The Effects of an Extended Day Math Program – "The Bobcat Club"

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Introduction

Orientation to the Topic

Georgia's average mathematics score for fourth grade students in 2011 of 238 was lower than that of the nation's public schools which was 240. Of further concern is the fact that the number of economically disadvantaged students in the state of Georgia is growing, and the average mathematics score for students who were eligible for the National School Lunch (NSL) Program grew from 225 in 2009 and 227 in 2011 (U.S. Department of Education, 2012.) With continued research based on math performance for students with disabilities, one may conclude that the rising number of economically disadvantaged students with math deficiencies is not receiving enough attention. As Caban-Vazquez pointed out, the category of "academically" disadvantaged students are defined by the fact that they struggle in math, they are minority in race, and they come from low income families (2010.) "Participant E," in Caban-Vazquez's research was quoted by saying, "They were usually some who were close to getting passing test scores and the parents wanted them to get this extra support for the test and be part of the math program" (2010, p. 78)

In broader view, according to U.S. Department of Education's Center for Education Statistics (2012), only 71% of 4th grade students on free lunch status are at or above basic math achievement levels. These facts alone call for further attention as we move into the overwhelming era of Common Core implementation. Low income students are continuing to fall behind. Today, numerous programs exist that are specifically directed at growing student achievement for this demographic through differentiating instruction and extending the school day. In 2011, researcher Matthew Burns stated, "Recent research has suggested that a skill-by-treatment interaction might be a promising approach to determine interventions for math with a high likelihood for success (as cited in Burns, Codding, Boice, & Lukito, 2010). Burns' research is among the latest in a long enduring effort to report findings on the importance of math performance at an early age. In his report "The U.S. Executive Summary of Mathematics Equals Opportunity," Richard W. Riley, the U.S. Secretary of Education, discusses the importance of 8th grade math and how, "Algebra is the "gateway" to advanced mathematics and science in high school, yet most students do not take it in middle school" (1996, p. 16) The prevalence of underperforming low income students at Bobcat Elementary, a title I school in Cobb County, needs a firm solution grounded in experienced administrative action and effective teaching efforts to create a steady upward trend.

According to data analysis from Bobcat Elementary, math performance of economically disadvantaged students from 2011 is 6% lower (79%) than it was 5 years ago in 2006 (85%) (Principal Bobcat Elementary, personal communication, October 24, 2012.) Our primary means of intervention is a software package called "Classworks." Its purpose is to affect a positive change in math through a combination of computer-assisted instruction (CAI) and teacher based intervention strategies. As an administrative team member for our Flexible Learning Plan (FLP), the "Bobcat Club" extended day program, we have discussed our after school structure as well as the students to be selected. Teacher training for our program was conducted on October 15, 2012, and continued software training occurs daily for any teacher in need of instructional assistance. Our 4 to 1 student teacher ratio combined with a variety of computer and small group based instruction should prove successful over the coming months in closing the achievement gap in math. The "Bobcat Club" will also provide transportation home or the option for students to attend one of the after school clubs.

According to the U.S. Department of Education, teachers spending an average of 5-6.9 hours of math instruction per week has dropped from 69% in 2005 to 51% in 2011(U.S. Department of Education 2012.) This is a significant depreciation. One opinion offered by the Principal at Bobcat Elementary states that instruction appears to have changed to more a condensed approach towards teaching the standard. One could argue that the reduced amount of time is a direct result of declining district budgets as well as an attempt to teach CRCT related content. At Bobcat Elementary, it appears that boys have been most affected. Between 2010 and 2011, girls outperformed boys in math by nearly 10% (Principal Bobcat Elementary, personal communication, October 23, 2012.) Although I located gender-specific selections for extended day programs, I could find no specific data referring to single gender grouping, a characteristic of the "Bobcat Club."

Purpose Statement

The purpose of this study is to explore the effect of an extended day program on the performance in math among low achieving third through fifth grade economically disadvantaged students. Factors such as high transient rates, single parent families, poverty level income, reduced parental support, limited access to technology away from campus, large class sizes, reduced amounts of instruction time in math, and the appearance of a stronger focus on students with documented disabilities, all contribute in some fashion to the fact that these students are not performing at a higher rate. When considering a variety of instructional methodologies in the equation, these students could again be passed over. This researcher's personal experience with the development of a faulty math foundation qualifies the purpose of this research. Some instructional approaches are simply not effective in identifying strand and domain level problems in math. This leads to ineffective assignments and thwarts the best possible scenario for success.

