with males than females. Females have better graduation rates than males; nevertheless, males have been found to dominate STEM disciplines in college (Hong, Hwang, Wong, Lin, & Yau, 2012; Winston, Estrada, Howard, Davis, & Zalapa, 2010).

Studying ethnicity revealed several major differences in academic and math achievement that affect African American and Hispanic students more than Caucasian students. African American and Hispanic students consistently ranked at the bottom of achievement, while Asian and Caucasian students ranked at the top (Winston et al., 2010). Approximately 25% of African American students are prepared for college mathematics, and according to the NAEP data, these students are making gains in achievement (Noble, & Morton, 2013). Unfortunately, the majority of African American and Hispanic students maintain a less than minimum competency level for academic achievement (Lee, 2012).

Socioeconomic status (SES) is a key factor in the success or failure of math achievement for students. Low SES students achieve less on standardized tests and math testing in particular; consequently, low SES students are less likely to study and major in STEM disciplines in the future (MacPhee, Farro, & Canetto, 2013). Wang's (2010) study

revealed benefits for low SES students when given the opportunity to participate in activities that were analytical and involved reasoning. There are outside influences that affect low SES students. Boxer et al. (2011) reported that there are negative stereotypes with valid barriers that influence students. Many poor parents lack the support, modeling, and background to encourage their children to succeed. Poor communities lack the facilities and resources to support families compared to high SES communities. The combination of ethnicity and SES are closely related to academic achievement (Gentry & Buck, 2010; Shores, Smith, & Jarrell, 2009; Wang, 2010), and foster a significant achievement gap in mathematics (Lee, 2012). The gap between low SES African American and low SES Caucasians increased over time based on the NAEP data from 1971 to 2004 (Lubienski, 2006; Reznichenko, 2013). While this is a very discouraging outlook, Wang (2010) suggested that well designed methods and strategies specific for ethnic and low SES students can benefit student academics in mathematics.

Background

The business and industry sector have spent "$55 billion in formal training programs and $180 billion in informal on-the-job training yearly" (Johnson & Rubin, 2011) to keep up with technological innovation and skilled labor. The demands for higher achievement in math, science, and language arts have led to a need to develop effective strategies. If primary and secondary education could raise academic achievement in these subjects, then industry could reduce costs and boost productivity. The passing of the NCLB has also encouraged the use of research-based instructional strategies along with technological implementations to prepare citizens for the workforce (Billingsley, Scheuermann, & Webb, 2009).

The Elementary and Secondary Education Act (ESEA) was enacted in 1965 by President Lyndon B. Johnson to fight the "War on Poverty." In 2001, President George W. Bush reauthorized ESEA, known as the No Child Left Behind (NCLB) Act, to improve education in public schools. The NCLB Act has challenged states to raise academics by setting high achievement goals for all students and requiring a system of accountability for reaching those objectives. Consequently, technology is being used by school systems to evaluate progress through data management systems (Slavin, 2006; Carnegie Foundation, 2009). The Race to the Top is the latest program to advance education reform. The program focuses on four areas in innovation, including standards and assessments for success, data systems for measuring growth, enhancing teacher effectiveness, and reestablishing success in underachieving schools (USDOE, 2009). Georgia in particular is following the recommendations and receiving funds from the program. The focus of accountability is on proven strategies, methods, and systems. NCLB has implemented Adequate Yearly Progress (AYP) to measure accountability for school systems. The AYP model focuses on specific achievement goals, continual assessments, and program evaluations to meet achievement (NCLB, 2001). All students must reach 100% proficiency by 2014. The NCLB Act requires states to sanction Title I schools for not meeting their goals after two consecutive years or school reconstruction after five consecutive years (Stover, 2007).

In the 1980s, the National Commission on Excellence in Education was formed to analyze the problems in education. The committee discussed problems and offered solutions to improve education in American. In the report *A Nation at Risk* (NCEE, 1983), the committee asserted that education is mediocre and society is in danger.

American students have repeatedly ranked at the bottom of several academic assessments

compared to other industrialized countries (Holland, 2004). Math scores have fallen 40

points on SATs, and only 33% of seventeen year-olds can solve multiple step math

problems (Holland, 2004). This shows a lack of higher-order thinking skills and problem

solving skills among high school students. The committee offered several solutions to

this deficiency, including strong content in the curriculum, more rigorous standards,

longer instructional time, increased teacher knowledge in the subject matter, and

leadership support (Holland, 2004).

Fifteen years later, a committee was formed to provide a follow-up on *A Nation at

Risk* (NCEE, 1983). Its report was titled *A Nation Still at Risk* (1998). The investigation,

based on the Third International Math and Science Study (TIMSS), found some gains but

also some losses. There had been a positive increase in college attendance, longer

instructional time, and lower dropout rates. The negative aspects showed that compared

to other developed countries, the U.S. still ranked at the bottom of math (19 out of 21)

and science (16 out of 21), and last in physics (Bennett et al., 1998). The committee

offered two main suggestions. First, they asserted that public education needs to be

released from government control and placed with the local environment for

accountability and, secondly, choice and competition needs to be given to parents and

communities for effective alternatives.

In 2007, the National Center on Education and the Economy formed a committee

to analyze the skills of the American workforce. They found that even if Americans

could reach the same educational levels of China and India, Americans still could not

compete with the low earnings of these countries. The committee provided a 10 step

process to better prepare people for the workforce, including assessments for various levels of education, rigorous curriculum and standards, competition and choice, and job training. To enhance the allure of Americans to high paying employers, Americans must have competitive math and science skills along with creative and innovative abilities. Higher-order thinking, problem solving, and analytic thinking are vital for American students to acquire in order to set them apart from students in other countries.

Georgia has adopted the Common Core Performance Standards that have been developed and implemented by 44 states. Toch (2009) revealed the effort from the federal government to persuade states by "voluntarily adopting a common core of internationally benchmarked standards in math and language arts for grades K-12" (p. 72). The governors of these states believe that having common standards will provide consistency, rigor, relevant content, and clear expectations (GDOE, 2010c).

The state of Georgia has filed with the federal government to waive requirements of NCLB in 2011. The state has requested that the implementation of Georgia's College and Career Ready Performance Index be used to measure preparedness rather than AYP. The U.S. Department of Education granted a waiver to Georgia from the NCLB act in 2012 (GDOE, 2012). Georgia has won funding under the Race to the Top program to implement reform for better educators, assessments and standards for students, data systems, and improving the schools that are the lowest achieving (GDOE, 2010b).

The state of Georgia utilizes the Criterion-Referenced Competency Test (CRCT) to determine accountability for AYP. The Report Cards for the State of Georgia provided important information on the seventh grade students' math scores using the CRCT. The report showed growth in results of meet and exceed standards through the years,

including 75% in 2008-2009 for grade six, 86% in 2009-2010 for grade seven, and a

difference of 11 points from grades six to seven (GOSA, 2009a; GOSA, 2010a). The

control school reflected similar results as the Georgia State statistics with 74% in 2008-

2009 for grade six, 84% in 2009-2010 for grade seven, and a difference of 10 points from

grades six to seven (GOSA, 2009c; GOSA, 2010c). The treatment school showed lower

meet and exceed results, but showed larger differences from year to year. The treatment

school statistics were 49% in 2008-2009 for grade six, 72% in 2009-2010 for grade

seven, and a difference of 23 points from grades six to seven (GOSA, 2009b; GOSA,

2010b).

Table 1.1

The Governor's Office of Student Achievement, CRCT-Math, Meet or Exceed Standards

Students	State of Georgia	Treatment School	Control School	Average
6th Grade 2008-09	75	49	74	66
7th Grade 2009-10	86	72	84	81
Difference	+11	+23	+10	+15

Source: (GOSA, 2009a; GOSA, 2009b; GOSA, 2009c; GOSA, 2010a;GOSA, 2010b; GOSA, 2010c)

Computer-based Instruction

Several meta-analyses have been conducted on computer-based instruction that

provide a broad view of the subject. Tamim, Bernard, Borokhovski, Abrami, and Schmid

(2011) conducted a second-order meta-analysis for the influence of technology on

learning over the past 40 years. The results revealed that technology had a small to moderate significance over traditional instruction. Traditional instruction along with supplemental technology performed better than technology alone. Li and Ma (2010) administered a meta-analysis and studied the effects of computer technology for grades K-12 in mathematics learning.   The results showed that math achievement rose for students, including special education students, who used computer technology over traditional instruction. A meta-analysis by Waxman, Wu, Michko, and Lin (2013) studied technology in regards to specific teaching and learning strategies of various technologies. The results illustrated positive effects for teaching and learning with various technologies. Both Li and Ma (2010) and Waxman et al. (2013) agreed that higher effect sizes over the past decade or two may have been established by more integration of constructivist strategies and pedagogical soundness in technology.

Hannafin and Foshay (2008) conducted a study on PLATO® Learning, which is a computer-based instructional program that is theoretically and research-based. Their study was performed to see if the PLATO® remediation program could raise standardized test scores in mathematics. The participants were 10th grade students who scored around the 220 and below level out of a top score of 280 on the eighth-grade standardized math test. There were 126 students in the study (87 in the experimental group and 39 in the control group). The intervention was 45 minutes a day, four days a week, for two semesters. The results showed a statistically significant increase in scores for both groups, but the experimental group showed a statistically significant increase over the control group.

PLATO® Learning is pedagogically rigorous. The program incorporates the theory of Bloom's Revised Taxonomy. Out of this foundational theory, the program utilizes mastery learning to build knowledge and foster scaffolding. Each unit measures understanding with formative and summative assessments to provide evidence of mastery. The CBI builds on higher levels of learning, knowledge, and relevance. The system infuses national, state, and local standards while using pacing guides (PLATO Learning, 2011).

Many former computer-based instructional programs relied on drill and practice, movies, fun activities, tutoring, and assessments (Borokhovski, Tamin, Bernard, Abrami, & Sokolovskaya, 2012; Li & Ma, 2010; Tamim et al., 2011; Wang, Kinzie, McGuire, & Pan, 2009). Some evidence has suggested that CBI programs that are pedagogically sound increase academic achievement. The PLATO® Learning program, conducted by Hannafin and Foshay (2008), was an excellent study utilizing research and sound theory that showed significant progress for students' achievement in high school. In Slavin's (2008) meta-analysis, there were several research-based CBI programs that did not qualify for lack of various evidence criteria (e.g. effect size, duration, adequate control group, data, etc.) including PLATO®, SuccessMaker™, and LearnStar®. Classworks® was found to be a pedagogically sound program with the highest evidence of effectiveness among CBI programs (Slavin, 2008). Winters, Greene, and Costich (2008) stated, "This research is particularly important because there have been numerous calls for more considered implementation of technology in education, utilizing pedagogy and content informed by research" (p. 430). This study will add to the evidence of theory and research-based CBI programs for students and may show evidence of math achievement.

Problem Statement

Students in the United States rank low on mathematics achievement compared to other industrialized countries. The past 20 years have seen increases in achievement; however, the achievement has not raised the competitiveness of the United States. In addition, Hispanic and African American students continue to lag far behind Caucasian and Asian students in mathematics (Slavin & Lake, 2008; Young, Worrell, & Gabelko, 2011). Socioeconomic status has provided a moderate to average connection to math achievement and may predict certain success or failure (Young et al., 2011). The Mathematical Association of America (MAA) has been discussing the reform needed to maintain literacy in mathematics and technology. Small and Snook (2011) "emphasize real-world problem solving in the sense of modeling . . . rather than in the sense of exercises" (p. 1). However, the MAA committee found providing solutions and agreements for proper implementation difficult. The gap in implementation may be solved by computer-based instruction that incorporates modeling, inquiry, student-centered learning, and real-world experiences (Small & Snook, 2011).

Computer-based instruction (CBI) has entered education to supplement traditional instruction and has seen some positive and negative findings. Johnson and Rubin (2011) investigated a review of literature on computer-based instruction for business and industry. They discovered that many CBI programs simply imitate traditional instruction with no better results. The study emphasized that CBI should incorporate active engagement, individual pacing, mastery, and feedback. These suggestions are parallel for

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primary and secondary education in using CBI (Ross et al., 2009). Moos and Azevedo (2009) conducted a literature review on K-12 CBI and found beneficial results. CBI showed some positive results in knowledge development. Unfortunately, some students struggled to use the tools for knowledge development. Overall, researchers have suggested that CBI is comparable to traditional instruction but lacks substantial evidence that it is an improvement over traditional teaching techniques (Cook, 2009; Kulik, 1994; Schmid, Miodrag, & Di Francesco, 2008; Slavin & Lake 2008).

Self-efficacy is a vital aspect of math achievement, which can bridge the gaps among traditional instruction, computer-based instruction, and research-based strategies. Moos and Azevedo (2009) made the connection of self-efficacy and computer-based learning. They found that the use of computers does not foster self-efficacy, but "it is the quality, and not the quantity, of computer experience that is the most critical determinant in computer self-efficacy" (p. 583). Computer self-efficacy has shown varying findings for differences among gender. Many studies have found that females are more anxious and resistant to computers, while other studies have found no statistical significance (He & Freeman, 2010; Saleem, Beaudry, & Croteau, 2011). More research is needed to address the potential differences.

Low math achievement, inconclusive results with computer-based instruction, and lack of implementation of pedagogically rigorous strategies have left adults unprepared for their future. The problem is that there is an increased demand for competencies in technology, which depends on greater mathematical ability for adults (Garii & Okumu, 2008). Therefore, math achievement must rise to prepare citizens to enter society with the skills and knowledge that foster productivity and self-determination. This study will

attempt to understand the differences between traditional instruction and traditional instruction infused with the supplemental Classworks® program that has adaptive learning, active learning, and pedagogically rigorous strategies (e.g., self-efficacy, Bloom's Revised Taxonomy, content alignment) to increase mathematics achievement.

Purpose Statement

The purpose of this causal-comparative study was to compare 258 seventh grade students' mathematics achievement mean scores on the Criterion-Referenced Competency Test (CRCT) between students who learned from traditional instruction and students who learned from traditional instruction with the supplemental Classworks® software program. This study utilized 258 seventh grade students from two public schools in Georgia. The curriculum and previous achievement were controlled in this study. Both the traditional and computer-based math instruction was aligned with the Georgia Performance Standards (GPS). The dependent variable was the mathematics achievement measured by the math portion of the Criterion-Referenced Competency Test (CRCT).

The first independent variable was the *mathematics instruction*, including traditional instruction and traditional instruction with the supplemental Classworks® program. Traditional instruction was defined as instruction taught face-to-face in the teachers' classrooms. The supplemental Classworks® program was defined as a computer-based instructional program that supplements the traditional instruction on an individualized basis. Bloom's Taxonomy is a theoretical framework that is based on learning objectives that are classified from simple or low level to complex and higher level skills. Anderson and Krathwohl (2001) revised the taxonomy to represent two

dimensions (knowledge and cognitive) that provide deeper understanding and mastery. The Classworks® program infuses the Bloom's Revised Taxonomy into the curriculum for consistent learning that progresses to higher levels of learning.

The second independent variable was *gender*. The third independent variable was *ethnicity*, including African Americans, Hispanics, and Caucasians. The fourth independent variable was the *socioeconomic status* (*SES*) of the participants. Low *SES* students were defined as students who received free/reduced lunch, while high *SES* students were defined as students who did not receive free/reduced lunch. Social cognitive theory is a learning theory that incorporates five basic concepts, including observation, outcome expectations, self-efficacy, goal setting, and self-regulation (Denler, Wolters, & Benzon, 2013). Social cognitive theory is based on society forces of socialization (Kim, 2010; Bembenutty, 2010; Williams & Takaku, 2011). *Ethnicity*, *gender*, and *socioeconomic status* are greatly moved by societal influences. The Classworks® program instills the balance of difficulty that encourages persistence in the social cognitive category of self-efficacy. The Classworks® program challenges overachievers and underachievers by adjusting the difficulty and academic level to the students' abilities; consequently, overachievers are not bored and underachievers are not frustrated.

The dependent variable was student mathematics achievement. Math achievement was defined and measured by the math portion of the Criterion-Referenced Competency Test (CRCT). The control variable was student previous achievement and was statistically controlled by using an ANCOVA. Previous achievement was defined as the students' 2009 CRCT-Math mean scores.

Significance of the Study

This study is significant because it aims to examine computer-based instruction as a method for improving math achievement. Parents and educators need to be informed of the various best practices in mathematics education to improve academics. According to Moos and Azevedo (2009), computer-based learning provides inconclusive outcomes on the resources' effectiveness. Nevertheless, students who have a deep understanding by employing prior knowledge and scrutinize their understanding raise their achievement (Moos & Azevedo, 2009). In addition, there is little evidence of effectiveness for CBI based on active learning strategies. The practical significance consists of raising student achievement in mathematics and preparing students to enter the workforce with adequate mathematics skills. This study may make the connection. This study incorporates computer-based instruction that stimulates active learning and pedagogically sound instruction in a systematic way.

Research Questions

1. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national Criterion-Referenced Competency Test-Math (CRCT- Math) mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone?

2. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*?

3. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status and ethnicity*?

Research Hypotheses

1. There will be a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone.

   H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone.

2. There will be a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*.

   H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*.

3. There will be a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*.

   H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*.

4. There will be a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *ethnicity*.

   H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean when using the supplemental Classworks® program based on *ethnicity*.

5. There will be a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic and ethnicity*.

   H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math

achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic and ethnicity*.

Identification of Variables

Mathematics instruction was the first independent variable in this study. The *math instruction* was analyzed to see if there were any differences between the students who used traditional math instruction alone and the students who used traditional instruction along with the supplemental Classworks® program. Both instructional programs controlled curriculum by following the Georgia Performance Standards (GPS). *Gender* was the second independent variable. *Gender* was analyzed to see if there were any differences in the treatment group between boys and girls who used the traditional math instruction along with the supplemental Classworks® program. *Socioeconomic status* was the third independent variable. *Socioeconomic status* was analyzed to see if there were any differences in the treatment group between higher and lower *socioeconomic status* students who used the traditional math instruction along with the supplemental Classworks® program. *Ethnicity* was the fourth independent variable. *Ethnicity* was analyzed to see if there were any differences in the treatment group between African American, Hispanic, and Caucasian students who used the traditional math instruction along with the supplemental Classworks® program. The fifth independent variable, both *ethnicity* and *socioeconomic status*, was analyzed to see if there were any differences among the treatment group. The dependent variable was the mathematics achievement that was measured by the Criterion-Referenced Competency Test (CRCT) for math. Mathematics achievement for 2009 CRCT-Math represented

previous achievement and the covariate, and 2010 CRCT-Math represented the post math achievement.

Assumptions

For the purpose of the study, several assumptions were made. First, both schools learned math for 180 days for both the 2008-2009 and 2009-2010 school years. Second, traditional instruction and the Classworks® program were based on the Georgia Performance Standards (GPS) for the 2008-2009 and 2009-2010 school years. Third, the control group was matched to the treatment group according to *gender*, *socioeconomic status*, and *ethnicity*. Lastly, the treatment group used the Classworks® supplemental program approximately 45-minutes per session once a week, for the 2009-2010 school calendar year. The treatment group used traditional instruction for the remainder of the instructional time.

Research Plan

This quantitative study used the causal-comparative method to compare the differences in mathematics achievement for seventh grade students in two school districts in Georgia. Math achievement was measured by using the national Criterion-Referenced Competency Test-Math (CRCT- Math) mean scores to see if there were any differences between students who used traditional instruction and students who used traditional instruction along with the supplemental Classworks® program. In addition, the study analyzed the relationships among the independent variables (e.g., *mathematics instruction*, *gender*, *ethnicity*, and *socioeconomic status*). The treatment group is from a Title I public middle school in Georgia that used traditional instruction and the supplemental Classworks® program in mathematics based on the Georgia Performance

Standards (GPS). The participants used the Classworks® program for 45 minutes a session once a week, throughout the 2009-2010 school year. The remainder of the math sessions was used for traditional instruction.   The control group is from a Title I public middle school in Georgia that used traditional instruction for mathematics based on the GPS. The control group was matched to the treatment group by *gender*, *socioeconomic status*, and *ethnicity*. Data was gathered on *gender*, *socioeconomic status*, *ethnicity*, and CRCT-Math mean scores for the years 2009 and 2010. The data from the school district were stripped of any identifying information that could reveal students' identities. Using randomization would allow for a stronger research design (Ary et al., 2010); however, randomization was not possible because only data was analyzed. The CRCT-Math mean scores from 2008 to 2009 represent the previous achievement (covariate) and the CRCT-Math mean scores from 2009 to 2010 represent the post math achievement (dependent variable).

Definitions

Active Learning: being engaged in higher-order thinking activities that include "visual learning, writing in class, problem solving, computer-based instruction, cooperative learning, debates, drama, role playing, simulations, games, and peer teaching" (Bonwell & Eison, 1991, p.1).

Classworks®: the computer-based instructional software program that supplements the mathematical curriculum in the study. Classworks® is a unique type of CBI which incorporates active learning, adaptive learning research-based strategies, and pedagogical soundness. Assessment of students provides a foundation for individual instruction. Students can move at their own pace, level, and with various learning styles. The

program utilizes a four to five step process for every learning unit. Initially, students engage in a mini lesson that focuses on basic skills of precise concepts. The lesson draws from previous knowledge and scaffolds new information. Next, students take part in instructional activities. The activities are differentiated, interactive, use many perspectives, and employ various learning modalities. Then, students are assessed with a 10-question quiz that measures mastery of the unit. Students who demonstrate mastery move on to step five, and students who do not demonstrate mastery move to step four. Next, students participate in a remediation course that utilizes different strategies and methods. Finally, students demonstrate higher-order thinking in a real-world situation through a dynamic project (Curriculum Advantage Inc., 2011).

Bloom's Revised Taxonomy: learning objectives that are classified from simple or lower level to complex and higher level skills. Anderson and Krathwohl (2001) revised the taxonomy to represent two dimensions. The first is called knowledge (e.g., "factual, conceptual, procedural, and metacognitive;" Green & Emerson, 2010, p. 116) and the second is called cognitive (e.g., "remember, understand, apply, analyze, evaluate and create;" Nasstrom, 2009, p. 42). Therefore, the knowledge that is being learned is combined with the cognitive process for deep understanding and mastery.

Computer-based instruction (CBI): computer software programs that supplement traditional instruction through tutorials, assessments, guided practice, and simulations; also referred to as technology-based instruction, computer-assisted instruction, and computer-based learning.

Mathematics achievement: the Criterion-Referenced Competency Test (CRCT-Math) mean scores are the previous achievement and the post math achievement results used for

the purpose of this study. The traditional instruction and the supplemental Classworks®

program are based on the Georgia Performance Standards (GPS).

Social cognitive theory: Bandura's (1986) social-cognitive theory posits that students

need to believe that they can accomplish the tasks to be successful in learning. In other

words, students learn or are molded by the observation of others. This is a learning

theory that incorporates five basic concepts including observation, outcome expectations,

self-efficacy, goal setting, and self-regulation (Denler, Wolters, & Benzon, 2013).

Self-efficacy: the "beliefs in one's capabilities to organize and execute the course of

action required to manage prospective situations" (Bandura, 1995, p. 2). When it comes

to academic achievement, self-efficacy is an important indicator for success (Schweinle

& Mims, 2009).

Traditional instruction: direct implementation of skills, knowledge, and information by a

teacher to students; also referred to as direct instruction. The traditional instruction was

based on the Georgia Performance Standards (GPS).

CHAPTER TWO: LITERATURE REVIEW

The purpose of this study was to investigate the difference in seventh grade students' math achievement and self-efficacy when using traditional instruction and the supplemental Classworks® program compared to traditional instruction alone. Internet access and usage has risen to approximately 99% of school systems in America (NCES, 2006). Teachers and school systems are incorporating technology into the curriculum to assist in learning and achievement. The No Child Left Behind (NCLB) Act has influenced school systems to incorporate research-based instructional methods along with implemented technology (Billingsley et al., 2009). Present and future curricula are ready for technology, but incorporating research-based strategies to increase academic achievement is essential. Classworks®, a computer-based instructional program, has provided a means to raise math achievement by utilizing a research-based design, and promotes self-efficacy and pedagogical soundness (Curriculum Advantage Inc., 2009). In addition, the Classworks® program incorporates the Bloom's Revised Taxonomy for higher levels of thinking. The combination of the theoretical framework and research-based design has created an environment for the academic and future success of productive citizens.

Theoretical Framework

Bloom's Taxonomy

When students become adults, they need more than knowledge of facts; they need an understanding of problem solving and critical and analytical thinking skills. Bloom's taxonomy addresses these issues. Bloom's (1958) taxonomy has been a significant matrix for establishing objectives that are progressively complex. The lower-order skills

of knowledge and comprehension are typically dominant in education. The higher-order skills (e.g., analysis, creation, and evaluation) need to be substantially increased for improved well-rounded and skilled learners. Classworks® utilizes the Revised Bloom's Taxonomy for learning. Anderson and Krathwohl (2001) modified the original by creating two dimensions called knowledge (e.g., "factual, conceptual, procedural, and metacognitive") (Green & Emerson, 2010, p. 116) and cognitive (e.g., "remember, understand, apply, analyze, evaluate and create") (Nasstrom, 2009, p. 42). This theory has provided for learning that is more authentic and instills long-term knowledge.

Students need to do more than listen; they need to be active learners. Active learning is a taxonomy that focuses on a student-centered methodology. Bonwell and Eison (1991) developed this approach to enhance student learning and achievement. Active learning is being engaged in higher-order thinking activities that include "visual learning, writing in class, problem solving, computer-based instruction, cooperative learning, debates, drama, role playing, simulations, games, and peer teaching" (Bonwell & Eison, 1991, p.1). Many research studies have revealed the effectiveness of active learning to be deep and lasting (Graffam, 2007; Kapur, 2010; Prince, 2004; Yoder & Hochevar, 2005). Prince (2004) stated, "There is broad but uneven support for the core elements of active, collaborative, cooperative and problem-based learning" in the discipline of engineering. Active learning, along with Bloom's taxonomy, has the potential to increase the knowledge and cognitive ability that is provided in the Classworks® program.

Social Cognitive Theory

Students need more than ability to succeed in academics or the workforce. Bandura's (1986) social-cognitive theory posited that students need to believe that they can accomplish the tasks to be successful in learning. This is a learning theory that incorporates five basic concepts, including observation, outcome expectations, self-efficacy, goal setting, and self-regulation (Denler, Wolters, & Benzon, 2013). Social cognitive theory has been applied to various environments, including media, marketing, health, and education. Education has focused on student motivation, learning concepts, and academic achievement (Schunk & Zimmerman, 1994; Schunk & Zimmerman, 1998).

Social cognitive theory is not based on biological differences, but rather society forces of socialization (Kim, 2010; Bembenutty, 2010; Williams & Takaku, 2011). Society molds individuals into the behaviors and interests it thrusts upon them. Gender, ethnicity, and socioeconomic status are three categories that are greatly influenced by societal forces. Gender reveals significant differences in the realms of science, technology, engineering, and math (STEM). The fields of STEM are dominated by males and are attributed to perceived stereotypes (Hong, Hwang, Wong, Lin, & Yau, 2012; Winston, Estrada, Howard, Davis, & Zalapa, 2010). Males are encouraged more to pursue STEM disciplines and are rewarded and praised for their successes (Kim, 2010; Soldner, Kenyon, Inkelas, Garvey, & Robbins, 2012). Bandura (1997) stated that boys are socialized to exhibit control, exploration, objectivity, autonomy, and independence, while girls are more emotional, sensitive, collaborative, verbal, and dependent. Females have lower self-efficacy when it comes to using technology and utilizing computers. Both males and females demonstrate equal results on standardized tests; nevertheless,

females feel unprepared for advanced studies in STEM (DiBenedetto & Bembenutty, 2013). Consequently, educators must incorporate strategies, curricula, and pedagogy that stimulate achievement for both males and females in the STEM disciplines for academic success.

Ethnicity holds several social influences, perceived or actual, that persuade races to excel or surrender self-efficacy. Asians tend to have the lowest dropout rates and the most STEM participants. Caucasians rank second, while African-Americans, Latinos, and Native Americans rank at the bottom of the scale (Winston et al., 2010). Many influences to self-efficacy among ethnicity depend on family norms, cultural leanings, discrimination, racism, parent education and social class (Winston et al., 2010; Westerwick, Appiah, and Alter, 2008). There is a very disturbing statistic among African-American and Hispanic high school students. Both are underrepresented in Advanced Placement (AP) courses (Chambers, 2009; Taliaferro & DeCuir-Gunby, 2008). This is a problem that needs to be addressed and steps need to be taken to bring African-Americans and Hispanics to higher achievement. Discrimination has created a stigma of low performance among minorities in the past and present, but the support of peers, parents, and teachers is necessary in order to elevate achievement (Taliaferro & DeCuir-Gunby, 2008). Raising minority self-efficacy may close the gap.

Socioeconomic status has an obvious influence on student success in academics (Boardman & Robert, 2000). Boxer, Goldstein, DeLorenzo, Savoy, and Mercado (2011) stated, "Economically disadvantaged children are perceptive to barriers they face in order to succeed at the same level as children from non-disadvantaged communities, and thus might be disengaged from education and less likely to pursue higher education" (p. 610).

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Social makeup and parental perception makes an impact on students' outcome. Low SES communities present a milieu of hopelessness and struggle, and many parents focus on the daily grind of "getting by" and would be happy with their children having the high school diploma that they do not. There is the reality of the high costs of higher education and the lack of resources and mentors to guide students in the right direction (Boxer et al., 2010). Conversely, high SES communities and families provide the perfect milieu for student success (Boardman & Robert, 2000). Communities have the resources for exposing students to culture, sports, activities, and safety, among countless other benefits. Many parents have the education and background to guide and mentor their children for academic and adult success. The self-efficacy of high SES students is elevated and propels students' academic achievement and success (Boardman & Robert 2000).

Self-efficacy. Self-efficacy is the belief in one's own ability to finish responsibilities and achieve goals. Bandura (1995) defined self-efficacy as the "beliefs in one's capabilities to organize and execute the course of action required to manage prospective situations" (p. 2). Regarding academic achievement, self-efficacy is an important indicator for success (Schweinle & Mims, 2009). Even considering technological advances and evidence of academic success in education, self-efficacy is a major factor and forecaster of academic achievement (Schweinle & Mims, 2009; Wigfield & Eccles, 2000). A student's confidence in the ability to reach academic goals is more important than the authentic ability itself (Steese, Dollette, Phillips, Hossfeld, Matthews, & Taormina, 2006; Pintrich, & Schunk, 1996). This confidence drives students to success. Students with elevated self-efficacy in mathematics have a better inclination to higher achievement in math (Borman & Overman, 2004; Ross, Sibbald, &

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Bruce, 2009; Ryan, Ryan, Arbuthnot, & Samuels, 2007; Stevens, Olivarez, & Tallent-Runnels, 2004). In addition, the effectiveness is increased because of the specific problems and situations mathematics brings (Isiksal & Askar, 2005). Isiksal and Askar (2005) discussed how "computer self-efficacy is positively related to willingness to choose and participate in computer activities, expectation of success, persistence when faced with computer-related difficulties, and computer-related performance" (p. 336). Therefore, self-efficacy is vitally important to understand in the environment of math and computer-based instruction. In addition, understanding the level of self-efficacy by gender, ethnicity, and socioeconomic status will help academics to focus on strategies and pedagogy that will boost achievement.

Cost of Technology

The world is becoming more technologically advanced and providing more opportunities for developing countries to incorporate technology in education. The United Nations (2013) under the Millennium Development Goals and Education for All encouraged educational resources to be freely available to citizens. Mobile communication has opened up educational resources to less developed regions; 2.7 billion people or 39% of the world's population have Internet access (United Nations, 2013). Developing countries have the ability to circumvent hardwired infrastructure at a lower cost (Ally & Samaka, 2013). In fact, there are approximately 5.3 billion subscriptions for cellular service around the world (Ally & Samaka, 2013).

In America, there are established infrastructures and new wireless communications. Ireh (2010) researched the technology costs for education, and suggested addressing professional development, software, replacement costs,

connectivity, and retrofitting. Professional development is vital for teachers, administrators, and staff to adequately incorporate technology in the classrooms. Software is important for basic programs and integrated programs to infuse standards and assessments. Replacement costs are suggested every three to five years for upgrading infrastructure and new technology. Connectivity costs are a balance of speed and availability. Retrofitting costs require planning and forethought. Ireh (2010) warned, "To sustain these operating expenditures, the school district must be able to generate large amounts of new revenue on a continuing basis" (p. 20).

The U. S. Census Bureau (2013), in the *Public Education Finances: 2011,* provided the costs for education in elementary and secondary school systems. The average expenditure per pupil in the United States was $10,000, while the average expenditure per pupil in Georgia was $9,253 including federal, state, and local revenue. The cost has risen 111% since 1992, but achievement has not risen accordingly. In comparison, the cost of living increased 54.4% over the same time period (Department of Labor, 2013). The Thomas B. Fordham Institute (2012) conducted a study comparing the costs between virtual schools and blended schools. Virtual schools are schools that instruct students 100% over the Internet. Blended schools are schools that offer both in-person and Internet instruction. Blended schools cost an average of $8,900 per year compared to virtual schools, which cost an average of $6,400 annually (NEPC, 2012). Blended schools had an 11% lower cost than traditional schools, and virtual schools had a 36% lower cost than traditional schools. The greatest costs are labor. Blended and virtual schools are able to reduce labor costs dramatically and increase technology and content expenditures, while still reducing overall costs (NEPC, 2012).

Traditional Instruction

Traditional instruction focuses on teacher-centered methods that are also recognized as direct instruction. Teachers who use traditional instruction methods tend to use lectures, drill and practice, question and response, presentation of materials, and modeling. Ryder, Burton, and Silberg (2006) affirmed:

> Direct instruction approaches can be tied to three basic principles: (a) language is broken down into components that are taught in isolation, not in a meaningful context; (b) learning is highly teacher directed; and (c) students have little input into what is to be learned. (p. 180)

Research has found inconclusive results on using traditional instruction; nevertheless, direct instruction has provided useful strategies for basic skills (Slavin, 2008). Presently, many teachers use traditional instruction and neglect the more advanced methods that address the higher level thinking methods described in the taxonomies. Arslan (2010) studied procedural and conceptual learning. Procedural learning is memorizing operations while conceptual learning makes connections and relationships to concepts. The results showed that students that understood learning conceptually were able to understand procedurally; nevertheless, procedural knowledge does not influence conceptual knowledge. This study revealed that higher-level learning could enhance basic skills. For instance, students with an understanding of the concept of measuring concrete to fill a foundation should have a solid understanding of the procedure of calculating volume. On the other hand, students with the understanding of calculating volume (procedural knowledge) may not have the skill to measure concrete to fill a foundation (conceptual knowledge).

Ryder, Burton, and Silberg (2006) conducted a study on direct instruction for reading on students in grades one through three. This was a three-year study of urban and suburban students. The results showed several findings. First-grade students who were taught using direct instruction were significantly lower in reading achievement. Suburban students had a statistically significant increase in reading with both direct and non-direct instruction. Urban students had a statistically significant increase in reading without direct instruction. Nevertheless, the body of evidences presented in this study showed that there is no statistically significant advantage between methods. Although direct instruction can have immediate evidence of effectiveness, long-term results fail to show a lasting impact (Kuhn, 2007).

Computer-based Instruction

Twenty years ago, computer-based instruction (CBI) focused on drill and practice, movies, tutoring, testing, and fun activities (Kulik & Kulik, 1991). These methods did not provide meaningful learning or achievement for students. Many of the instructional programs lacked research to substantiate their claims. Presently, 99% of school systems have access to the Internet, while only 23% utilize computers for evaluations and assessments on a weekly basis (Stetter & Hughes, 2010). Technology is not being utilized properly for academics; consequently, students are missing out on innovation. Computer-based instruction has flourished in recent years and has become more sophisticated. In the milieu of the 21st century digital age, current technologies have the potential to prepare students with the competencies for success, including "problem solving, critical thinking, creativity, self-learning strategies, meta-cognition, reflective

thinking, social discussion skills, team work, and personal skills, such as persistence, curiosity and initiative" (Eyal, 2012, p. 40).

Tamim, Bernard, Borokhovski, Abrami, and Schmid (2011) conducted a second-order meta-analysis for the influence of technology on learning over the past 40 years. The study analyzed 25 meta-analyses covering 1,055 studies. The focus was on classrooms that used computer technology in a formal setting compared to classrooms that did not use computer technology in a formal setting. The results showed that there was a significant difference, small to moderate, with technology use compared to traditional instruction alone. In addition, supplemental technology with traditional instruction had a higher effect size over computer technology as direct instruction. This study supported present research that revealed that supplemental technology enhances achievement more than technology as the main delivery system for learning (Larwin & Larwin, 2011; Sosa, Berger, Saw, & Mary, 2011).

The U.S. Department of Education (2010) conducted a meta-analysis of online learning practices. Online learning is becoming more readily available to students throughout the 50 states. Picciano and Seaman (2009) estimated that approximately over one million students in K-12 participate in online courses (2007-2008). Many students are taking individual courses online and attending traditional brick-and-mortar schools, while other students are participating full-time in online schools. The U.S. Department of Education (2010) study compared 50 contrasts of online and face-to-face learning classes. They concluded that online learning had a positive effect over face-to-face learning. Complete online learning was the same as face-to-face learning, while blended (online and face-to-face) had a strong positive outcome over face-to-face alone. The U.S.

Department of Education (2008) made several recommendations for evaluating online learning, including a clear vision, appropriate methods, sufficient budgets, and creating a culture of evaluations, communication, and time and money for communication.

There were several meta-analyses on the effects of computer technology that showed positive results. The National Council of Teachers of Mathematics (NCTM, 2012) is a global leader in mathematics education. NCTM encourages the use of technology for communication, problem solving, sense making and math reasoning. Li and Ma (2010) studied the effects of computer technology for grades K-12 in mathematics learning. There were 85 effect sizes—46 primary studies used that involved 36,793 participants. Computer technology was the software used in education, and math achievement referred to the standardized tests or instructor made assessments. The results illustrated a statistically significant effect in computer technology on math achievement, including special education. Gender had no effect on achievement, but elementary students exhibited greater effects than secondary students did. In addition, the type of methods used, constructivist or pedagogical, had larger effects than traditional methods. Lee, Waxman, Wu, Michko, and Lin (2013) administered a meta-analysis on the effect of specific teaching and learning on various technologies. There were 58 studies and 366 effect sizes from grades K-12. The results showed a positive effect for teaching and learning with various technologies. Both studies concluded that focus on constructivist strategies and pedagogical soundness in technology may have raised the effect sizes in recent years (Li & Ma, 2010; Wu, Michko, & Lin, 2013).

D'Mello (2013) conducted a meta-analysis on emotional effects of learning with technology. There were 24 studies that included 1,740 elementary to college-aged

participants from five different countries. The results revealed several affective states including "engagement/flow, boredom, confusion, curiosity, happiness, and frustration" (D'Mello, 2010, p.1093). Engagement was the highest response, but there were negative responses as well, including boredom and confusion. Suggestions were made for future learning technologies, which include incorporating dynamic adaptive learning for individual students.

Mathematical statistics were studied to better understand the effectiveness of computer-assisted instruction (CAI). Larwin and Larwin (2011) conducted a meta-analysis on computer-assisted statistics instruction for postsecondary education. The study evaluated 70 studies, with 219 effect sizes, for 40,125 participants, over a 40-year period. The results communicated a moderate effectiveness of computer-assisted instruction for statistics achievement in postsecondary education. The participant scores rose 23 percentile points from 50th to 73rd. There were greater results for CAI when used for drill-and-practice ($d = 0.849$) and in face-to-face course settings ($d = 0.706$), while exclusive online CAI resulted in an effect size that was negative ($d = -0.035$) and no impact for CAI only instruction ($d = 0.06$). Sosa, Berger, Saw, and Mary (2011) conducted a similar meta-analysis on the effectiveness of computer-assisted statistics instruction for college students. CAI with or without lectures instruction was compared to lectures only instruction. The study evaluated 45 experimental studies with an average effect size of $d = 0.33$. The results provided a modest benefit of statistics learning with CAI over lectures alone. Greater benefit was shown for students who receive more CAI instructional time over lectures only. On the other hand, CAI only students did not benefit more from instruction than students who used CAI as a supplement with lectures.

Both of these studies showed modest to moderate effectiveness with CAI, no effectiveness with CAI only, and better effectiveness using CAI as a supplement to face-to-face instruction.

Several studies have shown that the effect sizes for computer-assisted instruction have steadily risen over the last few decades and concluded that better integration of instructional methods and pedagogy may have influenced growth (Bernard et al. 2009; Cobb, 2007; Larwin & Larwin, 2011; Li & Ma, 2010; Wu et al., 2013). Larwin and Larwin (2011) stated:

> That CAI did not reveal any significant impact on student achievement until the 1980s ($d = 0.386$). Since the 1980s, the level of impact has consistently increased in the research across the 1990s ($d = 0.420$) and 2000s ($d = 0.761$), with the greatest gains in impact found between 1990 and 2000. (p. 268)

Distance education has grown into a recognized alternative to face-to-face instruction. K-12 education has increased distance education by 65% for the 2002-03 and 2004-05 school years, and has approximately one million students enrolled online for the 2007-08 school year (U.S. Department of Education, 2010). Bernard et al. (2009) conducted a meta-analysis on distance education for college students utilizing three interactive treatments including *student/student*, *student/teacher*, and *student/content*. The research evaluated 74 studies, 74 effect sizes, and 44 attitude outcomes. Sixty-eight percent of the studies were from 2000 to 2006. The results showed that the most interactive treatments made a significantly moderate benefit over the least interactive treatments. All three interactive treatments made a difference, but *student/student* and *student/content* had a more positive impact than *student/teacher*. In addition, the

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researchers looked at the synchronous, asynchronous, and mixed distance learning, and found that all three were comparable for achievement.

Borokhovski, Tamim, Bernard, Abrami, and Sokolovskaya (2012) revisited and built upon the study of Bernard et al. (2009). The study focused on one of the three interactive treatments (*student/student*). This study separated the *student/student* interactive treatment into *contextual* and *designed*. The research evaluated 32 studies, 36 effect sizes, and 3,634 participants. Contextual interactions were *student/student* interactions that were not encouraged but available. Designed interactions were *student/student* interactions that were intentional. The results revealed that designed interaction impacted achievement more than contextual interaction.

Kulik (1994) conducted a meta-analysis on the results of computer-based instruction. The study analyzed approximately 12 meta-analyses and concluded that computer-based instruction was a positive resource. The results showed that students whose classrooms used computer-based instruction (CBI) learned more, learned quicker, were more motivated, and had a positive attitude. The negative results showed that CBI is not effective in all subjects and environments. The evaluation of these programs focused on methods, broad conclusions, and effectiveness. The study utilized Slavin's (1990) three levels of instructional precision. Level I uses a variety of methods (e.g., whole-language) that have no conceptual foundation. Level II uses more conceptually founded methods, including "cooperative learning, direct instruction, mastery learning, and individualized instruction" (p. 18). Level III uses specific techniques and procedures. The results showed that Level I was positive but unpredictable, Level II was mixed but showed good results for tutoring, and Level III was most positive, but there

were few programs that were highly qualified. The Stanford CCC program was the only

program that had sufficient studies to conclude high effectiveness. Today, there are

many more Level III programs, but there are still few high quality studies to conclude

effectiveness (Slavin, 2008). Kulik (1994) discussed a potential problem to consider in

regards to evaluating the effectiveness of CBI:

> It may be that evaluator-design measures are unconsciously biased toward the
>
> experimental treatments, or it may be that standardized tests are too global to use
>
> to evaluate specific curricula. Whatever the case, it seems unfair to compare
>
> effects from different areas when evaluation studies in some areas rely heavily on
>
> local tests and evaluation studies in other areas rely largely on standardized tests.
>
> (pp. 24, 26)

The majority of CBI studies rely on standardized testing to measure achievement. This

type of testing is conducted about once a year on information that may or may not have

been taught by the teacher. Consequently, standardized testing may be *too global* a test

to measure effectiveness.

In the transformation toward online instruction and ubiquitous technology, there

exists a flurry of educators, administrators, and institutions seeking proven methods and

strategies. Mayes, Lueback, Akarasriworn, and Korkmaz (2011) investigated a review of

literature on themes and strategies in online instruction. The themes and strategies

consisted of six areas of investigation, including learning and instruction, medium,

community and discourse, pedagogy, assessment, and content. Learners and instructors

have provided a milieu of flexibility and convenience. Online learning has created an

environment that personalizes the instruction and learning, while being adaptable to

individual needs (e.g., pace, time, place). To be successful with online learning, students must be self-learners, self-motivated, critical thinkers, and problem solvers (Beal, Qu, & Lee, 2008). The instructors of online learning establish a position that acts as facilitators, specialists, and collaborators.

The medium used in online instruction is vast and evolving (e.g., discussion boards, emails, blogs, applets, wikis, databases, video and audio conferencing, etc.). There are several recommendations for online instruction, including establishing a home course site for learning, incorporating audio and video media, developing norms and rules for interaction, and integrating various forms of technology. Community and discourse is important to address, which may bring a sense of isolation and lack of interaction. Instructors can address questions and concerns immediately, and encourage interaction between learners and instructors. Pedagogy is very important in online instruction. Specifically, courses should incorporate constructivist methods, interpersonal interactions, student-centered settings, and problem-based learning (Rourke & Coleman, 2010; Winters et al., 2008). Assessments are essential for progress and feedback for online learning. Researchers propose several forms of assessments, including formative assessments with immediate feedback, summative assessments that are performance-based, and specifically designed rubrics. Content can be challenging for educators to convey and hamper the understanding of certain concepts. Educators should consider incorporating student-centered approaches, communication tools, technology and resources, feedback and details, and attentiveness to concepts within their instruction.