Delivery of the content and its real world application in a rigorous and relevant format is proven to stand the best chance in the creation of a solid mathematical foundation. Therefore, the purpose of this study is to investigate the effectiveness of the extended day computerized math program with disadvantaged students.

Importance of the Study

Why are these students continuing to perform on the edge of success, and what are the factors involved with the conception of this problem? The severity of the situation has quietly remained consistent over the past 5 years. The data collected in this study will offer a relevant and broad perspective of student and faculty perceptions on extended day instruction, the effectiveness of technology, and the effects of small group instruction as research in these areas is scant at best on the elementary level. This research will add to long span of the effectiveness with CAI in the classroom and in the extended day format. Research has shown that extended day programs, computer assisted instruction, and effective teaching practices are solutions to raising math performance (Lewis 2010.) As we continue to move into the common core era and in addition to the growing list of effective math interventions for students with disabilities, it will also be essential to train teachers in methods for reaching students who are in danger of falling behind due to economic circumstances.

Research questions

My central research question is as follows: Do students attending a computer-based extended day program have higher math achievement than those who do not? The sub-questions are as follows: What are students' perceptions of the computer-based math curriculum? What are the teacher's perceptions of effective teaching strategies during the extended day program?

Definition of terms

Bobcat Club: A required extended day program with an emphasis on math and reading for economically disadvantaged students as well as students who are not performing on grade level. The program is a requirement of the state for "focus" schools as determined by the waiver to NCLB (U.S. Department of Education, 2012.)

CAI: refers to Computer Assisted Instruction (Lewis, 2010.)

Classworks: is a software package provided by Curriculum Advantage. The platform provides a series of screenings, skill snapshots, instruction, and assessments through computer assisted instruction in math and reading.

CRT: is a criterion referenced test.

ILP: is an individualized learning plan.

Skills Snapshot: is a domain level lesson assigned according to screener scores. Its purpose is to measure student mastery of the material and automatically create an individualized learning plan for skills not mastered.

Universal Screener: is a test to measure grade level readiness in math.

Literature Review

Extended Day Programs

Extended day programs have been in existence since the 1940s with a dual purpose of serving students with working parents and providing more academic time to underprivileged students (NCES 1997). Today, these programs are being used to combat the achievement gap in student performance. A recent resurgence has taken place regarding the topic of lengthening the school day as well as the school year. The President and the Secretary of Education have both asked the nation to look at extending time for education (Patall, Cooper, Allen, 2009.) Recent research has shown that in order to close the achievement gap, the primary catalyst for effective results rests upon the teacher's ability to accurately diagnose and assign appropriate intervention material through an extended day format (Caban-Vazquez 2010).) The interest in extended day programs has been pursued across the nation for four decades. Patall et al., (2009) states that more than 300 extended learning initiatives were launched between 1991 and 2007 in high poverty and high minority schools across 30 different states. In an effort to study the effectiveness of these programs, a review was conducted of more than 30 research initiatives between 1971 and 2008 (Patall et al., 2009). For example, Adelman, Haslam, and Pringle (as cited in Patall et al., 2009) reported dramatic improvement with 14 Boston schools that extended the day to 7.5 hours. Their state reading test results improved from 77% to 90% over a 3 year period. New York, North Carolina, New Jersey, and Louisiana are among several other states with documented achievement gains due to an extended day format. Furthermore, Patall et al., (2009) reports a small chance of a negative effect as a result of extended time, and that many of the findings may be more helpful to students who are high failure risks, but the primary conclusion is supported by an effective structure to the extended day.

Computer Assisted Learning

Lowe, (as cited in Patterson, 2005) reports that the educational use of computers can be traced to the early 1980's. Traynor (as cited in Lewis, 2010) stated that computer-assisted instruction (CAI) could be useful in accommodating student needs and increasing student math achievement. Today, elementary school students have only known a technology based world, and their ability to learn through technology at a very young age seems almost innate. The use of computers in the classroom to supplement instruction at the elementary level is critical for success. A synthesis of effective math programs conducted by Slavin & Lake (2008) reviewed approaches to growing math achievement. According to their research, the most effective studies were developed around cooperative learning, motivation programs, and supplemental tutoring programs, and they showed that as little as three 30-minutes computer based sessions per week as a supplement to the curriculum will show positive results.