Cook (2009) reiterated the point that concepts and strategies are more important now than comparing old methods with new technology. Mayes et al. (2011) imparted

many themes and strategies to advance online learning, while Cook (2009) encouraged research comparing new concepts. Cook's study illustrated the point when it compared horse drawn carriages to automobiles. Both are useful and serve a purpose, but eventually the new technology of automobiles must compete amongst itself to prove which vehicles are the best to use. Researchers need to transition from the question of 'if' technology should be used, to 'when' to incorporate technology and 'how' to utilize it successfully. Cook (2009) stated, "We must pursue research in the basic sciences that will inform the development of the new technology, and then perform field tests that assess performance in practice" (p. 161).

Johnson and Rubin (2011) conducted a literature review on computer-based instruction and found several compelling results. Many of the studies (64.3%) showed significant gains in interactive CBI compared to 31% of the studies that showed no significant gains. Only 4.8% of the studies regarding traditional instruction were significantly better than CBI. Therefore, "interactive CBI was found to be at least as good as, if not better, than instructional alternatives 95.2% of the time" (p. 64). Stetter and Hughes (2010) conducted a review of literature on computer-based instruction and focused on reading comprehension. The participants in the different studies struggled with reading or were students with disabilities. Close to 90% of the participants had difficulty with literacy, including reading, expressing ideas in text, and comprehension. The results were inconclusive. Some studies showed favorable results while other studies showed less positive results.

Moos and Azevedo (2009) conducted a review of the literature on computer self-efficacy. The literature indicated that positive self-efficacy instilled an independent

attitude in students that propelled them to take control of their learning. The researchers examined 33 articles that matched this criteria. The articles were separated into experimental and non-experimental studies. The non-experimental studies revealed that self-efficacy had a significant relationship among behavioral and psychological factors. The outcomes showed that the older the students were, the more stable their attitudes. The degree of positive and negative attitudes reflected computer self-efficacy. The experimental studies discovered that the quality of the computer experience was more powerful than the quantity for improved computer self-efficacy. In addition, self-efficacy was greater for students who received behavioral modeling and self-evaluations than those who did not. All three reviews of the literature supported the continued advancement and integration of computer-based instruction programs. Technology clearly plays a significant role in education and the advancement of academics.

Traditional Instruction Supplemented with Computer-Based Instruction

Computer-based instruction has become more prevalent in recent years to supplement learning and influence educational practices (Chang, 2008). Programs were designed to assist in mathematics, science, history, language arts, music, and social studies. Slavin and Lake (2008) conducted a meta-analysis on effective math programs for elementary schools. They studied three aspects of instruction, including *computer-assisted instruction* (software programs), *instructional process strategies* (e.g., direct instruction, cooperative learning, mastery learning, etc.), and *mathematics curricula* (e.g., textbooks, professional development). Eighty-seven studies were analyzed and provided significant results. Math curriculum provided the lowest effectiveness and computer-based instruction was the second highest in effectiveness. Unfortunately, these two

categories do not have many high quality studies to compare. The instructional process programs had the highest effectiveness and showed a better environment between teachers and students. Interestingly, Classworks® was the highest rated CBI program and was moderately effective. Overall, "a number of studies showed substantial positive effects of using CAI [Computer-Assisted Instruction] strategies, especially for computation, across many types of programs" (Slavin & Lake, 2008, p. 481).

Limited research has been carried out on mathematics while utilizing computer-based instruction. The studies range in students' age and academic level. Hannafin and Foshay (2008) conducted a case study on 187 high school students who were using Plato Learning Systems (a computer-based instruction program) for mathematics instruction. The program focuses on mastery learning. The results were significant, illustrating those students who participated went from a 62% passing rate before the program to an 84% passing rate after the program. The school surpassed the state passing rate of 75% by 9%. One high school student who participated in the PLATO® program in New Brunswick was Keith Russell. He was a struggling student who turned his academics around with the program and was motivated to fulfill his requirements and graduate school on time (Becoming a Winner, 1996).

Two studies from Taiwan researched computer technology. Yang and Tsai (2010) conducted a study of 64 sixth-grade students in mathematics. The study focused on number sense and attitudes in a technology-based environment. There were no statistically significant differences between the experimental and control groups on the pretest and pre-survey; however, the results showed that the experimental group had a statistically significant increase in number sense ability and positive attitudes concerning

the ability to learn math. Chang (2008) conducted a large study involving 1,539 students and their computer literacy and attitudes. The results showed that students, who were competent in computer literacy, used technology at home for learning. In addition, females were more computer literate than males and showed differences in behavior and attitude.   Gender stereotypes (boys better than girls) regarding the use of computers were contradictory, which demonstrated a need for further investigation on the subject.

Some studies did not show statistical significance favoring computer-based instruction. Tienken and Maher (2008) studied 284 eighth-grade students who used computer-based instruction for drill and practice in math computation. The experimental participants did no better than the control group, and in some cases, did significantly worse. The researchers suggested that the software program should have focused on higher-order thinking skills. In addition, school systems should investigate software programs for effectiveness before implementation. The fact that this was a drill and practice program may have been the downfall of the instruction. Drill and practice software limit decision-making, decrease initiative, and create disinterested learners (Johnson & Christie, 2009).

Word-problem solving is a difficult concept to instill in students, which is important for problem solving in mathematics (Leh & Jitendra, 2012). Schoppek and Tulis (2010) administered a study for word-problem solving skills using computer-assisted technology that was individualized.   An adaptive learning system called Merlin's Math Mill (MMM) was used to enhance individualized learning. Merlin is an animated character that provides feedback throughout the program. There were 113 third grade students from four classes that used the MMM program for one hour a week for

seven weeks. The control group used traditional instruction alone and the experimental group used traditional instruction and the MMM supplemental program. The results showed that the experimental groups raised achievement over the control groups. Both low and high performing participants made significant gains. The researchers believed that the adaptive nature of the computer-assisted software attributed to the success.

Leh and Jitendra (2012) conducted a study on word-problem solving skills comparing computer-mediated instruction (CMI) and teacher-mediated instruction (TMI). CMI is similar to computer-assisted instruction (CAI) in that both use computers for instruction. CMI is different from CAI in that CMI uses teachers to operate and facilitate the software and instruction, while CAI relies on the software program alone and supplements the teacher's instructing. There were 25 third grade students in the study. The software used for CMI was the Go Solve Word Problems program and the software used for TMI was Solving Math Word Problems. The results showed that there was no statistically significant difference between CMI and TMI. The researchers concluded that both CMI and TMI were beneficial to instruction and complimented teacher instruction for enhancing student achievement.

A unique study by Wang and Woodworth (2011) compared two different supplemental computer-based instructional programs. The math programs used were DreamBox and Reasoning Mind and the study was conducted at an elementary charter network of three schools. The students were from low socioeconomic status and from minority families. There were 1,255 participants from kindergarten through fifth grade, with kindergarten and first grade using DreamBox and second through fifth grade using Reasoning Mind. Both programs are considered adaptive learning programs. All

participants learned traditional instruction from their teachers and supplemented the software program at varying amounts (K, 1 = 90 minutes per week; 2, 3 = 180 minutes per week; 4, 5 = 450 minutes per week). The control group used an online math literacy program for the same amount of time. The results showed no statistically significant difference between the control and experimental groups. However, DreamBox did show a positive impact on achievement. The researchers concluded that four months was too short of a time to provide adequate analysis.

Comparison of Computer-based Testing and Paper-Pencil Testing

Assessing student achievement is moving in the direction of computer-based testing, which provides efficiency and data analysis. The mandates of accountability have driven administrators to seek better facilitation of information. Wang, Jiao, Young, Brooks, and Olsen (2007) conducted a meta-analysis of computer-based versus paper-pencil testing in mathematics. When transferring paper-pencil tests to computers, many factors should be considered, including font size, page quantity, resolution, the review and revise of information, and the use of graphic media. In general, students who take tests have more positive attitudes towards computer-based tests than paper-pencil tests. Over 300 studies were scrutinized within the past 25 years. The results showed that there was no statistically significant difference between computer and paper tests. Threlfall, Pool, Homer, and Swinnerton (2007) conducted a case study on paper-pencil and computer-based tests. They discovered that both methods have positives and negatives, but no significant advantages. Therefore, addressing the essential objectives of the assessments is more beneficial than the instruments (paper, computer) that record the results. Knowing what to assess with clarity is most important.

Adaptive Learning

Many of today's computer-based instructional programs are incorporating adaptive learning strategies. Project Tomorrow (2012) defined *intelligent adaptive learning* as:

> a new class of education technology that captures every decision a student makes and adjusts the student's learning path both within lessons and between lessons, thereby providing millions of individualized learning paths, each tailored to a student's unique needs in real time. (p. 3)

Computer programs are personalizing software by adjusting learning to take into consideration backgrounds, goals, preferences, interests, learning styles, learning performances, prior knowledge, academic level, learning pace, gender, and modalities (Walkington, 2013; Pushpa, 2012; Cheng, Chen, Wei, & Chen; Arroyo, Burleson, Tai, Muldner, & Woolf, 2013). The benefits of adaptive learning with computers include increased efficiency, less resources used, less materials shipped or handled, and better test security (Stone & Davey, 2011). In addition, students are challenged according to their ability, which challenges high achieving students and lessens discouragement for low achieving students. The U.S. Department of Education awarded funding to the SMARTER Balanced Assessment Consortium (ODOE, 2011) to develop a computer-based adaptive testing system. The testing system will incorporate the Common Core State Standards (CCSS) and provide assessment data. The Classworks® program uses adaptive learning by adjusting curriculum based on students' standardized tests and baseline data, learning performances, academic level, and learning pace (Curriculum

Advantage Inc., 2005). This provides students with individualized learning programs that motivate them to higher achievement.

Project Tomorrow (2012) is a non-profit national educational organization that focuses on technology and digital learning in education. Project Tomorrow conducted a national survey of students, parents, teachers, administrators, and stakeholders that addressed intelligent adaptive learning. Positive support for technology exists that personalizes instruction and raises student achievement. Administrators ranked the benefits of intelligent adaptive learning and stated that individual students need "just right" instruction as the number one benefit. Administrators believe that *intelligent adaptive learning* is the number one reason for improvement on student achievement. Parents are encouraged and feel adaptive learning will be a solution to large classes and individualized learning. Teachers who use the system with their students find that students are more engaged and motivated. Students are more collaborative and teachers like the assessment data gathered for revealing student proficiency. Administrators are interested in future educators to have the skills to implement intelligent adaptive learning strategies.

Shih, Kuo, and Liu (2011) conducted research on an adaptive learning system called "adaptive U-learning path system." There were 118 fifth grade students who utilized mobile devices to learn math in Taiwan. The results showed a statistically significant difference in the dimensions of *consciousness*, *transformation*, and *problem-solving* for the adaptive learning students compared to the students who used paper-and-pencil activities. Walkington (2013) conducted a study on adaptive learning for secondary mathematics. There were 145 ninth grade students in Algebra I who utilized

an adaptive tutoring system. The focus was on student interests. The results showed a statistically significant difference in performance, time, and accuracy for the experimental group compared to the students who did not have personalized algebra problems. Arroyo, Burleson, Tai, Muldner, and Woolf (2013) conducted research on adaptive learning technologies in mathematics, which focused on gender. There were four study groups who utilized the Wayang Outpost program. The groups were from various grades and were analyzed over a 10-year period. The results showed a statistically significance difference when students used learning companions compared to students who did not use the companions.

<div align="center">**Classworks®**</div>

This study focuses on the implementation of a computer-based instructional program that helps raise math achievement. Classworks® is a CBI software program that motivates and engages students in learning. The subjects (e.g., math, English, science, language arts, and reading) are matched with national, state, and local standards for assessments (Millikin, 2008). Students receive a personalized learning course according to their assessment scores. Students can learn at their own academic level and learning pace. In turn, the program accommodates various learning styles and incorporates audio, video, text, and media information. Classworks® provides scaffolding in the curriculum and employs the Bloom's Revised Taxonomy.

A typical unit starts with a mini lesson that focuses on specific concepts of basic skills, while recalling and retrieving previously learned knowledge. Then, students participate in instructional activities that are interactive, differentiated, multi-perspective, and incorporate various learning styles. Next, students take a 10-question quiz to assess

learning. If the students master the curriculum, they will move on, while those who

struggle will take a remediation course with different strategies. Finally, students move

on to a project that incorporates higher-order thinking skills (e.g., evaluation, synthesis)

in a real-world situation (Curriculum Advantage Inc., 2011).

There are a limited numbers of studies that demonstrate significant effectiveness

for the Classworks® program. Millikin (2008) conducted an independent study of the

Classworks® program and concluded that the program made a connection between

instruction and intervention. Classworks® provided a Response to Intervention (RtI) that

upholds an alternative process for meeting students' needs. Rather than wait for students

to fail assessments or receive diagnoses, students can receive monitoring as soon as they

start to fall behind. The intervention consists of a three or four-tier system. The first

level is preventive and proactive for 80% of students, the second level focuses on

problem solving for 15% of students, and the third level is an intensive intervention for

five percent of students. Buford Middle School implemented the RtI and has seen a

positive learning environment for the students. Turner (2010) investigated and

implemented the Classworks® program into Saturday and after-school programs and had

tremendous results. Students made increases in attendance, math and English scores,

self-efficacy, graduation rates, accountability status, and Adequate Yearly Progress (that

schools are required to measure by the NCLB Act), and dropout rates were reduced.

McCrea (2009) conducted a study on 144 students at four alternative academies in grades

six through 12. The students used the Classworks® program two to three sessions a

week. There were significant gains on the Measures of Academic Progress (MAP): (a)

reading scores increased 69% for the PRIDE Academy, (b) math scores increased 62%

for the PRIDE Academy, (c) reading scores increased 62% for the TEAM Academy, and (d) math scores increased 38% for the TEAM Academy. Slavin and Lake (2008) conducted a meta-analysis on effective programs for mathematics. Classworks® was studied and scored the highest among computer-based instructional programs, and it was the only CBI program ranked as *moderate evidence of effectiveness*. The highest level (*strong effectiveness*) was comprised of the instructional process strategies (e.g., cooperative learning, direct instruction, mastery learning, etc.). Classworks® ranked higher than all mathematics curricula (e.g., textbooks, professional development) and all other CBI programs. All of the other computer-based instructional programs fell into the category of *limited evidence of effectiveness* (i.e., Accelerated Math, Project CHILD, Lightspan) and 24 programs fell into the *no qualifying* category, including Academy of Math, PLATO®, and SuccessMaker. Unfortunately, there were few high quality studies for analysis that included effect size. Overall, Slavin and Lake (2008) saw "substantial positive effects of using CAI strategies, especially for computation" (p. 481).

Classworks® and Motivation

Motivation is a key aspect of computer-based instruction and propels students to focus, enjoy the school environment, increase achievement, graduate, and seek a college education (Bodovski & Farkas, 2007). Beal, Qu, and Lee (2008) conducted research on motivation in mathematics among 90 high school students. The students used the problem solving Wayang Outpost system, which is an Internet-based tutoring format for geometry. The teachers evaluated the students' math performance as high, average, or low. The students filled out a mathematics motivation questionnaire, including questions that measured self-efficacy, perception, and expected achievement. High and low

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achieving students scored higher than average achieving students when seeking help. Inappropriate guessing scores showed no differences; nevertheless, self-concept was a factor in inappropriate guessing. The researchers suggested that students with low self-concept should receive intervention to boost achievement and give them support. Classworks® helps motivate students by providing various study strategies and methods. A superintendent that implemented the Classworks® program stated, "It can be tough to get students' attention these days—we have to compete with the media—but Classworks® does a great job of engaging them" (Curriculum Advantage Inc., 2005).

Classworks® and Learning Styles

Learning styles are incorporated into the Classworks® program; it provides varying methods to learn information through auditory, visual, and kinesthetic learning. Wang, Wang, Wang, and Huang (2006) conducted a study on 455 junior high students in regards to learning styles and assessments in a web-based environment. The researchers suggested that individualized learning increases achievement. The results showed that students' achievement was affected by learning styles and assessment methods; nevertheless, learning styles and assessment methods did not have any significant interaction. Furner, Yahya, and Duffy (2005) provided 20 strategies to influence students in mathematics, and one of the strategies was to incorporate learning styles to motivate and focus students. The researchers suggested that teachers present specific activities for transitions. In addition, technology can be an effective means to meeting the different learning styles. Once learning styles are integrated, teachers must challenge students to complete difficult tasks (McAllister & Plourde, 2008). Tasks that are too easy will discourage bright students when challenges become hard in the future, while tasks that

are too difficult will create frustration and cause students to give up before completing their tasks.

Conclusion

Technology is an extremely powerful tool and resource for enhancing curriculum and raising student achievement. Traditional instruction fosters limited learning while taxonomies like Bloom's Revised Taxonomy have brought the focus to higher-order thinking skills. Self-efficacy provided a catalyst to motivate students to take responsibility of their learning. If students lack motivation, even the best programs will not help. Today's computer-based instruction has the potential for adaptive learning, which can individualize learning for better academic achievement. The Classworks® program allows individualized learning by adjusting curriculum based on students' standardized tests and baseline data, learning performance, academic level, and learning pace (Curriculum Advantage Inc., 2005). Computer-based instruction is the present and future frontier for knowledge and learning. The most recent meta-analyses on computer-based instruction have shown results that are positive to significant. The key is to incorporate proven strategies and resources to advance learning. Classworks® has illustrated promise for CBI. Initial research on CBI has demonstrated a significant increase in achievement, but was less significant than cooperative learning, direct instruction, and mastery learning. Computer-based instruction needs further examination in taxonomies, methods, and strategies. This study will fill the gap in the literature by determining if Classworks® can raise math achievement and help teachers to advance curriculum based on CRCT-Math assessments. The CRCT test scores are the main instrument for analysis, which assesses knowledge and skills taught throughout the

school year. This study will add to the limited research available and provide valuable

results.

CHAPTER THREE: METHODOLOGY

The purpose of this causal-comparative study was to compare 258 seventh grade students' mathematics achievement mean scores on the CRCT assessment to students who learn from traditional instruction and students who learn from traditional instruction with the supplemental Classworks® software program. The 129 pairs were matched based on *gender*, *ethnicity*, and *socioeconomic status*. The study statistically controlled the curriculum and previous achievement for the treatment and control groups of seventh-grade students at two Title I public schools in Georgia. Past computer-based instruction focused on drill and practice, assessment, and games (Li & Ma, 2010; Sarama, 2004). Today, studies are concentrating on scaffolding, pedagogical concepts, and developmental skills (Borokhovski, Tamin, Bernard, Abrami, & Sokolovskaya, 2012; Li & Ma, 2010; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011; Wang, Kinzie, McGuire, & Pan, 2009). This study investigated the synthesis of active learning, adaptive learning, researched-based methods, and pedagogically sound strategies to improve math achievement. The participants learned mathematics for the years 2008-2009 and 2009-2010, while controlling for specific standards called the Georgia Performance Standards (GPS) in both traditional instruction and the supplemental Classworks® program. Math achievement was measured to better understand the differences between the participants who used traditional instruction and the participants who used traditional instruction along with the supplemental Classworks® program. Question one was analyzed using a one-way analysis of covariance, question two was analyzed using a one-way analysis of covariance, and question three was analyzed using a two-way analysis of covariance.

Participants

The participants were selected from 407 seventh grade students from two Title I public schools in central rural Georgia. Woodstock Middle School (pseudonym) represented the control group and John Valley Middle School (pseudonym) represented the experimental group. The groups represented a convenience sampling. The NCLB (2001) Act requires students to be successful in all areas of academics regardless of *gender*, *ethnicity*, and *socioeconomic status* (*SES*). For instance, females, African Americans, Hispanics, and low *SES* students consistently underperform in mathematics compared to their counterparts in many conditions (MacPhee, Farro, & Canetto, 2013; Reznichenko, 2013; Shores, Smith, & Jarrell, 2009. A matching procedure was utilized to "rule out the possible influence of extraneous independent variables" (Gall et al., 2010). The control and experimental groups were matched according to *gender*, *ethnicity*, and *socioeconomic status*. There were 149 students from the control group and 258 students from the experimental group. The data from the two groups were entered into an Excel document and were arranged according to *gender*, *ethnicity*, and *socioeconomic status*. There were 143 matching pairs. Asian students were eliminated due to insufficient numbers for adequate analysis, leaving 142 pairs.

Both the control and treatment groups participated in traditional math classes from 2008 to 2010. The treatment group utilized the supplemental Classworks® program from 2009 to 2010, participating in a scheduled 45-minute session (averaged just over 40-minutes per week), once a week, for the school year (Curriculum Advantage, 2014). Both traditional instruction and the supplemental Classworks® program were based on the Georgia Performance Standards (GPS). After removing outliers and addressing

nonnormality, there were 258 participants. Permission was granted from the school

systems to analyze data for the causal-comparative study. The data included CRCT-Math

mean scores from the 2008-2009 and 2009-2010 school years, *gender*, *ethnicity*, and

socioeconomic status. All identifying information was removed from the data. The

study used an analysis of covariance (ANCOVA) to "control for the effects of an

extraneous variable known to be correlated with the dependent variable" (Ary et al.,

2010, p. 287). An independent *t*-test was used to examine the differences in previous

achievement, and if found significant, the previous achievement scores would be used as

the covariate.

Setting

The study gathered data from two rural public school systems in the state of

Georgia. The schools are Title I schools and the control group has met Adequate Yearly

Progress (AYP) (12 out of 12 categories) for the 2009-2010 school year in the study,

while the treatment group has met 10 out of 12 categories for AYP. These sites were

chosen because the treatment school used the Classworks® program and was willing to

provide statistics and demographic information for this study, and the control school was

a similar rural school system willing to provide statistics and demographic information

for this study as well. The study focused on seventh grade students' math achievement

for the school years 2008-2009 and 2009-2010. The control group used traditional

instruction for the 2008-2009 and 2009-2010 school years. The treatment group used

traditional instruction in math for the 2008-2009 school year, and the treatment group

used traditional instruction along with the supplemental Classworks® program for the

2009-2010 school year. In addition, the control and treatment groups were assessed on

the math portion of the CRCT for the 2008-2009 and 2009-2010 school years. The

traditional instruction and the Classworks® program used specific GPS standards to

prepare for the CRCT-Math assessment. The treatment group used the supplemental

Classworks® program in math just over 40 minutes per week for the school year

(Curriculum Advantage, 2014). Traditional instruction was used 50 minutes per section

on the days when the Classworks® program was not being utilized.