As part of the NCLB waiver for the state of Georgia, the newly implemented College and Career Readiness Index (CCRPI) is the instrument for achievement accountability (U.S. Department of Education, 2012), and CAI will play a vital role in our success. "Focus" schools must close the gaps in math achievement, but the decision for choosing appropriate software is difficult with the multitude of achievement software available. Slavin et al., (2008) cited four separate elementary based computer assisted instruction packages. "Classworks," the package purchased by the Cobb County School District, was among the four that were studied. Early research from the effectiveness of "Classworks" shows minimal positive effects (Slavin et al., 2008), but a more recent study of the software in Mitchell County, Georgia demonstrated a 6.1% increase in math achievement for the 2011-12 school year (Classworks Curriculum Advantage, 2012.) Another quasi-experimental study in Texas among 30 third grade students over a 14 week period showed a 9.06% increase in math post-test results while using the "Classworks" software (Patterson, 2005). Patterson also stated how this type of software has progressed from a stand-alone format to integrated learning systems where the interactivity with the software will adjust the activities based on the students' progress (2005.)

Since 1991, students who participated in CAI showed an 81% gain in academic performance (Patterson, 2005). He also reports the difficulty in integrating computers into classroom instruction and that only 43% of elementary teachers assign CAI (as cited in Becker, Ravitz, & Wong 1999.) Although a specific percentage of actual CAI at Brumby Elementary can only be estimated, the fact still remains that our technology is outdated, slow, and limited in quantity. In addition to this, the district's servers incur intermittent internet issues with the Classworks software, thus rendering a higher level of frustration and a potential for skewed data due to incomplete test results. This will be a barrier for us to overcome in the coming months in addition to the fact that our teachers will undergo a learning curve with the application of the software.

Individualized CAI, in addition to classroom instruction, has also proven to be effective for low achieving students. Burns, Kanive, DeGrande (2010) reported significant gains from 216 fourth grade students through the use of a computer-based fact fluency intervention. Researchers at the University of Massachusetts Amherst assessed 125 fourth graders in three rural communities by the using "4MALITY" web based tutoring software (Burns et al., 2010). "4MALITY" was used as necessary for low achieving math students in addition to normal classroom instruction. Their results posted a mean gain of 25.51% while 36 students posted gains of 40% or more from pre-test to post-test (Maloy, Edwards, & Anderson 2010.) In 2002, a Meta-analytic study was conducted of 15 mathematics interventions designed to improve performance in low achieving students (Baker, Gersten, & Lee, 2002.) Their conclusions yielded several consistent findings: providing students and teachers with specific performance information enhances achievement; peer tutoring is effective to support low achievers, providing specific feedback to parents seems to enhance achievement, and finally principles of direct or explicit instruction is helpful for math concepts and procedures (Baker et al., 2002.)

Students Served

The "2011 State Snapshot Report" states that students in this subgroup scored an average of 25 points lower than non-economically disadvantage students (U.S. Department of Education, 2012). This statistic has remained relatively consistent since 1996. Furthermore, only 18% of Blacks and 29% of Hispanics were at or above proficiency in math, and both male and female subgroups were at 37% at or above proficient. On a larger scale, Georgia was only ahead of nine other states in mathematics performance during 2011.

Perceptions of an Extended Day Program

The components to consider as reasons for Georgia schools not meeting the needs of our low achieving and economically disadvantaged students can be attributed to the following possibilities: overcrowded classrooms, insufficient teacher training, and insufficient technology for the classroom. Additionally, economically disadvantaged students simply do not have easy access to technology away from school due to lack of resources, and many of them are placed in parental roles by supporting siblings while parents are at work. This situation places many of these students at risk for failure. As discussed in the U.S. Department of Educations "After-School Programs in Public Elementary Schools" (2009), Supplemental Educational Sources such as an extended day, are the most appropriate opportunity to assist students at risk of failure.

Three themes were explored as part of a dissertation centered on a Supplemental Educational math program with economically disadvantaged students: program structures, after school students, and after school instructional strategies (Caban-Vazquez, 2010.) After linking the similarities of Caban-Vazquez's themes with those of the "Bobcat Club," I expect to find similar results in my assessment. The program structures of both are created around CRT data. In other words, state testing data was the primary source used for the selection of participants (Caban-Vazquez, 2010, p. 69.) Some students were allowed to participate despite the range of their test scores, as collaboration among teachers would determine specific students who truly needed the extra time. Several teachers have questioned why certain students were not selected based on the CRT qualifier. The answer is that Title I funding for the "Bobcat Club" will only support specific subgroups (Dr. Richie, Principal, personal communication, September 2012), and the State Education Agency (SES) places top priority on economically disadvantaged students. In addition to this, we are required to include grades kindergarten through fifth grade. Most of the research discovered on the elementary level has only included second through fifth grade.

After further exploration of Caban-Vazquez's "after school students" theme, another commonality can be noted in that the research was conducted on students without disabilities, and I found the same for Patterson's research in 2005. Several of the teachers responses in Caban-Vazquez's research described these students as being at risk for failure, and according to her research, this type of student has been classified as academically disadvantaged (2010).

As a final point of interest in Caban-Vazquez's research, a reference was made to the minority math gap. Latino's and African-American students were the primary demographic with math difficulties; however, Patterson stated that 57% of participants in his study were Anglo with only 37% Hispanic, and 6% African-American. With both research assessments yielding positive results in closing the achievement gap, one can assume that the structure of the extended day program is pivotal for success despite ethnicity and that the instructional strategies and motivational teaching are the primary source for a successful extended day environment.

A closer look at instructional strategies as part of the extended day program provides further insight to the success of the extra time, and as noted earlier in Patall et al., (2009, p. 430.), the most productive extended day programs plan effectively for the time. With regards to structure, Caban-Vazquez discovered three subthemes that directly affect teacher's ability during extended time. They are instructional technology, cooperative learning instructional strategies, and strategy-based math instruction. The "Bobcat Club" teachers will be presented with a 3 tier planning initiative involving training and planning with the "Classworks" software, analyzing the pre-test baselines for each student in their group, and creating differentiated plans for small group learning strategies based on common core implementation (U.S. Department of Education, 2012.)

Summary

With so much discussion concerning teachers, time, and technology, consideration needs to be given to the student's perceptions of learning through an extended day format. Theoretically, it is possible that a longer academic day may produce a negative effect on student's attitudes after settling into a routine. Mottet, Garza, Beebe, House, Jurrells, & Furler (2008) examined 497 ninth grade student's perception of their teacher's instructional communication behaviors in math and science. The primary conclusion they found is that the use of clear content delivery and course content that speaks directly to life skills are the most effective instructional characteristics that a teacher can possess. In contrast, teacher's perceptions of extended time strategies learned through professional development were met with observations of fully engaged students provided the time was used to focus on quality teaching (Gould, 2010, p.92.) No perception data or research was located at the elementary level. Perception research is complex in nature, and although it is not a primary component in my research, I feel it is important to include how our students feel about their teachers, the content, the instruction, and how it affects their classroom instruction.

Methodology

Research Design

The intent of this concurrent mixed methods study was to examine academic growth. The researcher served as an administrator over the "Bobcat Club" and had the opportunity to collect information from a variety of sources. The researcher utilized a mixed methods approach to gather and report findings. The quantitative component measured the overall effect of the extended day program and provided evidence to the local and state education agencies. The qualitative assessment created a framework around the extended day, CAI, and perception portions of the program from multiple perspectives thus allowing for a holistic measurement of the program's value in growing math achievement.

Case Selection

At Bobcat Elementary, a 34.6% gap exists in math between the White and SWD subgroups. Furthermore, economically disadvantaged students across all subgroups have grown from 68% in 2006 to 79% in 2011. Due to this deficiency, the learning portion of our day was extended as required by our State (SEA) and Local (LEA) Education Agencies (U.S. Department of Education, 2012.) As one of five newly designated "focus" schools in the Cobb County District, Bobcat Elementary unveiled its first extended day program as required by Title I and

Metro RESA officials under the NCLB waiver (U.S. Department of Education 2012). The program known as the "Bobcat Club" began on October 29, 2012 and is scheduled for completion on May 16, 2013. It is comprised of 31 teachers, 2 administrators, and 126 students from kindergarten through fifth grade. The numbers will fluctuate in small amounts as students move, and as we adjust the classroom settings with regards to student-teacher ratio and software implementation. A majority of these students have demonstrated insufficient math skills, and they also fall into the economically disadvantaged subgroup.