The teachers involved in the treatment group received three hours of professional

development from Curriculum Advantage, Inc. (the developers of the Classworks®

program), where they learned how to implement the program, teach the students the use

of the program, utilize the tools, and read and utilize the management reports. The

students used a computer lab to access the math software program. The computer lab

was furnished with individual computer stations equipped with a PC, monitor, keyboard,

mouse, and headphones. The computer stations have high-speed internet access and are

installed with Internet Explorer (IE7 or higher) and Adobe Flash Player. The software

was not downloaded to the computer stations, but rather each student accessed the

software from a secured URL address with a personal username and password. All data

recorded from the students was stored on the Classworks® secured cloud. Teachers and

administrators had access to the database for analysis and results.

John Valley Middle School and Woodstock Middle School are Title I schools.

Under the No Child Left Behind Act, teachers are required to be highly qualified. The

teachers must possess a bachelor's degree, retain licensure or certification from the state,

and demonstrate subject knowledge (GOSA, 2013). In addition, the state of Georgia

requires middle school math teachers to have a minimum of a degree in mathematics or the equivalent and to pass state assessments (GOSA, 2013).

Traditional learning and instruction for the control and experimental groups took place in the math teachers' classrooms. The teachers utilized traditional methods and practices, including lectures, hands on activities, small groups, and assigned homework. Traditional instruction and the supplemental Classworks® program followed specific standards under the Georgia Performance Standards (GPS). GPS provide a curriculum map that the schools follow throughout the year. Table 3.1 shows the sequence that the control and experimental groups used to follow throughout the year. Table 3.2 shows the standards taught for mathematics for seventh grade students for the 2009-2010 school year.

Table 3.1

Georgia Performance Standards: Curriculum Map

1st Semester				2nd Semester			
Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
Dealing with Data	Patterns and Relationships	Rational Reasoning	Flip, Slide, and Turn	Staying in Shape	Values that Vary	Slices and Shadows	Show What We Know
5 weeks	4 weeks	5 weeks	4 weeks	6 weeks	3 weeks	3 weeks	6 weeks
M7D1 M7A3a,c	M7A1 M7A2 M7A3a,b,c M7D1g	M7N1 M7A1 M7A2 M7A3a,b,c	M7G1 M7G2	M7G2 M7G3	M7A3	M7G4	

Source: (GDOE, 2009c)

Table 3.2

Mathematics Georgia Performance Standards for 7th grade

NUMBER AND OPERATIONS

Students will further develop their understanding of the concept of rational numbers and apply them to real world situations.

M7N1. Students will understand the meaning of positive and negative rational numbers and use them in computation.

> a. Find the absolute value of a number and understand it as the distance from zero on a number line.
> b. Compare and order rational numbers, including repeating decimals.
> c. Add, subtract, multiply, and divide positive and negative rational numbers.
> d. Solve problems using rational numbers.

GEOMETRY

Students will further develop and apply their understanding of plane and solid geometric figures through the use of constructions and transformations. Students will explore the properties of similarity and further develop their understanding of 3-dimensional figures.

M7G1. Students will construct plane figures that meet given conditions.

> a. Perform basic constructions using both compass and straight edge, and appropriate technology. Constructions should include copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing
> perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
> b. Recognize that many constructions are based on the creation of congruent triangles.

M7G2. Students will demonstrate understanding of transformations.

> a. Demonstrate understanding of translations, dilations, rotations, reflections, and relate symmetry to appropriate transformations.
> b. Given a figure in the coordinate plane, determine the coordinates resulting from a translation, dilation, rotation, or reflection.

M7G3. Students will use the properties of similarity and apply these concepts to geometric figures.

> a. Understand the meaning of similarity, visually compare geometric figures for similarity, and describe similarities by listing corresponding parts.
> b. Understand the relationships among scale factors, length ratios, and area ratios between similar figures. Use scale factors, length ratios, and area ratios to determine side lengths and areas of similar geometric figures.
> c. Understand congruence of geometric figures as a special case of similarity: The figures have the same size and shape.

M7G4. Students will further develop their understanding of three-dimensional figures.

> a. Describe three-dimensional figures formed by translations and rotations of plane figures through space.
> b. Sketch, model, and describe cross-sections of cones, cylinders, pyramids, and prisms.

ALGEBRA

Students will demonstrate an understanding of linear relations and fundamental algebraic concepts.

M7A1. Students will represent and evaluate quantities using algebraic expressions.

> a. Translate verbal phrases to algebraic expressions.
> b. Simplify and evaluate algebraic expressions, using commutative, associative, and

distributive properties as appropriate.

c. Add and subtract linear expressions.

M7A2. Students will understand and apply linear equations in one variable.

a. Given a problem, define a variable, write an equation, solve the equation, and interpret the solution.

b. Use the addition and multiplication properties of equality to solve one- and two-step linear equations.

M7A3. Students will understand relationships between two variables.

a. Plot points on a coordinate plane.

b. Represent, describe, and analyze relations from tables, graphs, and formulas.

c. Describe how change in one variable affects the other variable.

d. Describe patterns in the graphs of proportional relationships, both direct ($y = kx$) and inverse ($y = k/x$).

DATA ANALYSIS AND PROBABILITY

Students will demonstrate understanding of data analysis by posing questions, collecting data, analyzing the data using measures of central tendency and variation, and using the data to answer the questions posed. Students will understand the role of probability in sampling.

M7D1. Students will pose questions, collect data, represent and analyze the data, and interpret results.

a. Formulate questions and collect data from a census of at least 30 objects and from samples of varying sizes.

b. Construct frequency distributions.

c. Analyze data using measures of central tendency (mean, median, and mode), including recognition of outliers.

d. Analyze data with respect to measures of variation (range, quartiles, interquartile range).

e. Compare measures of central tendency and variation from samples to those from a census. Observe that sample statistics are more likely to approximate the population parameters as sample size increases.

f. Analyze data using appropriate graphs, including pictographs, histograms, bar graphs, line graphs, circle graphs, and line plots introduced earlier, and using box and- whisker plots and scatter plots.

g. Analyze and draw conclusions about data, including describing the relationship between two variables.

Process Standards

The following process standards are essential to mastering each of the mathematics content standards. They emphasize critical dimensions of the mathematical proficiency that all students need.

M7P1. Students will solve problems (using appropriate technology).

a. Build new mathematical knowledge through problem solving.

b. Solve problems that arise in mathematics and in other contexts.

c. Apply and adapt a variety of appropriate strategies to solve problems.

d. Monitor and reflect on the process of mathematical problem solving.

M7P2. Students will reason and evaluate mathematical arguments.

a. Recognize reasoning and proof as fundamental aspects of mathematics.

b. Make and investigate mathematical conjectures.

c. Develop and evaluate mathematical arguments and proofs.

d. Select and use various types of reasoning and methods of proof.

M7P3. Students will communicate mathematically.

a. Organize and consolidate their mathematical thinking through communication.

b. Communicate their mathematical thinking coherently and clearly to peers, teachers,

and others.
c. Analyze and evaluate the mathematical thinking and strategies of others.
d. Use the language of mathematics to express mathematical ideas precisely.
M7P4. Students will make connections among mathematical ideas and to other disciplines.
a. Recognize and use connections among mathematical ideas.
b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
c. Recognize and apply mathematics in contexts outside of mathematics.
M7P5. Students will represent mathematics in multiple ways.
a. Create and use representations to organize, record, and communicate mathematical ideas.
b. Select, apply, and translate among mathematical representations to solve problems.
c. Use representations to model and interpret physical, social, and mathematical phenomena.

Source: (GDOE, 2005)

The Classworks® program personalizes the instruction according to individual data (e.g., standardized test scores), strengths, and weaknesses. Therefore, students receive additional instruction for lessons they are struggling with and will move on to new lessons when they show mastery. The learning process for Classworks® has several stages for each unit. The stages are a mini-lesson, instructional activities, a quick quiz, review activities, and a project. The units are structured to incorporate research-based strategies and methods that synergize state and local standards and the revised Bloom's Taxonomy.

Figure 2.1. Unit Structure
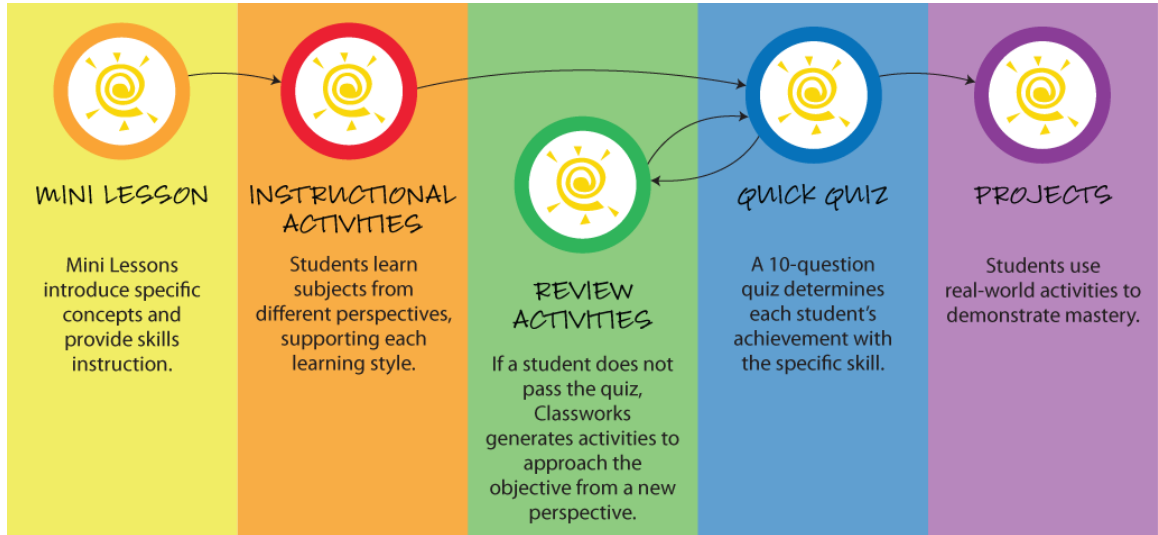
Figure 2.1: Unit Structure: Learn, apply, review, extend. Instructional Unit Grades 1-8

Curriculum Advantage Inc. (2013a). Retrieved from

http://www.classworks.com/index.cfm/instruction/unit-structure/. Reprinted with

permission.

During the first stage, students start with a mini-lesson that teaches a specific

concept as an overview in two or three minutes. There are three interactive activities in

every mini-lesson that focus on a particular skill or learning objective. These activities

are called Learn, Apply, and Review.

Figure 2.2. Mini-Lesson

Figure 2.2: Mini-Lesson. Curriculum Advantage Inc. (2013c). Classworks: Technology

for tailored learning. (Received as an email attachment from Rebecca Lathem, Marketing

Manager- Classworks on October 01, 2013). Reprinted with permission.

During the second stage, students participate in instructional activities that include

tutorials, various modalities, and practice sessions for understanding. There are two sets

of learning segments consisting of 10 to 30 activities each. The activities range in

difficulty and complexity, differentiation, methods, and modalities. The objective is to

instill mastery in students' learning with scores above 70%.

Figure 2.3. Instructional Activities
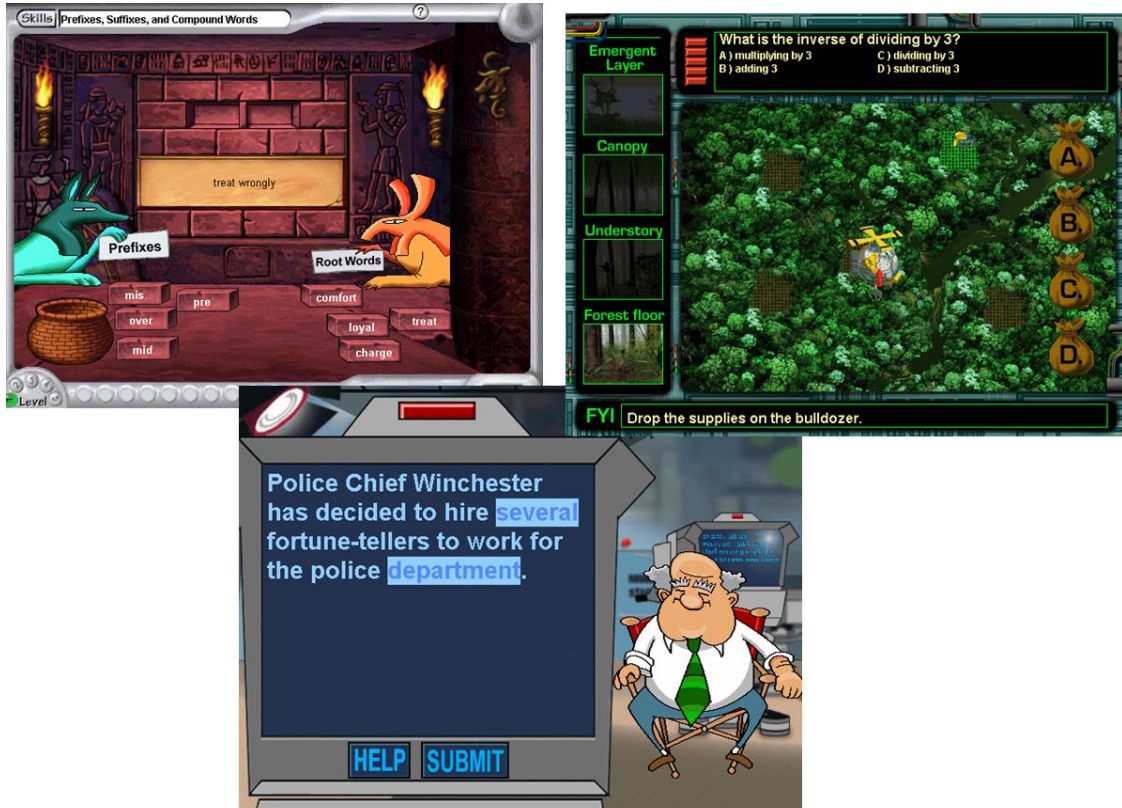
Figure 2.3: Instructional activities of various lessons. Curriculum Advantage Inc.

(2013c). Classworks: Technology for tailored learning. (Received as an email attachment

from Rebecca Lathem, Marketing Manager- Classworks on October 01, 2013).

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During the third stage, students take a formative assessment quiz of 10 questions to

determine mastery of a specific skill. Scores must be above 70% to move on to the

project stage. Students that do not meet mastery will move on to the *review stage*.

Figure 2.4. Quick Quiz

Multiplying and Dividing Rational Numbers

Quiz

You will need a paper and pencil for this quiz.
Choose the decimal to complete the equation.

$$5 \times \quad 5 \times \quad 2\frac{1}{4} = 5 \times \quad 5 \times \quad \blacksquare$$

⊙ 2.14   ⊙ 2.4

⊙ 2.25   ⊙ 22.5

screen
1 of 10 ▶

Figure 2.4: Quick Quiz. From Curriculum Advantage Inc. (2013c). Classworks: Technology for tailored learning. (Received as an email attachment from Rebecca Lathem, Marketing Manager- Classworks on October 01, 2013). Reprinted with permission.

In the fourth stage, students who do not master the quiz (70% or above) move on to the review activities. The review provides different activities, methods, and strategies that teach the same skills in different ways. After completing the review activities, students will undergo another formative assessment quiz. If the students show mastery on the quiz, they will then move on to the *project stage*. The students that fail to show mastery

(below 70%) on the quiz will move on to another unit and the teacher will intervene to address the unmastered skill.

Figure 2.5. Review Instructional Activities

Figure 2.5: Review Instructional Activities. From Curriculum Advantage Inc. (2013c). Classworks: Technology for tailored learning. (Received as an email attachment from Rebecca Lathem, Marketing Manager- Classworks on October 01, 2013). Reprinted with permission.

In the fifth stage, students who pass the quiz move on to a performance-based project. These projects are higher-order skills that represent real world situations. When the

students were not in the computer lab using Classworks®, the remainder of the math learning was with their math teacher learning math with traditional instruction.

Figure 2.6. Project Activity

Figure 2.6: Project Activity. Curriculum Advantage Inc. (2013c). Classworks: Technology for tailored learning. (Received as an email attachment from Rebecca Lathem, Marketing Manager- Classworks on October 01, 2013). Reprinted with permission.

Classworks® provides numerous reports to easily analyze and adjust student progress. Some of the reports include assignment results, benchmark results, comprehensive results, custom assessments, district summaries, high stakes test results, instruction results by state standards, progress monitoring results, placement results, mastery measurements, skills summaries, universal screener RtI recommendations, and student growths (Curriculum Advantage Inc., 2013b). The data can be incorporated into

a school's "Learning Management System (LMS) or Student Information System (SIS)"

(Curriculum Advantage Inc., 2013b).

Figure 2.7. Assignment Results

Assignment Results
3rd Grade Language Arts

Classworks
by CurriculumAdvantage

Report on: Ms. Thomas' 3rd Grade Class
School: Maplewood Elementary School
Number of Students Working in Assignment: 12
Date Range: 9/26/12 - 11/4/12
Date: 11/8/12

Student: Morales, Cathy

Unit #	Instruction	Date	Activities Score	Activities Total Time	Units Score	Units Total Time
59	Using the Direction Words Left and Right	10/18/12		00:02:14		
	Mini-Lesson		–	00:02:14		
72	Identifying the Beginning, Middle and End of a Story	10/20/12	89%	00:26:53	65%	01:13
	Mini-Lesson	10/12/12	–	00:01:46		
	Ugly Duckling - Plot	10/12/12	85%	00:09:07		
	Peter Rabbit - Plot	10/18/12				
	- Attempt 1 (not in avg.)	10/14/12	60%	00:05:33		
	- Attempt 2 (in avg.)	10/18/12	92%	00:10:27		
	Quick Quiz	10/20/12			65%	01:13
55	Introducing Capital Letters	10/24/12	80%	00:13:37	53%	00:55
	Mini-Lesson	10/21/12	–	00:01:05		
	Capitalization is Fun	10/24/12	80%	00:12:32		
	Quick Quiz	10/24/12			53%	00:55
34	Introducing Setting	11/4/12	81%	00:58:45	48%	00:32
	Mini-Lesson	10/28/12	–	00:12:10		
	City Mouse and Country Mouse (Story)	10/31/12	85%	00:12:10		
	City Mouse and Country Mouse (Puzzle)	11/2/12	80%	00:07:13		
	Quick Quiz	11/2/12			48%	00:32
	R. Setting Review	11/3/12	78%	00:15:28		
	Overall Assignment Score		83%	01:39:15	55%	00:02:40
			70%		70%	

Note: Unit Score = Unit test or the average of the activities (Skill Builders)

Purpose: Allows teachers to view how each student is doing within Classworks, both the unit activities' scores and the final unit test score.
Next Steps: Reassign units or add remediation units as needed.

Cascade Co. School District   Page 1 of 1

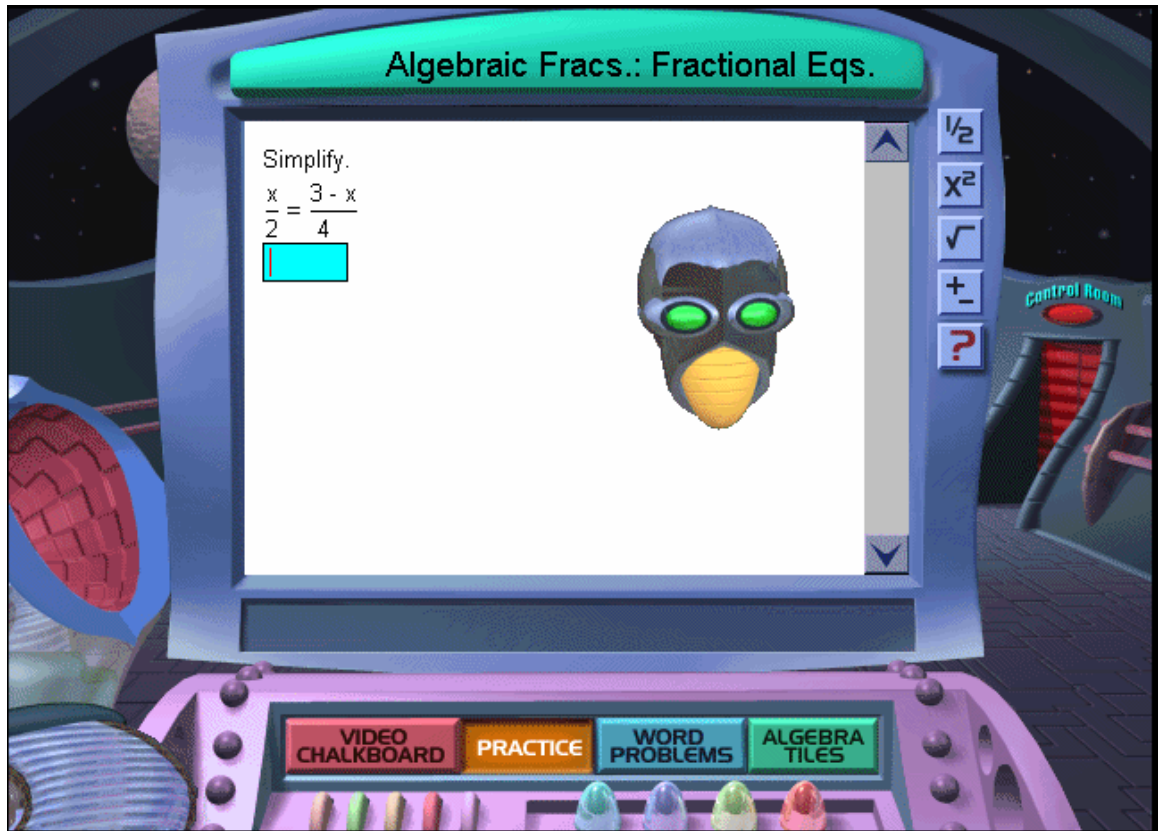*Figure 2.7:* Assignment Results. Curriculum Advantage Inc. (2013c). Classworks: Technology for tailored learning. (Received as an email attachment from Rebecca Lathem, Marketing Manager- Classworks on October 01, 2013). Reprinted with permission.

The program utilizes an integrated learning system (ILS) manager to match lessons and objectives to individual students. In addition, the Classworks® program can incorporate stand-alone software "such as Knowledge Adventure's JumpStart Learning System™, Tom Snyder's The Graph Club®, and Roger Wagner's HyperStudio®" (Curriculum Advantage, 2009b, p. 6). Classworks® synthesizes the different programs into a sequence of lessons that utilize different learning styles. Students have the ability to move through the lessons at their own speed and skill level.

Instrumentation

The mean scores for the control group and treatment group in this study were calculated using the math section in the Criterion-referenced Competency Test (CRCT-Math). The CRCT-Math mean scores was the dependent variable used to measure math achievement. The CRCT scores for 2009 were used as the covariate to adjust for previous differences. The state of Georgia has mandated the use of the CRCT to measure Adequate Yearly Progress (AYP) for the fulfillment of the No Child Left Behind (NCLB) Act. The CRCT is intended to determine the degree of knowledge and skills, based on the Georgia Performance Standards (GPS) and students retained throughout the year (GDOE, 2009a; GDOE, 2010a). Students are tested in the areas of reading, language arts, math, science, and social studies. The students in this study took the CRCT from

third grade through eighth grade at the end of each school year. The assessment scores

can fall into one of three categories; (a) Does Not Meet (800 and below), (b) Meets (800

to 849), and (c) Exceeds (850 and over). The Lowest Obtainable Scale Score (LOSS) for

the 2009 and 2010 CRCT-Math assessments was 650 and the Highest Obtainable Scale

Score (HOSS) for the 2009 and 2010 CRCT-Math assessments was 950 (GDOE, 2009b;

GDOE, 2010d). CRCT assessments are also used to compare countries' competitiveness

and educational effectiveness. The Trends in Mathematics and Science Study (TIMSS) is

one organization that compares countries using CRCT assessment data (Bennett et al.

1998; Hambleton, 2009).

The validity and reliability of the CRCT is established by the Georgia Department

of Education (GDOE) in *An Assessment and Accountability Brief* (2009a; 2010a). CRCT

validity "relies primarily on how well the assessment instrument matches the intended

curriculum and how the score reports inform the various stakeholders . . . about the

students' performance" (GDOE, 2010a). The GDOE uses a process to develop the tests,

which includes the academic purpose, state mandated curriculum, various educators from

Georgia to identify standards and assessments, field testing, a committee of educators to

reexamine field tests and data, test development, equating, and scores and results (2009a;

2010a). The GDOE stated that "a reliable assessment is one that would produce stable

scores if the same group of students were to take the same test repeatedly without any

fatigue or memory effects" (2009a; 2010a). The GDOE utilized Cronbach's alpha

coefficient and the standard error of measure (SEM) to measure for reliability. The

Cronbach's alpha for the CRCT-Math assessment ranged from .92 to .93, for an average

of .925. The SEM for the CRCT-Math assessment ranged from 3.11 to 3.26, for an

average of 3.185. These scores show strong reliability and consistent student

performance, while supporting validity in this study (see Table 3.1 for a breakdown for

the Cronbach's alpha and SEM).

Table 3.3

CRCT-Math Reliability scores for Cronbach's alpha and SEM

Grade	Alpha	SEM
6th Grade 2008—2009	.92	3.26
7th Grade 2009—2010	.93	3.11
Average	.925	3.185

Source: (GDOE, 2009a) (GDOE, 2010a)

Construct Validity

Mathematics achievement was the central construct of this study. The CRCT-

Math mean scores measure math achievement. The CRCT assesses students' knowledge

and skills that have been taught throughout the school year, which is evidence of face

validity. The assessments show content validity by gathering outside experts in standards

and assessments to evaluate the CRCT program (GDOE, 2009a; GDOE, 2010). The

Classworks® program maintains convergent validity with other computer-based

instruction that is research-based, stimulates active learning, incorporates adaptive

learning, and is pedagogically sound. The program is divergent to other computer-based

instruction that employ drill and practice, movies, fun activities, tutoring, and

assessments. Overall, the CRCT-Math measures and treatment of the control and

experimental groups are aligned and constant. The Classworks® math program was aligned with the standards used, but was the added element in the experimental group.

Procedures

Curriculum Advantage Inc., the software company that produced the Classworks® program, was contacted for names of school districts that used the program. The researcher contacted these school systems for permission to use their data, along with a permission letter. John Valley Middle School represented the experimental group. The researcher contacted a similar school, Woodstock Middle School, which did not use the Classworks® program and obtained permission to use their data, along with a permission letter. This school represented the control group. The school systems provided CRCT-Math mean scores for the years 2009 and 2010, and demographic information including *gender*, *socioeconomic status*, and *ethnicity*. The control group used traditional math instruction for the 2008-2009 and 2009-2010 school years.   The experimental group did not use the Classworks® math program in the 2008-2009 school year, but used the Classworks® math program for the 2009-2010 school year. The experimental group used the math program for 45 minutes a session (averaging just over 40 minutes per session), once a week, within the district systems' school calendar from 2009 to 2010 (Curriculum Advantage, 2014). The CRCT-Math mean scores from 2008-2009 were used to control for previous achievement and the CRCT-Math means from 2009-2010 were used as the post math achievement. The control and experimental groups were matched according to *gender*, *ethnicity*, and *socioeconomic status*. Both traditional instruction and the supplemental Classworks® program in math used the Georgia Performance Standards (GPS) (Table 3.2) and followed the curriculum calendar (Table

3.1). Approval for the study was obtained from the Institutional Review Board at Liberty University.

Treatment Fidelity

The effectiveness of a study must make certain that implementation is uniformed and precise. The treatment fidelity in this study is:

> defined as the strategies that monitor and enhance the accuracy and consistency of an intervention to (a) ensure it is implemented as planned and (b) make certain each component is delivered in a comparable manner to all participants over time. (Smith, Daunic, & Taylor, 2007, p. 2)

This study addressed five significant areas to uphold treatment fidelity including "study design, training, treatment delivery, treatment receipt, and treatment enactment" (Bellg et al, 2004; Smith et al., 2007). The study design was appropriate for an educational intervention. The intervention took place once a week for 45 minutes per session during the school year. Next, training of the teachers and staff at the school district was presented in a uniformed way for effectiveness and consistent implementation. The Classworks® instructors conducted predesigned three-hour training sessions for all teachers implementing the software program. Treatment delivery was consistent and provided monitoring. The teachers were consistent in their delivery of the software program by following the curriculum calendar and following instructional protocols. Treatment receipt was maintained by providing summative and formative assessments. Furthermore, treatment enactment was upheld by incorporating real-world situations into the Classworks® program curriculum.

Design

A causal-comparative design was used to examine seventh grade students' math achievement when participating in traditional instruction and the supplemental Classworks® program compared to traditional instruction alone. This type of quantitative design compares two groups on a dependent and independent variable, while utilizing ex-post facto data (Brewer & Kuhn, 2010). This is typical for educational research and reduces disruption in the learning process for participants (Ary et al., 2010; Gall et al., 2007). The dependent variable represented math achievement measured by the math portion of the Criterion-Referenced Competency Test (CRCT). The first independent variable was *mathematics instruction*, including traditional instruction and traditional instruction with the supplemental Classworks® program. The second independent variable was the *gender* of the participants. The third independent variable was *ethnicity,* including African Americans, Hispanics, and Caucasians. The fourth independent variable was the *socioeconomic status* of the participants. The fifth independent variable was the combination of *ethnicity* and *socioeconomic status*.

The causal-comparative design was chosen over a quasi-experimental and a true experimental design for several reasons. In general, research in computer-based instruction that incorporates research-based methods, active learning, adaptive learning, and pedagogically sound strategies are innovative in education at present (Borokhovski, Tamin, Bernard, Abrami, & Sokolovskaya, 2012; Li & Ma, 2010; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011; Wang, Kinzie, McGuire, & Pan, 2009). In particular, the Classworks® program has limited research studies, but revealed positive results for effectiveness (Slavin, 2008). Several attempts to conduct a quasi-experimental

study were rejected because of the uncertainty of student achievement, effectiveness, and potential negative results. A causal-comparative is appropriate in this case to demonstrate that the Classworks® math program may have a positive effect on CRCT-Math test scores, which would lead to full experimental research in the future (Brewer & Kuhn, 2010).

Research Questions and Hypotheses

Research Question 1: Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national Criterion-Referenced Competency Test-Math (CRCT-Math) mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone?

1: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone.

Research Question 2: Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*?

2: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*.

Research Question 3: Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status and ethnicity*?

3: H$_0$: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*.

4: H$_0$: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean when using the supplemental Classworks® program based on *ethnicity*.

5: H$_0$: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic and ethnicity*.

Data Analysis

All data was gathered and entered into the IBM SPSS Statistics 22 software

program for analysis. Since the study was a causal-comparative design there was no

randomization; therefore, a convenience sample was used. Specific analysis was taken to

control for validity. Previous achievement was used to control selection bias. The

dependent variable was mathematic achievement, which was measured by the Criterion-

Referenced Competency Test (CRCT) mean scores for math. The mean scores for the

year 2009 represented the covariate to control for previous achievement and the mean

scores for the year 2010 represented math achievement. The independent variables were

mathematics instruction (traditional instruction along with the supplemental

Classworks® program), *gender* (male/female), *ethnicity* (African American, Hispanic,

and Caucasian), and *socioeconomic status* (high/low).

A one-way analysis of covariance was used to analyze question one, a one-way

analysis of covariance was used to analyze question two, and a two-way analysis of

covariance was used to analyze question three. The ANCOVA was appropriate to

"control for the effects of an extraneous variable known to be correlated with the

dependent variable" (Ary et al., 2010, p. 287). In addition, the ANCOVA was the best

solution for equivalence among groups, which adjusts individual math achievement

(higher or lower) and accounted for individual previous achievement scores (Gall et al.,

2010). An independent *t*-test was used to examine the differences in the previous

achievement and if statistical significance was found, the previous achievement would be

used as the covariate. If the previous achievement was not statistically significant, a one-

way analysis of variance (ANOVA) would be used to analyze the results for questions

one and two. The ANOVA would be used to examine differences. The two-way analysis

of covariance (ANCOVA) would be used to analyze the results for question three. A

power analysis was conducted for the study, which showed that a minimum of 128

participants (64 pairs) is needed for adequate effect size (Cohen, 1988). The analysis of

this study used the significance level of $p < .05$ to conclude the potential rejection of the

null hypotheses. Assumption testing was conducted in this study. The Kolmogorov-

Smirnov normality test was conducted to account for normality for this large population.

In addition, a histogram was created to identify outliers and normal distribution. The

assumption of normality would be confirmed at the statistically significant level greater

than .05. Levene's Test for Equality of Variance was also conducted to evaluate

variance. The assumption of equal variance would be confirmed if there was a

statistically significant level less than .05.

In conclusion, the study provided many analyses to uphold rigorous investigation.

In the event that assumption testing violates normality or equal variance, further analysis

would be necessary. If normality cannot be assumed, the researcher would analyze the

histograms for outliers and remove them if appropriate, while adjusting or trimming for

nonnormality distribution (Howell, 2008). If equal variance cannot be assumed, the

researcher would use a statistical procedure that is modified including Brown-Forsythe or

Welsh (Howell, 2008).

CHAPTER FOUR: FINDINGS

Introduction

The purpose of this causal-comparative study was to examine the differences among seventh grade students' mathematics achievement mean scores on the Criterion-Referenced Competency Test (CRCT) and students who learned from traditional instruction and students who learned from traditional instruction along with the supplemental Classworks® software program. In addition, further examination was performed on the experimental group using students' *gender*, *ethnicity*, and *socioeconomic status*. The study used ex post facto data on seventh grade students. The data consisted of CRCT math mean scores for 2009 and 2010, and demographic information including *gender*, *ethnicity*, and *socioeconomic status* from two public school systems in Georgia. There are three sections in chapter four, including the demographic data of the participants, the results, and the summary.

Demographics

The participants in this study consisted of 258 seventh grade students enrolled in two public Title I middle schools from two rural counties in the middle of Georgia. One hundred forty-three paired students were matched by *gender*, *ethnicity*, and *socioeconomic status*. An examination of the histograms (Figure 4.1) shows violations of normal distribution for both the control and experimental groups in regards to previous achievement. In addition, a Kolmogorov-Smirnov test was conducted for the control and experimental groups. Previous achievement scores (for the year 2009) for the control group revealed a significance value of $p = .004$ and the experimental group revealed a significance value of $p = .000$, which are less than $\alpha = .05$. Therefore, both the control

and experimental groups violated assumptions of normality. Both groups were then

analyzed for outliers $[Q_1 - k (Q_3 - Q_1), Q_3 + k (Q_3 - Q_1)]$. The experimental group

showed six outliers. Those six outliers were removed, along with the highest scoring

matching pairs from the control group. After removing the outliers, normality was

established for the experimental group. The control group did not show any outliers, but

the histogram revealed a spike in the highest scores region.
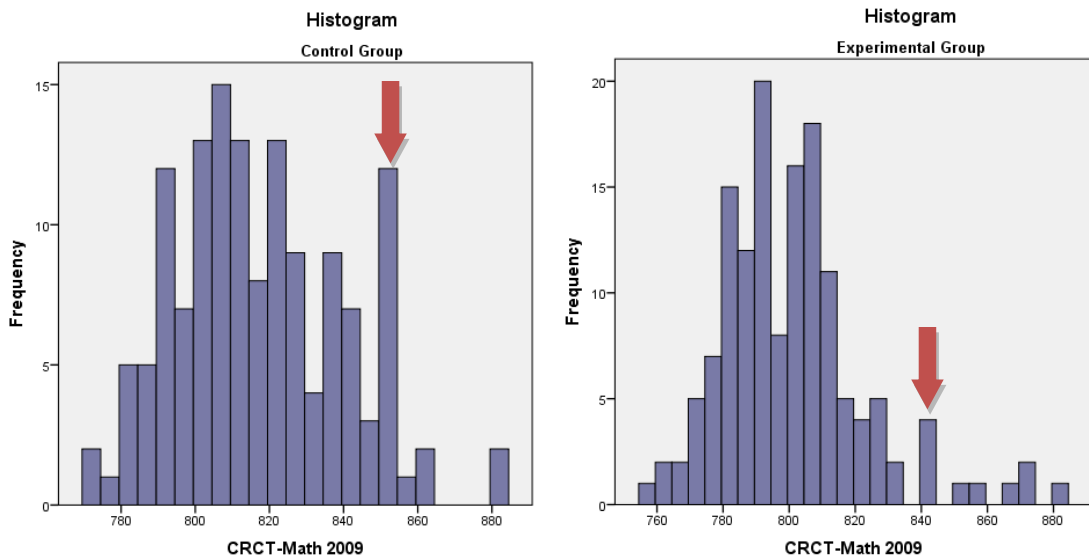
Figure 4.1. Histogram for 2009 CRCT-Math Scores

Both the control and experimental groups showed a spike at the 17th interval (Figure 4.1).

This appeared to be students who excelled on tests. Further analysis showed that these 13

students scored high on the subsequent post math achievement (2009 CRCT-Math $M =$

858.00; 2010 CRCT-Math $M = 873.21$); therefore, corroborating legitimate extreme

values (Howell, 2008). Nevertheless, the 13 highest values from the control group and

the matching highest scores from the experimental group were trimmed. After removing

the outliers and trimming 10% of the highest score pairs, there were 13 pairs from the

control and experimental groups removed. *Trimmed samples* of 10% are acceptable

"without eliminating the variability that we seek to study" (Howell, 2008, p. 80). In addition, the single pair of Asian students was eliminated because of inadequate numbers for analysis. The participants were 258 students (129 pairs) from the control and the experimental groups. There were 142 females (71 pairs) and 116 males (58 pairs) with a total sample of 258 ($n = 258$) students. *Ethnicity* was divided into 140 African Americans (70 pairs), 16 Hispanics (eight pairs), and 102 Caucasians (51 pairs). *Socioeconomic status* was established according to students who received or did not receive free/reduced lunch. There were 44 high *SES* participants (22 pairs) who did not receive free/reduced lunch and 214 low *SES* participants (107 pairs) who received free/reduced lunch. The demographics for the control and experimental groups are revealed in Table 4.1.

Table 4.1

Demographic Information for the Control and Experimental Groups, After Trimming and Removing Outliers

	Control	Experimental
Female	71	71
Male	58	58
African American	70	70
Hispanic	8	8
Caucasian	51	51
High SES	22	22
Low SES	107	107
Total	129	129

Note. SES=socioeconomic Status

Research Questions and Null Hypotheses

This study implemented and sought to answer several research questions and hypotheses: 1) Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national Criterion-Referenced Competency Test-Math (CRCT- Math) mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone? 2) Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*? 3) Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status and ethnicity*?

The research hypotheses relate to the research questions as follows: (1a) There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone. (2a) There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*. (3a)

There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*. (3b) There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean when using the supplemental Classworks® program based on *ethnicity*. (3c) There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status* and *ethnicity*.

Research Question One

Research question one asked if there was a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone. An analysis of covariance (ANCOVA) investigated the group means and whether there were statistical differences while controlling for effects of possible extraneous variables (Gall et al., 2010). An ANCOVA was conducted to analyze the first null hypothesis. $1H_o$: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using

traditional instruction with the supplemental Classworks® program compared to traditional instruction alone.

Assumption Testing

An independent *t*-test was administered to verify the differences between the control and experimental mean scores on the CRCT-Math assessment for 2009. There was a statistical significance according to the Levene's test: $F_{.05}(2,256) = 6.747 \ p = .010$. The difference between the mean scores was 16.87 (2%) and the eta square = .20. The *p*-value of .010 is less than 0.05 and indicates that the standard deviations were not equal and that equal variances not assumed (Howell, 2008). The *t*-test for equal variances not assumed shows <.0001 significance for the two-tailed test, suggesting a statistically significant difference between the control and experimental group means. The scores for the control group ($M = 812.64$, $SD = 19.024$) and the experimental group ($M = 795.77$, $SD = 15.013$); $t (256) = 7.91 \ p = <.0001$ showed statistical significance. Consequently, a covariate (2009 CRCT-Math mean scores) was used to adjust individual post math achievement scores (higher or lower) and account for individual previous achievement scores (Gall et al., 2010).

Reliability of Covariate

Reliability was assumed based on *An Assessment and Accountability Brief* (2009a) by the Georgia Department of Education (GDOE). The CRCT-Math reliability showed a Cronbach's alpha of 0.92 for the 2009 sixth grade math scores and had a high reliability rate.

Normality

An examination of normality was conducted on the CRCT-Math mean scores for

previous achievement (2009) and post math achievement (2010) (see figures 4.2 and 4.3).

An examination of the histograms (Figures 4.2 and 4.3) shows normal distribution for

both the control and experimental groups in regards to previous achievement and post

math achievement. In addition, a Kolmogorov-Smirnov test was conducted for the

control and experimental groups. The previous 2009 math achievement scores for the

control group revealed a significance value of $p = .058$ and the experimental group

revealed a significance value of $p = .200$, which are greater than $\alpha = .05$. The 2010 post

math achievement scores for the control and experimental groups revealed a significance

value of $p = .200$, which is greater than $\alpha = .05$. Therefore, both the control and

experimental groups for the previous achievement and post math achievement did not

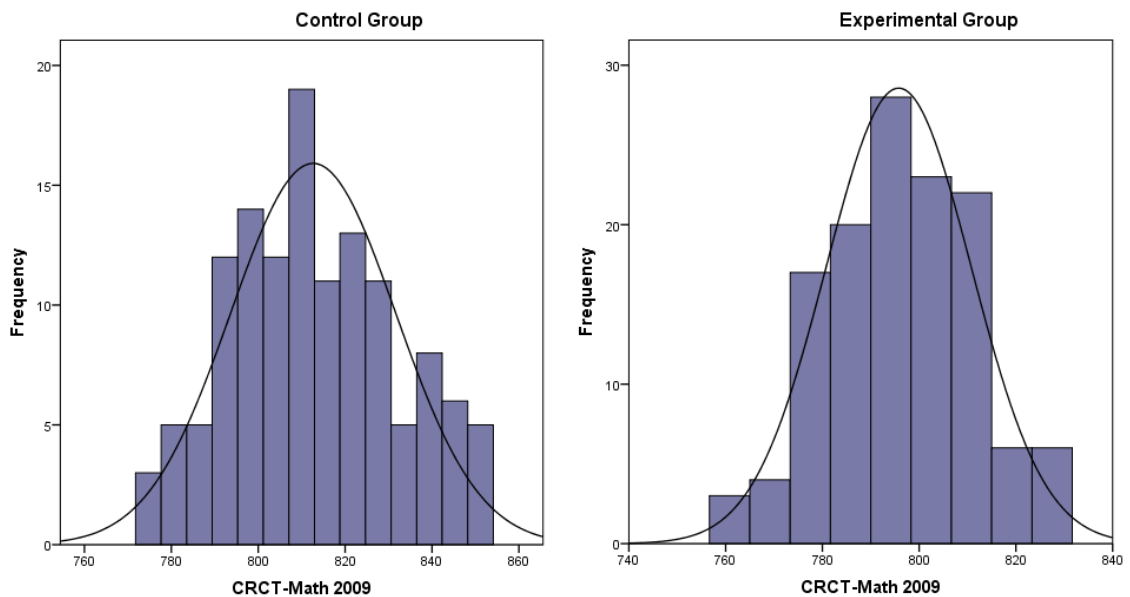violate assumptions of normality.
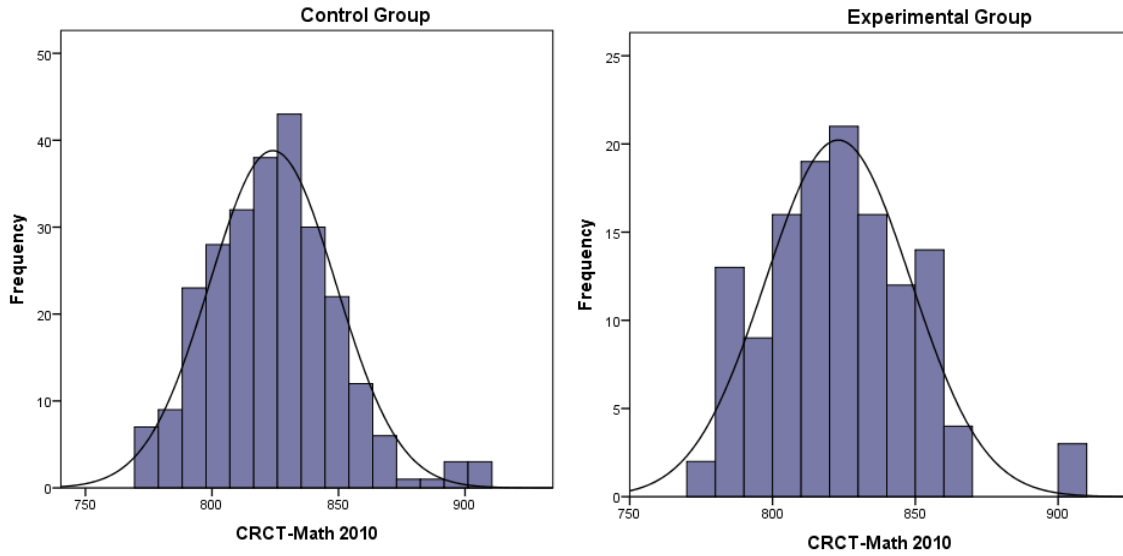

Figure 4. 2. Histogram for 2009 CRCT-Math Scores

Figure 4.3. Histogram for 2010 CRCT-Math Scores

Linearity

A scatterplot was used to examine the linearity of previous achievement and post math achievement (see Figure 4.4).
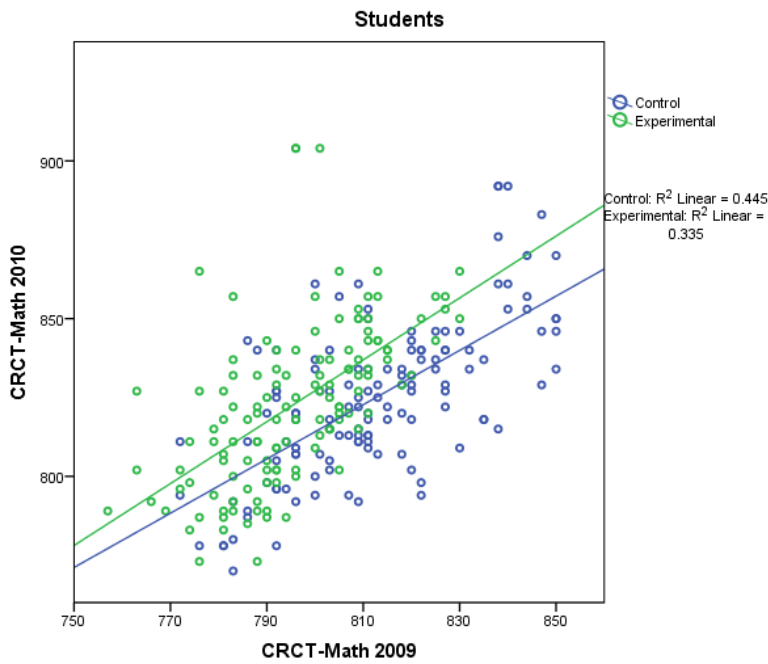
Figure 4. 4. Scatterplot of 2009 and 2010 CRCT-Math Scores for Control and

Experimental Groups

The scatterplot comparing the control and experimental groups in Figure 4.4 placed the 2009 CRCT-Math mean scores along the X-axis while the 2010 CRCT-Math mean scores are along the Y-axis. The results indicated a positive linear relationship that has a moderate strength. The control group had an R^2 = .445 and the experimental group had an R^2 = .335, indicating a moderate difference from .00. The slope of the line moves positively upward from 2009 to 2010. Thus, there were no violations of assumptions of linearity.