Quantitative Data Collection

Pretest and posttest quantitative instruments in the form of a "Universal Screener" were used to measure the actual gains among "Bobcat Club" students in grades 2 through 5. The screener measured if a student is performing on grade level through a scaled score. The results of the screeners were broken down into domain and strand level success ratios. The teachers then assigned "skills snapshots" that automatically generated an individualized learning plan (ILP) for skills that were not mastered. The final quantitative results were correlated in a paired t-test format. The researcher also quantified data points available through both student questionnaires and teacher interviews.

Qualitative Data Collection

The structure of the extended day program was explored through interviews with seven teachers, the administration of student questionnaires with 44 third and fifth grade students, and through the use of oral reflective comments. Two of the teachers were interviewed together as they team teach two classes of fifth grade boys. The researcher felt it was necessary to combine their interviews for purposes of consistency. These qualitative instruments covered instructional strategies with CAI, student perceptions of the software, and teacher and student's opinions of instructional approach.

Student Questionnaire

Student questionnaires (See Appendix A) were administered to 7 third grade females, 9 fifth grade females, 9 third grade males, and 19 fifth grade males. These students were chosen due to the fact that they are required to pass their respective CRT in order to advance to the next grade, and the "Bobcat Club" was designed to improve their achievement in mathematics. The purpose of the questions was to gather opinions and develop a broad view of the overall effectiveness of the program. The students were given the questionnaire during the "Bobcat Club" time period from 2:30PM to 4:00PM, and a maximum of 15 minutes was spent on any group during this period to protect instructional time. The questionnaires will be kept in a locked cabinet, and they will be destroyed approximately one year after the research is complete.

Teacher Interview

The researcher interviewed teachers using a minimum of 11 open-ended questions (See Appendix B). The interviews were recorded using a password protected audio application on a tablet that is kept in a locked cabinet. The researcher chose to interview the third and fifth grade teachers in the "Bobcat Club." The interviews took place before, after, and during the "Bobcat Club" as time permitted within teacher's busy schedules. No interview lasted more than 12 minutes. The researcher transcribed the responses in the data collection process. The audio files will be permanently deleted approximately one year after the research is complete.

Observation Reflections

Throughout both semesters of the "Bobcat Club," the researcher documented weekly activity that encompassed procedural, administrative, and behavioral observations. The information was recorded using a voice recorder application on a smartphone. The researcher also documented unexpected events in any part of the program, as well as potential reasons for the event and potential solutions. Upon closure of the journal reflections, the researcher included the comments in consideration of emerging themes and coding clarifications. The data will also be used in a clear description of the results.

Data Analysis

Due to a minimal amount of time for gathering data, the researcher used the concurrent triangulation strategy to confirm results relating to the effectiveness of the extended day program. The State Education Agency requires the quantitative results, but researchers in this field will benefit from a much more inclusive description of the components. The quantitative component of this research used results from a paired *t* test to measure the difference in pretest and posttest scores among a pre-determined group of third through fifth grades students. It was also possible for the researcher to quantify the qualitative data from the interviews through coding.

Validation Procedures

The validity of this mixed methods approach was blended through legitimate high yielding inferences as taken from the results of the quantitative and qualitative components. Comparisons to relevant research were made by looking for similarities and differences for extended day, CAI, and student's perception data. Only the pretest component of the data was in place prior to conducting the research, and the remaining quantitative data was taken at the final posttest data point. The findings from this research created a clear picture of achievement on an individual level. Detailed insight into the effectiveness of the software was measured, and inferences were generated through triangulating comparisons of normal instruction, extended day instruction, student questionnaires, teacher interviews, and quantitative measurements for growth.