Variances

The Levene's test was used to examine the assumptions of homogeneity of variance. The Levene's test analyzed whether the dependent variables were equal between groups (Rovai, Baker, & Ponton, 2013). This test provided a significance level of .646, indicating no violation of the assumption of homogeneity of variance and was tenable to post math achievement.

Hypothesis Testing One

Descriptive Statistics

Table 4.2 represents the descriptive statistics between the control and experimental groups. There were 258 participants (129 pairs) in the control and experimental groups who completed the previous achievement and post math achievement. The post math achievement mean score for the control group was 825.01 with a standard deviation of 24.53. The post achievement mean score for the experimental group was 822.99 with a standard deviation of 25.45. The overall posttest mean score was 825.02 with a standard deviation of 25.47. The adjusted mean scores

were calculated to account for the covariate, the control group resulting in 817.36

(SE = 1.83) and the experimental group resulting in 830.64 (SE = 1.83).

Table 4.2

Descriptive Statistics for the Control and Experimental Groups

		CRCT-Math 2009		CRCT-Math 2010		CRCT-Math 2010	
	n	*M*	*SD*	*M*	*SD*	Adjusted *M*	*SE*
Control	129	812.64	19.02	825.01	24.53	817.36	1.83
Experimental	129	795.77	15.01	822.99	25.45	830.64	1.83
Total	258	804.21	19.08	824.00	24.96	824.00	

Analysis

A one-way analysis of covariance (ANCOVA) was administered to determine the

differences between the control and experimental groups according to the CRCT-Math

mean scores. The Classworks® math program functioned as the independent variable,

with the control group using traditional instruction and the experimental group using

tradition instruction and the supplemental Classworks® program. The 2010 CRCT-Math

mean scores represented the dependent variable. The 2009 CRCT-Math mean scores

represented the covariate. There was a statistically significant difference between the

control and experimental groups at α = .05 level, F (2,256) = 23.76, p = .000002, partial

η^2 = .09, with an observed power of .998. The effect size for the study was (η^2 = .09) and

was inferred to be a medium to large effect size (Cohen, 1988; Tabachnick & Fidell,

2013). Consequently, the magnitude of treatment effect was medium to large (Rovai et

al., 2013). The observed power of .998 is higher than the desired power of .8, hence indicating a low probability of a Type I error (Rovai et al., 2013). Therefore, null hypothesis one was rejected. There was a statistically significant difference in the experimental group, which showed a 27.22 (3.42%) difference from the previous achievement to the post math achievement, compared to the control group, which showed a 12.37 (1.52%) difference from the previous achievement to the post math achievement.

Hypothesis One Results

The first null hypothesis stated that there was no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone. Therefore, the researcher rejected the first null hypothesis. The mean scores for the control group ($M = 825.01$, $SD = 24.53$) and the experimental group ($M = 822.99$, $SD = 25.45$) revealed a statistically significant difference from the previous achievement to the post math achievement scores. The experimental group showed a 27.22 point (3.42%) difference from the previous achievement to the post math achievement, while the control group showed a 12.37 point (1.52%) difference from the previous achievement to the post math achievement.

<center>**Research Question Two**</center>

Research question two asked if there was a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*. An analysis of covariance

(ANCOVA) investigated the group means and whether there were statistical differences while controlling for effects of possible extraneous variables (Gall et al., 2010). An ANCOVA was conducted to analyze the second null hypothesis. 2H$_o$: There was no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*.

Assumption Testing

An independent *t*-test was administered to verify the differences between female and male mean scores on the CRCT-Math assessment for 2009. There was no statistical significance according to the Levene's test: $F_{.05}(1,128) = 3.233$ $p = .075$. The difference between the mean scores was 2.96 (0.37%) and the eta square = .010. The *p*-value of .075 is greater than 0.05 and indicated that the standard deviations are equal and that equal variances could be assumed (Howell, 2008). The *t*-test for equal variances assumed showed <.267 significance for the 2-tailed test, suggesting no statistically significant difference between the female and male group means. The scores for the female group ($M = 797.10$, $SD = 16.64$) and the male group ($M = 794.14$, $SD = 12.70$); t (129) = 1.12 $p = .267$, partial $\eta^2 = .010$ showed no statistical significance. A covariate (2009 CRCT-Math mean scores) was used to adjust individual post math achievement scores (higher or lower) and account for individual previous achievement scores (Gall et al., 2010).

Reliability of Covariate

Reliability was assumed based on *An Assessment and Accountability Brief* (2009a) by the Georgia Department of Education (GDOE). The CRCT-Math reliability showed a Cronbach's alpha of 0.92 for the 2009 sixth grade math scores and has a high reliability rate.

Normality

An examination of normality was conducted on the CRCT-Math mean scores for previous achievement (2009) and post math achievement (2010) (see figure 4.4). An examination of the histograms below (Figures 4.4) shows normal distribution for both the female and male groups in regards to previous achievement and post math achievement. In addition, a Kolmogorov-Smirnov test was conducted for the female and male groups. The previous math achievement scores (2009) for the female group revealed a significance value of $p = .200$ and the male group revealed a significance value of $p = .010$, which showed the female group greater than $\alpha = .05$ and the male group less than $\alpha = .05$. Additional testing was taken on the male group. Skewness revealed a score of .927 and Kurtosis revealed a score of -1.447, indicating a range between 1.960 and -1.960. Skewness and Kurtosis indicate an acceptable range for normality. The 2010 post math achievement scores for the female group revealed a significance value of $p = .200$ and the male group revealed a significance value of $p = .087$, which are greater than $\alpha = .05$. Therefore, both the control and experimental groups for the previous achievement and post math achievement did not violate assumptions of normality (see Figure 4.5).
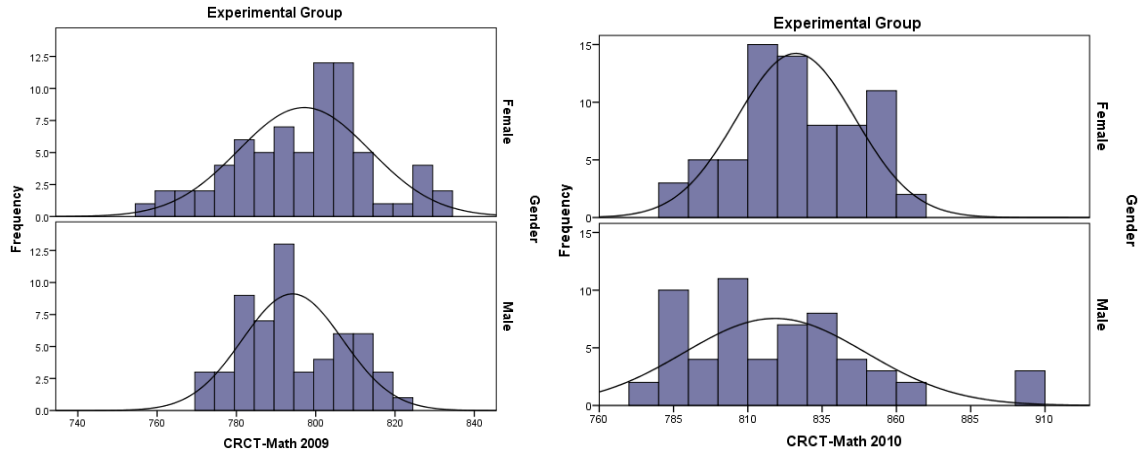
Figure 4. 5. Histogram for 2009 and 2010 CRCT-Math Scores for Gender

Linearity

A scatterplot was used to examine the linearity of previous achievement and post

math achievement (see Figure 4.6).
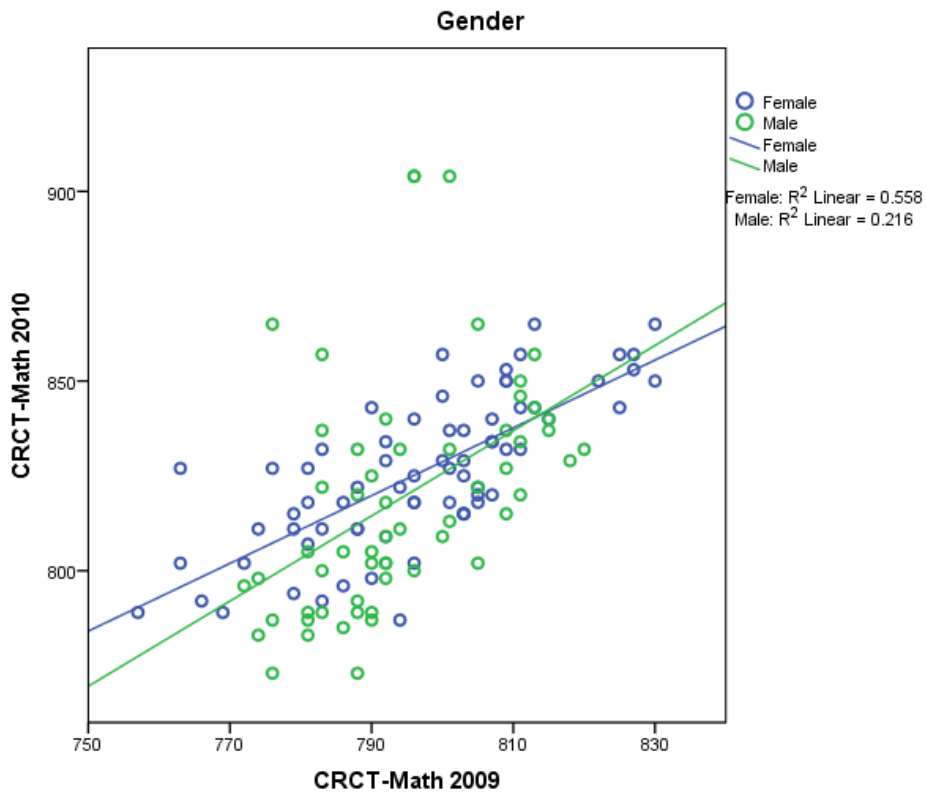
Figure 4. 6. Scatterplot for Gender

The scatterplot comparing the control and experimental groups in Figure 4.4 placed the 2009 CRCT-Math mean scores along the X-axis while the 2010 CRCT-Math mean scores were placed on the Y-axis. The results indicated a positive linear relationship that has a moderate strength. The female group had an $R^2 = .558$, indicating a moderate difference from .00, and the male group had an $R^2 = .216$, indicating a moderate to weak difference from .00. The slope of the line moves positively upward from 2009 to 2010. Therefore, there was no violation of assumptions of linearity.

Variances

Levene's test was used to examine the assumptions of homogeneity of variance. Levene's test analyzes whether the dependent variables are equal between groups (Rovai, Baker, & Ponton, 2013). This test provided a significance level of .075, indicating no violation of the assumption of homogeneity of variance and was tenable to post math achievement.

<div align="center">

Hypothesis Testing Two

</div>

Descriptive Statistics

Table 4.3 represents the descriptive statistics between females and males. There were 129 participants in the female ($n = 71$) and male ($n = 58$) groups who completed the previous achievement and post math achievement. The post math achievement mean score for females was 826.15 with a standard deviation of 19.99. The post achievement mean score for males was 822.99 with a standard deviation of 25.45. The overall posttest mean score was 819.12 with a standard deviation of 30.67. The adjusted mean scores

were calculated to account for the covariate. The female score was 824.87 (*SE* = 2.48) and the male score was 820.70 (*SE* = 2.74).

Table 4.3

Descriptive Statistics for Gender

| | *n* | CRCT-Math 2009 | | CRCT-Math 2010 | | CRCT-Math 2010 | |
		M	*SD*	*M*	*SD*	*Adj. M*	*SE*
Females	71	797.10	16.64	826.15	19.90	824.87	2.48
Males	58	794.14	12.70	819.12	30.67	820.70	2.74
Total	129	795.77	15.01	822.99	25.45	822.79	

Analysis

A one-way analysis of covariance (ANCOVA) was administered to determine the differences between females and males according to the 2010 CRCT-Math mean scores. *Gender* functioned as the independent variable, the 2010 CRCT-Math mean scores represented the dependent variable, and the 2009 CRCT-Math mean scores represented the covariate. There was no statistically significant difference between females and males at α = .05 level, $F (1,128) = 1.27$, $p = .262$, partial $\eta^2 = .01$, with an observed power of .201. The effect size for the study was ($\eta^2 = .01$) and the effect was inferred to be small (Cohen, 1988; Tabachnick & Fidell, 2013); therefore, the magnitude of treatment effect was small (Rovai et al., 2013). The observed power of .201 showed a higher probability of a Type II error. Therefore, null hypothesis two failed to be rejected. There was not significant evidence to recommend one *gender* over another for greater benefit.

Females showed a 29.05 point (3.64%) difference from the previous achievement to the

post math achievement, while males showed a 24.98 point (3.15%) difference from the

previous achievement to the post math achievement.

Hypothesis Two Results

Hypothesis two stated that there would be no statistically significant difference in

seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean scores when using the

supplemental Classworks® program based on *gender*. The researcher rejected the second

null hypothesis. The mean scores for females ($M = 826.15$, $SD = 19.99$) and males

($M = 819.12$, $SD = 30.67$) revealed no statistically significant difference from the

previous achievement to the post math achievement scores. Females showed a 29.05

point (3.64%) difference from the previous achievement to the post math achievement,

while males showed a 24.98 point (3.15%) difference from the previous achievement to

the post math achievement.

<div align="center">

Research Question Three

</div>

Research question three asked if there was a statistically significant difference in

seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean scores when using the

supplemental Classworks® program based on *socioeconomic status and ethnicity*.

A two-way analysis of covariance (ANCOVA) investigated the group means and whether

there were statistical differences while controlling for effects of possible extraneous

variables (Gall et al., 2010). A two-way ANCOVA was conducted to analyze the third,

fourth, and fifth null hypotheses.

Assumption Testing

In this study, *ethnicity* and *socioeconomic status* (*SES*) functioned as the independent variables. The 2010 CRCT-Math mean scores represented the dependent variable and the 2009 CRCT-Math mean scores represented the covariate.

Reliability of Covariate

Reliability was assumed based on *An Assessment and Accountability Brief* (2009a) by the Georgia Department of Education (GDOE). The CRCT-Math reliability showed a Cronbach's alpha of 0.92 for the 2009 sixth grade math scores and has a high reliability rate.

Normality

An examination of normality was conducted on the CRCT-Math mean scores for previous achievement (2009) and post math achievement (2010) among *ethnicity* and *SES* (see figure 4.7 and 4.8). An examination of the histograms below (Figures 4.7 and 4.8) shows normal distribution for both *ethnicity* and *SES* groups in regards to previous achievement and post math achievement.
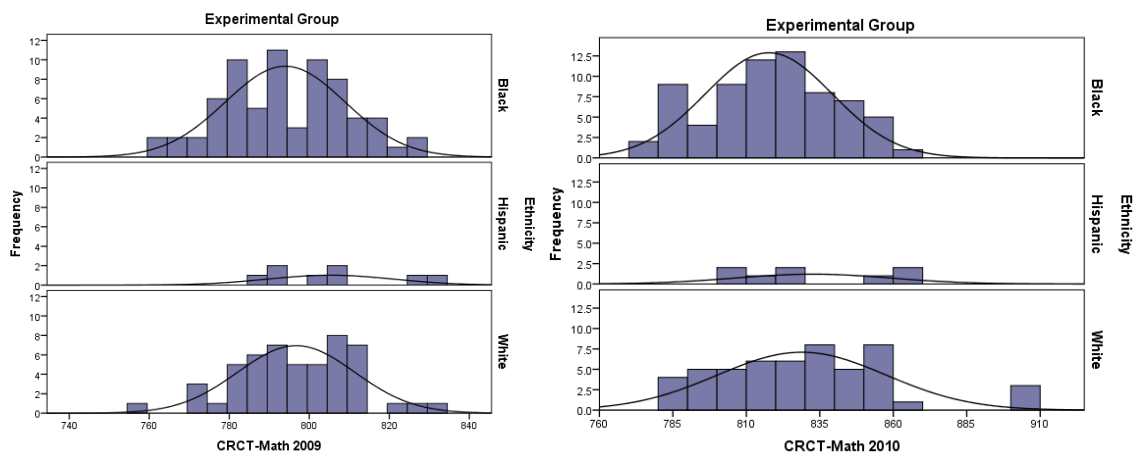
Figure 4. 7. Histogram for 2009 and 2010 CRCT-Math Scores for Ethnicity
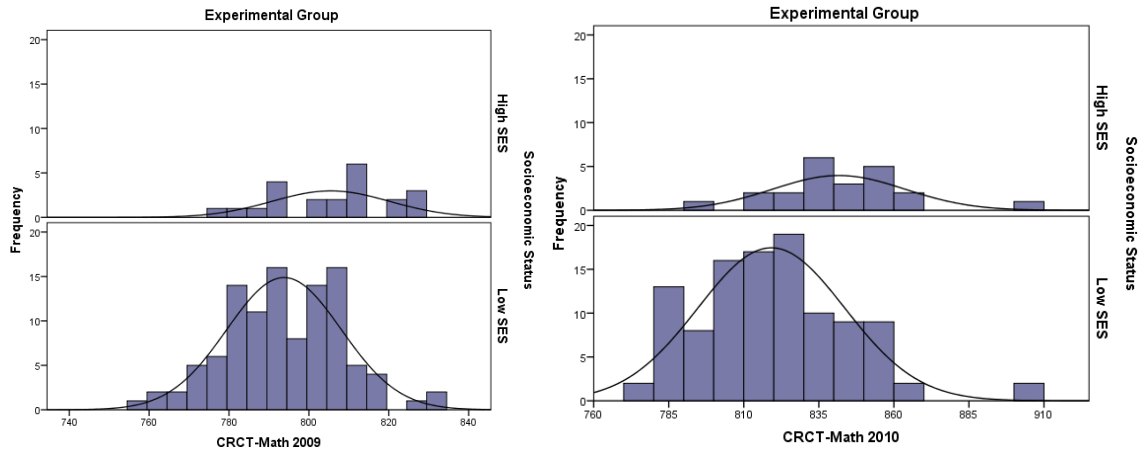
Figure 4. 8. Histogram for 2009 and 2010 CRCT-Math Scores for *SES*

In addition, a Kolmogorov-Smirnov test was conducted for *ethnicity* and *SES*. The

previous achievement scores (2009) and post math achievement for African American,

Hispanic, Caucasian, Low *SES*, and High *SES* students revealed a significance value of

$p = .200$ for each, which is greater than $\alpha = .05$. Therefore, both *ethnicity* and *SES* for the

previous achievement and post math achievement did not violate assumptions of

normality.

Linearity

A scatterplot was used to examine the linearity of previous achievement and post

math achievement for *ethnicity* and *SES* (see Figures 4.9 and 4.10).
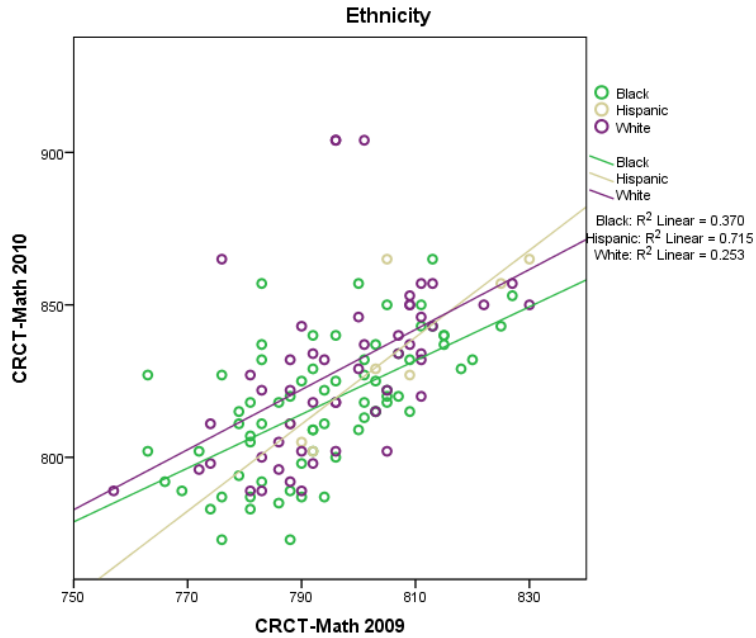
Figure 4. 9. Scatterplot for Ethnicity
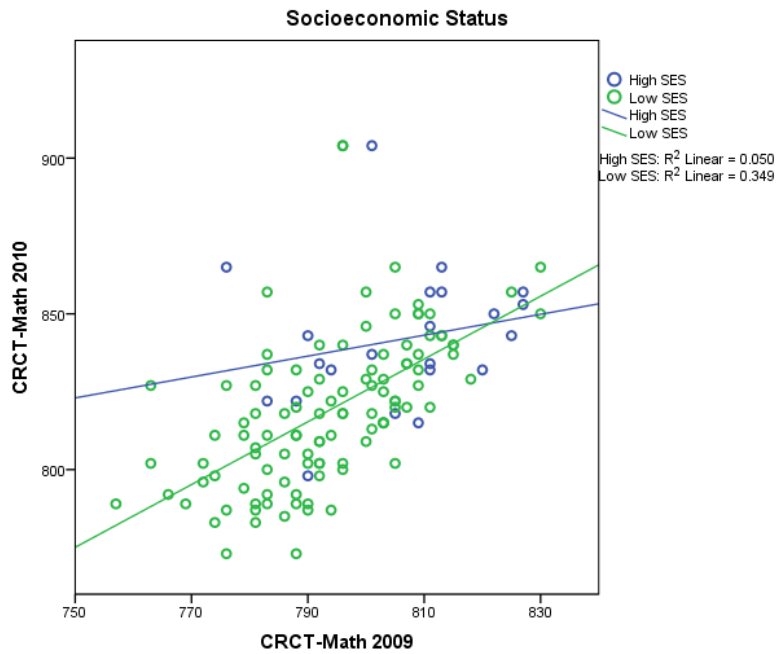
Figure 4. 10. Scatterplot for SES

The scatterplot that compared *ethnicity* in Figure 4.9 put the 2009 CRCT-Math mean

scores along the X-axis while the 2010 CRCT-Math mean scores were placed on the

Y-axis. The results indicated a positive linear relationship with a moderate strength.