Ethical Considerations

The researcher had an administrative role and was not designated as a specific "Bobcat Club" teacher. The students were chosen by demographic and testing qualifiers as determined by the State and Local Education Agency. The teachers volunteered to be instructors in the extended day program. The names of the students and teachers were not be used at any time in the collection of the qualitative interview questions. Students and teachers were informed prior to any questioning that no data will be provided that may link their name to any commentary. If a student or teacher mentioned a specific name in his or her response, the name was changed to a pseudonym or to that of "participant." No names were used in the collection of student pretest and posttest scores. For the purposes of protecting the research participants, they had the option to withdraw at any time. Electronic data in the form of CRCT and "Classworks" scores was extracted from reports and placed into an anonymous table for analysis.

Results

Quantitative Findings

A paired-samples *t*-test (see table 1 and 2) was calculated to compare the mean pretest score to the mean posttest score. The mean on the pretest was 343 (sd=65.65), and the mean on the posttest was 375.59 (sd=57.81). A significant increase from pretest to posttest was found

($t(83) = 10.07$, $p<.000$). Furthermore, 11 fifth grade students and 5 third grade students mentioned comments specifically related to that the fact that they do not receive very much time to work on the computers during class time. Question number 3 in the student questionnaire related to a student's perception of how he or she learned math best. The students were asked to place a smiling or frowning face beside their choice. The measurement of those results for both third and fifth grade was as follows: 35 students enjoyed working on the computer while 5 say they did not; 30 students say they enjoyed working with their teacher while 9 say they did not; 21 students say they enjoyed working in a small group with their teacher while 14 say they did not; 23 students enjoyed working in a group together on the computer while 15 say they did not.

Qualitative Findings

Student questionnaires

Twenty-eight fifth grade students and 16 third grade students chose to participate in the student questionnaire. After analyzing this data the researcher noted three emerging themes across both grades. The themes revolve around more access to computers, an increase in the number and variety of math activities, and the satisfaction of immediate access to their teacher. A small portion of the answers provided on questionnaires were illegible, but not enough to skew the overall analysis of the data. These themes addressed the second research question, "What are student's perceptions of the computer-based math curriculum?"

Time spent on the computers. The majority of third and fifth grade students participating in "Bobcat Club" stated directly that they enjoyed the increased time they are able to spend on the computers as noted from the quantitative analysis. All of these students are classified as economically disadvantaged and do not have regular access to technology at home. The researcher noted on multiple occasions through visual observation that all students were in direct proximity to a netbook, desktop, or laptop. This included time they were spending in a stand-alone location, or if they were in a small group session with their teacher. One comment taken directly from the questionnaire also supported this theme for, "We get more computer time." Furthermore, 16 students commented directly how they don't get to work on the computers very much during class time.

Increase in number of math functions. Exposure to more activities on the computers leads to more opportunity for growth. This theme is supported by student's replies such as "I'm better at number patterns, multiplying, and division;" "I learn more in Bobcat Club," and "In Bobcat Club I can do something over if I do it wrong." This statement refers to the selective nature of the *Classworks* Individualized Learning Plan. Students can quickly be re-assigned any section of a lesson, and the latter attempt is the only one that counts towards the student's average.

Enjoy small ratio with increased teacher attention. As students were asked to speak about their teachers, the researcher noted that many comments pointed directly towards immediate access to the teacher. Comments such as "More teachers means I don't have to wait for an answer;" "More teachers helps us be faster;" and "We have more teachers because we have more questions," point to the direct relationship of the 4 to 1 student-teacher ratio as required by local and state title I officials. The researcher confirms these comments through multiple visual observations each day during club time. The 32 point mean gain reported from the paired-samples *t*-test supports the effectiveness of a small student-teacher ratio in reference to academic growth.

Teacher interviews

Seven teachers were interviewed during data collection. Two of the teachers were fifth grade boys' teachers and were interviewed together as they are team teachers throughout the normal instructional day, a format they carried over to "Bobcat Club." One teacher was a fifth grade girls' teacher, two teachers were third grade boys' teachers; however they taught both boys and girls in the "Bobcat Club." One teacher was a special education teacher with students ranging from kindergarten through fifth grade. The final teacher interviewed was a specialist social studies reading teacher with over twenty years of experience as a public school educator. The other six teachers had between two and ten years of experience in education. Every teacher related to the fact that the low student-teacher ratio allowed for an immediate impact through instant remediation. The monitoring process in *Classworks* is the most critical phase of learning due to the potential for a convoluted nature of instructional design as students delve further into instruction. The fact that teachers are involved so directly made for rich learning time during "Bobcat Club." The teacher interviews addressed the third research question, "What are the teacher's perceptions of effective teaching strategies during the extended day program?" Two themes were evident as the data was analyzed. The first theme corroborates the third theme on student questionnaires.