African Americans had an R^2 of .370, Hispanics had an R^2 of .715, and Caucasians had

an R^2 of .253, indicating a moderate difference from .00. The slope of the line moves

positively upward from 2009 to 2010. There were no violations of assumptions of

linearity. The scatterplot compared *SES* in Figure 4.10 and put the 2009 CRCT-Math

mean scores along the X-axis while the 2010 CRCT-Math mean scores were on the

Y-axis. The results indicated a positive linear relationship with a moderate strength.

Low *SES* students had an R^2 of .050, indicating a weak difference from .00, and high *SES*

students had an R^2 of .349, indicating a moderate difference from .00. The slope of the

line moves positively upward from 2009 to 2010.

Variances

Levene's test was used to examine the assumptions of homogeneity of variance.

Levene's test analyzes whether the dependent variables are equal between groups (Rovai,

Baker, & Ponton, 2013). This test provided a significance level of .939 for *ethnicity*, .747

for *SES*, and .970 for *ethnicity*/*SES*, indicating no violation of the assumption of

homogeneity of variance and was tenable to post math achievement.

Hypothesis Testing Three

Descriptive Statistics

Table 4.4 represents the descriptive statistics among African American, Hispanic,

and Caucasian students. There were 129 participants grouped as follows: African

Americans (*n* = 72), Hispanics (*n* = 8), Caucasians (*n* = 51), Low *SES* students (*n* = 107),

and high *SES* students (*n* = 22). The post math achievement mean scores for each group

were as follows: African Americans (*M* = 817.63, *SD* = 21.67), Hispanics (*M* = 832.63,

$SD = 26.47$), Caucasians ($M = 828.84$, $SD = 28.67$), Low *SES* students ($M = 819.16$, $SD = 24.46$), and high *SES* students ($M = 841.64$, $SD = 22.12$). The post math achievement adjusted mean scores for African American (*Adj. M* $= 818.00$, *SE* $= 4.09$), Hispanic (*Adj. M* $= 823.91$, *SE* $= 7.21$), Caucasian (*Adj. M* $= 831.57$, *SE* $= 3.11$), Low *SES* (*Adj. M* $= 822.10$, *SE* $= 2.76$), and high *SES* (*Adj. M* $= 828.38$, *SE* $= 4.84$).

Table 4.4

Descriptive Statistics for Ethnicity and SES

			CRCT-Math 2009		CRCT-Math 2010		CRCT-Math 2010	
		n	*M*	*SD*	*M*	*SD*	*Adj.M*	*SE*
African American	High SES	7	812.71	12.89	832.00	23.42	816.42	7.90
	Low SES	65	791.90	13.73	816.03	21.06	819.58	2.58
	Total	72	793.99	14.95	817.63	21.67	818.00	4.09
Hispanic	High SES	-	-	-	-	-	-	-
	Low SES	8	805.25	15.71	832.63	26.47	823.91	7.21
	Total	8	805.25	15.71	832.63	26.47	823.91	7.21
Caucasian	High SES	15	802.07	14.67	846.13	20.75	840.34	5.25
	Low SES	36	794.50	14.24	821.64	28.64	822.80	3.35
	Total	51	796.73	14.64	828.84	28.67	831.57	3.11
Total	High SES	22	805.45	14.72	841.64	22.12	828.38	4.84
	Low SES	107	793.78	14.34	819.16	24.46	822.10	2.76
	Total	129	795.77	15.01	822.99	25.45	825.24	

Analysis

A two-way analysis of covariance (ANCOVA) was administered to determine the differences between *ethnicity* and *SES* according to the 2010 CRCT-Math mean scores. *Ethnicity* and *SES* functioned as the independent variables, the 2010 CRCT-Math mean scores represented the dependent variable, and the 2009 CRCT-Math mean scores represented the covariate.

There was no statistically significant difference between high *SES* and low *SES* students at $\alpha = .05$ level, F (1,128) = 1.79, p = .184, partial $\eta^2 = .01$, with an observed power of .264. The effect size for the study was ($\eta^2 = .01$) and the effect was inferred to be small (Cohen, 1988; Tabachnick & Fidell, 2013); therefore, the magnitude of treatment effect was small (Rovai et al., 2013). The observed power of .264 shows a higher probability of a Type II error. Therefore, null hypothesis four failed to be rejected and the researcher concluded that the third null hypothesis failed to be rejected. There was not significant evidence to recommend one *SES* over another for greater benefit. Low *SES* students showed a 25.38 point (3.20%) difference from the previous achievement to the post math achievement, while high *SES* students showed a 27.22 point (3.42%) difference from the previous achievement to the post math achievement.

There was a statistically significant difference between *ethnicity* at $\alpha = .05$ level, F (1,128) = 3.69, p = .028, partial $\eta^2 = .06$, with an observed power of .669. The effect size for the study was ($\eta^2 = .06$) and the effect was inferred to be medium (Cohen, 1988; Tabachnick & Fidell, 2013); therefore, the magnitude of treatment effect was medium (Rovai et al., 2013). The observed power of .669 is close to the desired power of .8, hence inferring a reduced probability of a Type I error (Rovai et al., 2013). Therefore,

the researcher rejected the fourth null hypothesis. There was a statistically significant

difference in *ethnicity* from previous achievement to the post math achievement, with

African Americans showing a 23.64 point (2.98%) difference, Hispanics showing a 27.38

point (3.40%) difference, and Caucasians showing a 32.11 point (4.03%) difference.

There was a statistically significant difference between *ethnicity* and *SES* at $\alpha =$

.05 level, F (1,128) = 4.08, p = .046, partial η^2 = .03, with an observed power of .517.

The effect size for the study was (η^2 = .03) and the effect was inferred to be small

(Cohen, 1988; Tabachnick & Fidell, 2013); therefore, the magnitude of treatment effect is

small (Rovai et al., 2013). The observed power of .517 is considered reasonable to the

desired power of .8, hence inferring a reduced probability of a Type I error (Rovai et al.,

2013). Therefore, the researcher rejected the fifth null hypothesis. Pairwise comparisons

showed a statistically significance difference between African Americans and

Caucasians, *p* = .009. In addition, comparisons between individual race and *SES* revealed

a statistically significant difference between low *SES* Caucasians and high *SES*

Caucasians, *p* = .006. The lowest 2010 CRCT-Math mean scores resided with the low

SES students. The groups were ranked from lowest to highest with percentage of

increased scores: African American (low SES, *M* = 816.03, 2.79%), Caucasian (low SES,

M = 821.64, 3.42%), African American (high SES, *M* = 832.00, 2.37%), Hispanic (low

SES, *M* = 832.63, 3.40%), and Caucasian (high SES, *M* = 846.13, 5.49%).

Hypothesis Three Results

Hypothesis three stated there would be no statistically significant difference in

seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean scores when using the

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supplemental Classworks® program based on *socioeconomic status*. The researcher

concluded that the third null hypothesis failed to be rejected. The mean scores for low

SES (*M* = 819.16, *SD* = 24.46) and high *SES* (*M* = 841.64, *SD* = 22.12) revealed no

statistically significant difference from the previous achievement to the post math

achievement scores. Low *SES* students showed a 25.38 point (3.20%) difference from

the previous achievement to the post math achievement, while high *SES* students showed

a 27.22 point (3.42%) difference from the previous achievement to the post math

achievement.

Hypothesis Four Results

Hypothesis four stated that there would be no statistically significant difference in

seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean when using the

supplemental Classworks® program based on *ethnicity*. The researcher rejected the

fourth null hypothesis. The mean scores for African Americans (*M* = 817.63, *SD* =

21.67), Hispanics (*M* = 832.63, *SD* = 26.47) and males (*M* = 819.12, *SD* = 30.67)

revealed a statistically significant difference from the previous achievement to the post

math achievement scores. African Americans showed a 23.64 point (2.98%) difference,

Hispanics showed a 27.38 point (3.40%) difference, and Caucasians showed a 32.11

point (4.03%) difference from the previous achievement to the post math achievement.

Hypothesis Five Results

Hypothesis five stated there would be no statistically significant difference in

seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic and ethnicity*. The researcher rejected the fifth null hypothesis. There were significant differences between African American high/low *SES* students (23.64, 2.98%) and Caucasian high/low *SES* students (32.11, 4.03%), and between Caucasian low *SES* students (27.14, 3.42%) and Caucasian high *SES* students (44.06, 5.49%).

Findings and Summary

Research question one focused on the differences between the control group and the experimental group, using a one-way ANCOVA. The 2010 CRCT-Math mean scores for the experimental group presented a statistically significant difference from the control group according to the *p*-value of 0.000002. As a result, the first null hypothesis, H_0, that there would be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone, was rejected.

Research question two focused on the differences between females and males, using a one-way ANCOVA. The 2010 CRCT-Math mean scores for females presented no statistically significant difference from the males according to the *p*-value of 0.262. As a result, the second null hypothesis, H_0, that there would be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores

when using the supplemental Classworks® program based on *gender*, failed to be rejected.

Research question three focused on the differences between high *SES* and low *SES*, using a two-way ANCOVA. The 2010 CRCT-Math mean scores for high *SES* presented a statistically significant difference from the low *SES* according to the *p*-value of 0.184. As a result, the third null hypothesis, H_0, that there would be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*, failed to be rejected.

Research question four focused on the differences between African American, Hispanic, and Caucasian students using a two-way ANCOVA. The 2010 CRCT-Math mean scores for *ethnicity* presented no statistically significant difference according to the *p*-value of 0.028. As a result, the third null hypothesis, H_0, that there would be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean when using the supplemental Classworks® program based on *ethnicity*, was rejected.

Research question five focused on the differences between *socioeconomic status* and *ethnicity* using a two-way ANCOVA. The 2010 CRCT-Math mean scores for *SES* presented a statistically significant difference from *ethnicity* according to the *p*-value of 0.047. As a result, the fifth null hypothesis, H_0, that there would be no statistically significant difference in seventh grade students' math achievement and self-efficacy,

while controlling for previous math achievement, on the national CRCT-Math mean
scores when using the supplemental Classworks® program based on *socioeconomic*
status and *ethnicity*, was rejected.

Table 4.5

Findings for Research Questions and Null Hypotheses

		p-value	Reject Null
RQ1	1 H_0	0.000002	Yes
RQ2	2 H_0	0.262	No
RQ3	3 H_0	0.184	No
RQ3	4 H_0	0.028	Yes
RQ3	5 H_0	0.047	Yes

The results have suggested that there are significant differences between the control and
experimental groups, high *SES* and low *SES*, and *ethnicity* and *SES*. Chapter five will
conclude with a discussion of the findings in the study and propose a rationale for the
importance and implications of the results.

CHAPTER FIVE: DISCUSSION

Technology has permeated the halls of academia and revealed an array of effectiveness including (a) no significance (Kulik & Kulik, 1991; Sarama, 2004), (b) inconclusive effectiveness (Moos & Azevedo, 2009), (c) comparable to traditional instruction (Cook, 2009; Kulik, 1994; Schmid, Miodrag, & Di Francesco, 2008; Slavin & Lake 2008), and (d) to helpful and significant (Hannafin & Foshay, 2008; Larwin & Larwin; Tamin et al., 2011; Li & Ma, 2010). The positive results of technology have made individualized instruction more available and necessary. Legislators have influenced school systems to incorporate research-based instructional methods through the No Child Left Behind (NCLB) Act. School systems need to achieve Adequate Yearly Progress (AYP) under the NCLB Act or risk the loss of funding and imposed sanctions (GDOE, 2010c). Computer-based programs have the potential to address individual needs, including individualized learning pace, precise level of academic rigor, and specific direction of study.

The purpose of this causal-comparative study was to investigate the difference in seventh grade students' math achievement mean scores on the national Criterion-Referenced Competency Test (CRCT) between students who learn from traditional instruction and students who learn from traditional instruction with the supplemental Classworks® software program. The control and treatment groups represented two rural public middle schools in the central region of Georgia. The findings will be presented in this chapter, along with a discussion of the results, limitations, implementations, recommendations, and conclusion.

Research Questions

1. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national Criterion-Referenced Competency Test-Math (CRCT- Math) mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone?

2. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*?

3. Is there a statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status and ethnicity*?

Hypotheses

Null hypotheses 1: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT- Math mean scores when using traditional instruction with the supplemental Classworks® program compared to traditional instruction alone.

Null hypotheses 2: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for

previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *gender*.

Null hypotheses 3: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic status*.

Null hypotheses 4: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean when using the supplemental Classworks® program based on *ethnicity*.

Null hypotheses 5: H_0: There will be no statistically significant difference in seventh grade students' math achievement and self-efficacy, while controlling for previous math achievement, on the national CRCT-Math mean scores when using the supplemental Classworks® program based on *socioeconomic* and *ethnicity*.

Findings

Findings for Research Question One

Research question one focused on the result that the Classworks® supplemental math program had on the achievement scores of seventh grade students in two public school systems, measured by the 2010 CRCT-Math assessment. The control and experimental groups' descriptive statistics were used to make generalizations of the population. The descriptive statistics provided the basic measures of the study that forms a foundation for analysis. Inferential statistics were used to make statistical analyses. A one-way analysis of covariance (ANCOVA) was used to reveal the differences between

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the control and the experimental groups. The *p*-value of the ANCOVA was 0.000002, which indicated a statistically significant difference between groups. The experimental group had significantly higher scores than the control group on the CRCT-Math assessment (2010). The results were extremely positive for the experimental group. The null hypothesis was rejected with a *p*-value that indicated a strong difference between the control and experimental groups. There was a statistically significant difference in the experimental group, which showed a 27.22 point (3.42%) difference from the previous achievement to the post math achievement, compared to the control group, which showed a 12.37 point (1.52%) difference from the previous achievement to the post math achievement.

Findings for Research Question Two

Research question two focused on the differences between the achievement scores of seventh grade females and males in a public school system, measured by the 2010 CRCT-Math assessment. The descriptive statistics of the females and males were used to make generalizations of the population. The descriptive statistics provided the basic measures of the study that forms a foundation for analysis. Inferential statistics were used to make statistical analyses. A one-way analysis of covariance (ANCOVA) was used to reveal the differences between females and males. The *p*-value of the ANCOVA was 0.262, which indicated no statistically significant difference between groups. Within the experimental group, females scored slightly better (4.07 points) than males on the CRCT-Math assessment (2010). The results were very positive for females and males. The null hypothesis failed to be rejected. There was no statistically significant difference for females, who showed a 29.05 point (3.64%) difference from the previous

achievement to the post math achievement, compared to males, who showed a 24.98

point (3.15%) difference from the previous achievement to the post math achievement.

Findings for Research Question Three

Research question three focused on the differences between *ethnicity* and

socioeconomic status. Hypothesis three focused on the differences between high *SES* and

low *SES* on the achievement scores of seventh grade students in a public school system

measured by the 2010 CRCT-Math assessment. Descriptive statistics were used for

socioeconomic status to make generalizations of the population. The descriptive statistics

provided the basic measures of the study that form a foundation for analysis. Inferential

statistics were used to make statistical analyses. A two-way analysis of covariance

(ANCOVA) was used to reveal the differences between high *SES* and low *SES*. The

p-value of the ANCOVA was 0.184, which indicated no statistically significant

difference between the groups. Within the experimental group, high *SES* scored slightly

better (1.84 points) than low *SES* on the CRCT-Math assessment (2010). The results

were very positive for low and high *SES*. The null hypothesis failed to be rejected.

There was no statistically significant difference for low *SES*, which showed a 25.38 point

(3.20%) difference from the previous achievement to the post math achievement,

compared to high *SES*, which showed a 27.22 point (3.42%) difference from the previous

achievement to the post math achievement.

Hypothesis four focused on the differences among Africans, Hispanics, and

Caucasians on the achievement scores of seventh grade students in a public school

system measured by the 2010 CRCT-Math assessment. Descriptive statistics were used

for *ethnicity* to make generalizations of the population. The descriptive statistics provide

the basic measures of the study that form a foundation for analysis. Inferential statistics were used to make statistical analyses. A two-way analysis of covariance (ANCOVA) was used to reveal the differences among, African Americans, Hispanics, and Caucasian. The *p*-value of the ANCOVA was 0.028, which indicated a statistically significant difference between the groups. Within the experimental group, Caucasians scored significantly higher than African Americans on the CRCT-Math assessment (2010). The results were very positive for all ethnic groups. The null hypothesis was rejected. There was a statistically significant difference for *ethnicity* with African Americans showing a 23.64 point (2.98%) difference, Hispanics showing a 27.38 point (3.40%) difference, and Caucasians showing a 32.11point (4.03%) difference from the previous achievement to the post math achievement.

Hypothesis five centered on the differences between *SES* and *ethnicity* on the achievement scores of seventh grade students in a public school system measured by the 2010 CRCT-Math assessment. Descriptive statistics were used for *socioeconomic status* and *ethnicity* to make generalizations of the population. The descriptive statistics provide the basic measures of the study that forms a foundation for analysis. Inferential statistics were used to make statistical analyses. A two-way analysis of covariance (ANCOVA) was used to reveal the differences between *SES* and *ethnicity*. The *p*-value of the ANCOVA was 0.047, which indicated a statistically significant difference between the groups. Within the experimental group, Caucasians of high and low *SES* scored significantly higher than African Americans of high and low *SES* on the CRCT-Math assessment (2010). In addition, Caucasians of high *SES* scored significantly higher than Caucasians of low *SES* on the CRCT-Math assessment (2010). The results were very

positive for all groups of *ethnicity* and *SES*. The null hypothesis was rejected. The lowest 2010 CRCT-Math mean scores resided in low *SES* and high *SES*. The groups were ranked from lowest to highest with percentage of increased scores: African American (low *SES*, $M = 816.03$, 2.79%), Caucasian (low *SES*, $M = 821.64$, 3.42%), African American (high *SES*, $M = 832.00$, 2.37%), Hispanic (low *SES*, $M = 832.63$, 3.40%), and Caucasian (high *SES*, $M = 846.13$, 5.49%). There were significant differences between African American high/low *SES* (23.64, 2.98%) and Caucasian high/low *SES* (32.11, 4.03%), and between Caucasian low *SES* (27.14, 3.42%) and Caucasian high *SES* (44.06, 5.49%).

Discussion

Computers have been used for drill and practice, movies, fun activities, tutoring, and assessments for over 20 years. These types of approaches have resulted in weak learning outcomes (Kulik & Kulik, 1991; Sarama, 2004). Today, computer-based instruction focuses more on research-based strategies and programs that are pedagogically sound (Borokhovski, Tamin, Bernard, Abrami, & Sokolovskaya, 2012; Li & Ma, 2010; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011; Wang, Kinzie, McGuire, & Pan, 2009; Winters, Greene, & Costich, 2008). The broad conclusion on computer-based instruction for student achievement is fairly positive (Johnson & Rubin, 2011; Kulik, 1994; Sarama, 2004; Slavin & Lake, 2008). Several recent meta-analyses show moderate to significant impact on achievement. Both Li and Ma (2010) and Waxman et al. (2013) agreed that higher effect sizes over the past decade or two may have been established by more integration of constructivist strategies and pedagogical soundness in technology. Slavin and Lake (2008) conducted a meta-analysis on

mathematics programs that were effective. The study revealed positive results and saw "substantial positive effects of using CAI strategies, especially for computation" (p. 481). Computer-based instruction has shown positive results but still lacks thorough analysis, adequate implementation, and sufficient research-based program choices. The systematic process of incorporating research-based curriculum, aligned assessment standards, self-efficacy, learning styles, Bloom's taxonomies, active learning, adaptive learning, and pedagogical soundness in the Classworks® program provides a unique reinforcement to traditional instruction. Traditional instruction relies heavily on the quality of teachers and their ability to communicate knowledge while incorporating the vast array of taxonomy levels, learning styles, active learning strategies, and pedagogical soundness. Classworks® upholds teachers' strengths and overcomes teachers' weaknesses by providing the balance necessary for student achievement.

The conclusion of this study supports the positive effect of computer-based instruction on student achievement. The findings of this study are significant and add to the body of evidence. This study focused on seventh grade students from two similar schools. Both schools are rural Title I schools, used the Georgia Performance Standards (GPS), and come from the mid-Georgia region; they have similar income levels, ethnic diversity, and population size. The information gathered was ex post facto data. The experimental group started using the Classworks® program in the 2009-2010 school year. Therefore, data was collected from the control and experimental groups on the CRCT-Math mean scores for the spring of 2009 (previous achievement) and spring of 2010 (post math achievement). Demographic information was also collected, including *gender*, *ethnicity*, and *socioeconomic status*.

This study discovered that the control and experimental groups had unequal variances on the 2009 CRCT for the previous achievement. The control group was 16.87 points (2.12%) higher than the experimental group's mean scores. Consequently, a covariate was used to account for the differences. Normality was addressed by trimming and removing outliers, which established a normal distribution. The results of the 2010 CRCT scores, representing the post math achievement, showed similar mean scores, control $M = 825.01$ and experimental $M = 822.99$. The experimental group showed significant differences from the previous achievement to the post math achievement scores compared to the control group.

The one-way analysis of covariance (ANCOVA) for research question one showed a statistically significant difference between the control group and experimental group. The results for the experimental group were very positive. In fact, the experimental group showed more than twice the difference as the control group from previous achievement to post math achievement. The control group showed a 12.37 point (1.52%) difference and the experimental group showed a 27.22 point (3.42%) difference. Implementation of the Classworks® program might have made a difference in the statistically significant outcome of the experimental group. Other possible explanations could be the quality of the teachers, professional development received, and the resources the groups used during the 2009-2010 school year. Nevertheless, the experimental group raised their achievement significantly. This study supported past research conducted on the Classworks® program, which showed a positive to significant impact (McCrea, 2009; Millikin, 2008; Slavin & Lake, 2008; Turner, 2010).

The systematic process of incorporating research-based curriculum, aligned assessment standards, self-efficacy, learning styles, Bloom's taxonomies, active learning, adaptive learning, and pedagogical soundness in the Classworks® program provides a unique reinforcement to traditional instruction. Traditional instruction relies heavily on the quality of teachers and their abilities to communicate knowledge while incorporating the vast array of taxonomy levels, learning styles, active learning strategies, and pedagogical soundness. Classworks® upholds teachers' strengths and may help to overcome some of their weaknesses.

Hypotheses two, three, four, and five focused on the experimental group and the differences among their demographic statistics, including *gender*, *ethnicity*, and *socioeconomic status*. The one-way analysis of covariance (ANCOVA) for research question two showed no statistically significant difference between females and males. Nevertheless, the performance of females and males were very positive compared to the control group and the Georgia average. Both groups had similar previous achievement scores (female $M = 797.10$, males $M = 794.14$) and females made the largest difference on the post math achievement scores (female $M = 826.15$, 3.64%, males $M = 819.12$, 3.15%) with no significant difference. The Classworks® math program supports both females and males, respectively. In addition, the results showed that females overcame low self-efficacy and stereotypes compared to males. It appears that females were confident with the Classworks® software program and utilized technology very well to achieve considerable differences. Females made significant differences (29.05 points) over the Georgia average differences of 11 points and the control group differences of 12.37 points. The outcome for females was very positive.

The two-way analysis of covariance (ANCOVA) for hypothesis three showed no statistically significant difference between high *SES* and low *SES*. The results were very positive for high and low *SES* and showed significantly higher results over the control group and Georgia averages. Similar to *ethnicity*, a disproportionate number of participants are in the low *SES* ($n = 107$) category compared to the high *SES* ($n = 22$) category. However, the results supported some studies in regard to *socioeconomic status* that showed a positive effect on low *SES* by utilizing technology (Fairlie, 2012; Leach & Williams, 2007) but not as dramatic as high *SES* by utilizing technology (Matsumura, Slater, & Junker, 2006). The high *SES* group had no statistically significant amount of improvement over the low *SES* group. Low *SES* students showed a 25.38 point (3.20%) difference from the previous achievement to the post math achievement means, while high *SES* students showed a 27.22 point (3.42%) difference from the previous achievement to the post math achievement means. The Classworks® math program may have a better effect on high *SES* students. Students with high *SES* may have an advantage in their everyday lives. Computers, software, resources, and other electronic devices are more readily available to high *SES* students. They have more experience using the various applications with computers, which stimulate background knowledge, schemas, and previous experiences. Consequently, low *SES* students may be learning or struggling with the basics of computer use and navigation, rather than utilizing background knowledge and previous experiences. The disproportionate number of participants in the low *SES* category may have impacted the results as well. Hence, the differences in low *SES* participants of 25.38 (3.20%) are better than the differences of male participants of 24.98 (3.15%), which may speak to adequate differences overall for

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the low *SES* bracket. Classworks® appeared to support both high and low *SES* participants, respectively. In addition, the results showed that low SES upheld low self-efficacy and stereotypes compared to high *SES*. Nevertheless, low *SES* made significant differences (25.38 points) over the Georgia average differences of 11 points and the control group differences of 12.37 points. The results are extremely positive for low *SES*, and show the potential for raising academic achievement while using the Classworks® math program.

The two-way analysis of covariance (ANCOVA) for hypothesis four showed a statistically significant difference among *ethnicity*. The overall results showed very positive outcomes for ethnicity compared to the control group and the Georgia average. Nevertheless, some results were more difficult to interpret. The distribution of participants was not evenly distributed nor substantially represented among Hispanics (African American = 72, Hispanic = 9, Caucasian = 55). The mean score differences rose for African Americans 23.64 (2.98%), Hispanics 27.38 (3.40%), and Caucasians 32.11 (4.03%). There was a statistical significance difference between African Americans and Caucasians with a *p*-value of .009. In addition, the results revealed that African Americans and Hispanics upheld low self-efficacy and stereotypes compared to Caucasians. Nevertheless, African Americans showed a 23.64 point difference and Hispanics showed a 27.38 point difference and did significantly better than the Georgia average differences of 11 points and the control group differences of 12.37 points. The results are extremely positive for minorities, and show the potential for raising academic achievement while using the Classworks® math program.

The two-way analysis of covariance (ANCOVA) for hypothesis five showed a statistically significant difference between *socioeconomic status* and *ethnicity*. The overall results are very positive for *SES* and *ethnicity* compared to the control group and the Georgia average. The low *SES* of African Americans and the low *SES* of Caucasians appeared to lag behind the high *SES* of Caucasians. The groups were ranked from lowest to highest: low *SES* African American ($M = 816.03$, point difference of 22.04, 2.78%), low *SES* Caucasian ($M = 821.64$, point difference of 27.14, 3.42%), high *SES* African American ($M = 832.00$, point difference of 19.29, 2.37%), low *SES* Hispanic ($M = 832.63$, point difference of 27.38, 3.40%), and high *SES* Caucasian ($M = 846.13$, point difference of 44.06, 5.49%). The results supported previous studies that show low *SES* of African Americans and low *SES* of Caucasians are far behind high *SES* of Caucasians (Cheung & Slavin, 2013; Fairlie, 2012). However, remembering that the distribution of participants was not evenly distributed nor substantially represented among Hispanics is important (African American = 72, Hispanic = 9, Caucasian = 55). In addition, there were no high *SES* Hispanics represented. The smallest differences from previous achievement to post math achievement were low *SES* African American participants at 22.04 (2.78%) and high *SES* African American participants at 19.29 (2.37%). Classworks® appears to support post math achievement differences in *SES*/*ethnicity* for low *SES* Caucasian 27.14 (3.42%), high *SES* Caucasian 44.06 (5.49%), and low *SES* Hispanic 27.38 (3.40%). There was a statistically significant difference between low *SES* Caucasian and high *SES* Caucasian with a *p* value of .006. Low *SES* Caucasian showed a 27.14 point (3.42%) difference and high *SES* Caucasian showed a 44.06 point (5.49%) difference. *Socioeconomic status* appeared to have made a difference. Nevertheless, low

SES Caucasian showed a 27.14 point (3.42%) difference, which is equivalent to the differences of the overall experimental group, 27.22 points (3.42%). In addition, the results showed that low *SES* of African Americans and low *SES* of Caucasians upheld low self-efficacy and stereotypes to high *SES* of Caucasians. Nevertheless, low *SES* of all ethnicities made significant differences over the Georgia average of 11 points and the control group average of 12.37. The results are extremely positive for minorities and low *SES*, and show the potential for raising academic achievement while using the Classworks® math program.

Limitations

Based on the early stages of learning technology, the availability of few research-based instructional programs, and the insufficient body of research on Classworks®, further research is needed. Technology in education should continue to grow and studies will be needed to substantiate the learning trend's effectiveness. Classworks® has shown significant effectiveness through various studies (McCrea, 2009; Millikin, 2008; Slavin & Lake, 2008; Turner, 2010) and fosters further research and analysis.

There are several limitations to consider in this study. Participant data in this study presented limited generalizability. The participating school systems were restricted to two rural Title I middle schools in central Georgia, and focused exclusively on seventh grade student participation. The results of the study may not be germane to various school districts and diverse geographical compositions. In addition, results may not be relevant to other state standardized tests or standards in math.

In the commencement of this research, efforts were made to incorporate a quasi-experimental design for more rigorous analysis. There was reluctance from school

officials to accommodate the study. They feared that their overall test scores would be adversely affected and only existent data should be used. Unfortunately, current school culture is focused mainly on previous research and methods to fulfill accountability, which may stifle student achievement. If school culture could embrace and encourage new ideas, innovation, and research, greater progress could be made for academics. A causal-comparative study was used and utilized ex post facto data. The study is less rigorous than true experimental or quasi-experimental studies. However, the results of a causal-comparative study can lead to more rigorous studies in the future. The control and experimental groups were not randomly assigned for optimal sampling. Rather, convenience samples were used. The CRCT-Math mean scores for the years 2009 and 2010 were used to measure differences among the groups. The CRCT assessments do not constitute a pre and posttest analysis for measuring gains. It is important to understand that each grade level is tested on different standards and information and cannot recognize gains from year to year. Therefore, the CRCT scores hold less weight for analysis when analyzing group differences. The 2009 CRCT-Math mean scores were used as the covariate to prevent selection bias and show equivalence between groups. Initially, the control and experimental groups were paired according to *gender*, *ethnicity*, and *socioeconomic status*, strengthening equivalence. After testing for normal distribution, the groups were trimmed and outliers removed, which helped evaluate differences.

Further limitations consisted of different school systems, teacher quality, and research study design. Each school system may have used various teacher programs to enhance effectiveness in the classroom. This may have strengthened or weakened

achievement between groups. Teacher quality (e.g., knowledge, degrees, experience, etc.) was not measured and may have varying influence on academic achievement between groups. The scope of this causal-comparative study is circumscribed. This study was a precursor to ascertain if the supplemental Classworks® program for math was an efficacious treatment for raising CRCT-Math scores.

Implementations and Recommendations

Based on the early stages of learning technology, the availability of few researched-based instructional programs, and an insufficient body of research on Classworks®, further research is needed. Technology in education should continue to grow and studies will be needed to substantiate the learning trend's effectiveness. Classworks® has shown significant effectiveness in various limited studies (McCrea, 2009; Millikin, 2008; Slavin & Lake, 2008; Turner, 2010); therefore, further investigation is warranted.

Replicating this study would help to better understand the effectiveness of Classworks®. Expanding the size and scope of this research would be helpful and should include adequate sample sizes of *gender*, *ethnicity*, and *socioeconomic status*. Studies should include various grade levels and incorporate various school districts and settings. Convincing school officials and administrators to allow true experimental studies would also provide a more thorough analysis. School systems should strive to lead the way with researched-based computer programs and not be satisfied with the present levels of accomplishment. School systems need to understand that technology is the future of education that must be systematically examined. Many legislators and school districts utilize different standards and standardized testing to show student achievement.

Additional studies in different assessments may be warranted. The effectiveness of Classworks® on students with disabilities may provide interesting results. Utilizing technology has increased in recent years for students with disabilities. No Child Left Behind has focused on at-risk students and incorporating technology to raised academics. Future studies should center on students who are limited in English, as well as economically and socially disadvantaged.

This causal-comparative study should inspire other researchers to investigate more in the Classworks® program. Affirmative statistical evidence can lead to more inquiries that are substantial. This study may point researchers to conduct more meticulous research designs, including experimental and quasi-experimental instruments.

Conclusion

Reforms in education have been thrust upon school systems from federal, state, and local jurisdictions to raise the achievement for all students from all backgrounds. Mandates from No Child Left Behind (NCLB) and Race to the Top all the way to Common Core State Standards (CCSS) speak to the seriousness of the situation. The era of technology is here that incorporates research-based instruction, self-efficacy, active learning strategies, adaptive learning strategies, taxonomies, and pedagogical soundness. Programs like Classworks® are leading the way to overcome the stagnant performance of education in a new and exciting way. Technology in the classroom has the potential to assist students with individualized learning by strengthening weaknesses and improving strengths, while at the same time assisting teachers with analysis, statistics, and progress reports.

The purpose of this causal-comparative study was to examine the differences among students' mathematics achievement and self-efficacy who learn from traditional instruction and students who learn from traditional instruction with the supplemental Classworks® program. The results of the study showed a statistically significant difference between the control group and the experimental group. The experimental group more than doubled the control group's previous achievement to post math achievement mean scores. The experimental group showed a statistically significant difference between *ethnicity* and between *socioeconomic status* and *ethnicity*. There were statistically significant differences with Caucasians making greater differences over African Americans, and high *SES* Caucasians outperformed low *SES* Caucasians. Recommendations for future study with the Classworks® program consist of reproducing the study with larger sampling, incorporating more rigorous instruments including experimental and quasi-experimental studies, and studying participants of all age groups and diverse backgrounds.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL

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The Graduate School at Liberty University

May 6, 2013

Todd Clark
IRB Exemption 1605.050613: Differences in Math Achievement: Utilizing Supplemental Computer-Based Instruction and Traditional Instruction

Dear Todd,

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 to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 46.101 (b)(4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:

> (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

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

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master's thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.
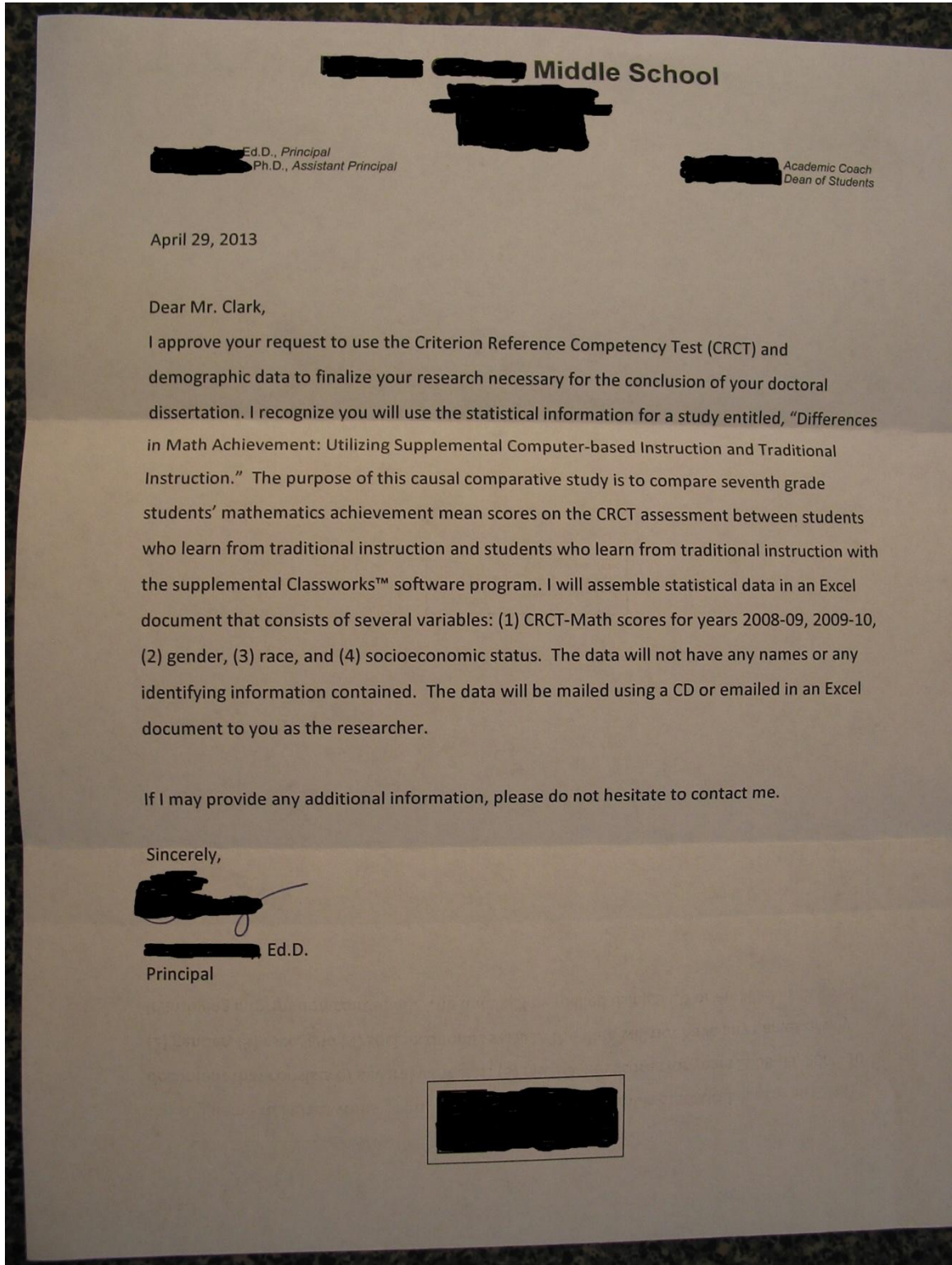
Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

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APPENDIX B: APPROVAL LETTER FROM THE CONTROL GROUP
Data Permission Letter

██████ ████ Middle School

████████

████████ Ed.D., *Principal*
████ Ph.D., *Assistant Principal*

████████ Academic Coach
Dean of Students

April 29, 2013

Dear Mr. Clark,

I approve your request to use the Criterion Reference Competency Test (CRCT) and demographic data to finalize your research necessary for the conclusion of your doctoral dissertation. I recognize you will use the statistical information for a study entitled, "Differences in Math Achievement: Utilizing Supplemental Computer-based Instruction and Traditional Instruction." The purpose of this causal comparative study is to compare seventh grade students' mathematics achievement mean scores on the CRCT assessment between students who learn from traditional instruction and students who learn from traditional instruction with the supplemental Classworks™ software program. I will assemble statistical data in an Excel document that consists of several variables: (1) CRCT-Math scores for years 2008-09, 2009-10, (2) gender, (3) race, and (4) socioeconomic status. The data will not have any names or any identifying information contained. The data will be mailed using a CD or emailed in an Excel document to you as the researcher.

If I may provide any additional information, please do not hesitate to contact me.

Sincerely,

████████

████████ Ed.D.
Principal

████████

APPENDIX C: APPROVAL LETTER FROM THE EXPERIMENTAL GROUP
Data Permission Letter

Telephone ▮▮▮▮▮
Fax ▮▮▮▮▮

January 07, 2013

To: Todd C. Clark

From: ▮▮▮▮▮▮▮▮, Superintendent

Re: Research Approval

I approve your request to use the Criterion Reference Competency Test (CRCT) data to finalize your research necessary for the conclusion of your doctoral dissertation. I recognize you will use the statistical information for a study entitled, "Differences in Math Achievement Before Using and After Beginning the Use of the Classworks™ Software Program." The purpose of this causal comparative study is to compare the Class of 2016 students' mathematics achievement scores on the CRCT assessment before and after using the supplemental Classworks™ software program while comparing the relationships among its independent variables (e.g., gender, socioeconomic status, and race).

Mr. Dale will assemble statistical data in an Excel document that consists of several variables: (1) CRCT-Math scores for years 2006-07, 2007-08, 2008-09, 2009-10, 2010-11, 2011-12, (2) gender, (3) race, (4) socioeconomic status, and (5) age for your use. The data will not have any names or any identifying information contained. The data will be mailed using a CD or emailed in an Excel document to Todd Clark.

Sincerely,

APPENDIX D: CLASSWORKS® GRAPHIC PERMISSION

Copyright Permission

← REPLY   ← REPLY ALL   → FORWARD   ...

Rebecca Lathem <rlathem@classworks.com>
Tue 10/1/2013 4:48 PM

mark as unread

To: Clark, Todd C;

 1 attachment

CopyrightPe
—.docx

Action Items   + Get more apps

Dear Todd Clark,

I have reviewed your request for using copyright for your dissertation titled "Differences in Math Achievement: Utilizing Supplemental Computer-based Instruction and Traditional Instruction."   I give you permission to use the graphics entitled "Instructional Unit Grade 1-8," "Mini-Lesson," Instructional Activities," "Quick Quiz," "Review Instructional Activities," "Project," and "Assignment Results."

Please use a registered sign after your first use of the name Classworks as well as specify that it is by Curriculum Advantage, Inc. For instance, the first time you mention the product please use "Classworks® by Curriculum Advantage, Inc." then you can just refer to it as "Classworks" from there on. Please also show that copyright of these graphics are the property of Curriculum Advantage, Inc.

Also, we would LOVE to see a copy of the final dissertation and possibly even feature the study on our website. Once you have the study completed, please send a copy my way for review.

I look forward to seeing the results of your hard work!

Sincerely,

Rebecca

Rebecca Lathem
Marketing Manager
Curriculum Advantage, Inc.
T: 770-325-6715
E: rlathem@classworks.com

APPENDIX E: INVESTIGATOR AGGREEMENT & SIGNATURE PAGE

Minimal risk is defined as "the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests." [45 CFR 46.102(i)]

IV. INVESTIGATOR AGREEMENT & SIGNATURE PAGE*

BY SIGNING THIS DOCUMENT, THE INVESTIGATOR AGREES:

1. That no participants will be recruited or entered under the protocol until the Investigator has received the final approval or exemption email from the Chair of the Institutional Review Board.
2. That no participants will be recruited or entered under the protocol until all key personnel for the project have been properly educated on the protocol for the study.
3. That any modifications of the protocol or consent form will not be initiated without prior written approval, by email, from the IRB and the faculty advisor, except when necessary to eliminate immediate hazards to the participants.
4. The PI agrees to carry out the protocol as stated in the approved application: all participants will be recruited and consented as stated in the protocol approved or exempted by the IRB. If written consent is required, all participants will be consented by signing a copy of the approved consent form.
5. That any unanticipated problems involving risks to participants or others participating in the approved protocol, which must be in accordance with the Liberty Way (and/or the Honor Code) and the Confidentiality Statement, will be promptly reported in writing to the IRB.
6. That the IRB office will be notified within 30 days of a change in the PI for the study.
7. That the IRB office will be notified within 30 days of the completion of this study.
8. That the PI will inform the IRB and complete all necessary reports should he/she terminate University Association.
9. To maintain records and keep informed consent documents for **three years** after completion of the project, even if the PI terminates association with the University.
10. That he/she has access to copies of 45 CFR 46 and the Belmont Report.

Todd Clark

Principal Investigator (Printed) Principal Investigator (Signature) _2/26/13_ Date

FOR STUDENT PROPOSALS ONLY

BY SIGNING THIS DOCUMENT, THE FACULTY ADVISOR AGREES:

1. To assume responsibility for the oversight of the student's current investigation, as outlined in the approved IRB application.
2. To work with the investigator, and the Institutional Review Board, as needed, in maintaining compliance with this agreement.
3. That the Principal Investigator is qualified to perform this study.
4. **That by signing this document you verify you have carefully read this application and approve of the procedures described herein, and also verify that the application complies with all instructions listed above.** If you have any questions, please contact our office (irb@liberty.edu).

Nathan Putney

Faculty Advisor (Printed) Faculty Advisor (Original Signature) _2/27/13_ Date

*The Institutional Review Board reserves the right to terminate this study at any time if, in its opinion, (1) the risks of further experimentation are prohibitive, or (2) the above agreement is breached.