Remediation can occur immediately. Participant A's first comment was that "we get to remediate on the spot, and it's something we can't get to that quickly during normal class time." Two basic models of instructional delivery have been noted during visual observations throughout both semesters of "Bobcat Club." The first model involves the process where teachers immediately place students on the netbooks and desktops, and the second is that the teacher intervenes as necessary for remediation based on monitoring results.

The structure of the second model involves grouping both on the computers where students work together and help each other while the teacher pulls 2 or 3 students for small group hands on instruction based on deficiencies. The researcher observed a wide variety of materials being used during the teacher and student small group sessions such as white boards and dry-erase markers, base 10 blocks and charts, *smartboard* instruction, and a variety of physical games in between questions. Both models revolve around immediate formative feedback with computer-based summative assessments guided by each student's progress.

With respect to instant remediation, teachers were asked to describe methods of instructional delivery. The most common answer by the teachers was directly observed by the researcher daily. This model was a combination of computer instruction backed by work with the teacher. Teachers commented that students working either individually or with a buddy on a computer next to them were only minimally effective. Participants H and S stated that they, "conferenced with each kid on their scores so they know where and at what level they are performing." Participant P said she "focused first on their learning style and identifying their weakness before proceeding with remediation." Several teachers mentioned that their particular math teaching strategies did not change between the normal instructional day and "Bobcat Club," but the strategies were more effective with a smaller teacher-student ratio.

Students learn math best through visual models, games, and manipulative's. One of the researcher's questions was with regard to words they would use to describe the software. "Engaging" was in every teacher's response. Participant Q noted that it was "very different from class:" "*Classworks* is very effective for practicing math." On some occasions it is necessary for the student to study the game strategy first before proceeding with understanding the content, but in any case all teachers interviewed said that students learn best through hands on games and activities. Participant C said, "Hands-on manipulatives, strategies, and tricks to solve problems are how they learn math best."

Again, the mean gain result from the paired-samples *t*-test in the quantitative findings supports the comments made by teachers with regard to this theme. *Classworks* is comprised of more than 20,000 various games and activities. As the teachers noted, when a computer-assisted approach is combined with a series of hands on manipulatives, the results will be positive. Students increased their scores by more than 32 points with this model for extended day instruction.

Other comments worthy of mentioning, but not enough to emerge as a theme covered the potential for a language barrier when students try to gain access to the software from home, the frustration level of some of the games on *Classworks*, and the teachers' desire to make this type of instruction available to a larger audience, not only to those who are economically disadvantaged. Participant C, a special education teacher, said, "the computers have no way of applying accommodations." This comment referred to the fact that *Classworks* reads instructions and content to students at lower grade levels, but does not for higher grades. Several of her fourth and fifth grade students have accommodations where teachers are required to read specific content to them, and this gap in the software performance impedes progress at times and requires a higher level of teacher intervention.

Observation Reflections

The researcher has served as an administrator for the program for two semesters. The club dropped to three days a week after the first semester. A need existed to cover four days per week until a foundation for proper club administration could be built. During the time since the

"Bobcat Club" began, the researcher observed classrooms daily either by quietly passing through or by briefly interacting with both students and teachers. The visual observations gathered fully support the themes analyzed from both qualitative and quantitative data. Students were always within immediate proximity to a netbook or desktop with either the *Classworks* software being used or a similar resource to cover a particular noted student weakness.

As each day passed teachers were observed using small group instruction and manipulatives, monitoring individual students while working through *Classworks* lessons, and overseeing students working in groups on adjacent computers. The effects of immediate feedback were seen as students were explained the results of the scores and sent directly back to revisit a particular lesson, activity, or quiz. The researcher also observed multiple occasions where motivation and behavior needed attention. An extension of the learning day didn't particularly sit well with some students, and it promoted a need for teachers to foster and maintain a positive attitude within them as well as regular reminders about the benefits they were receiving as members of the club.

The researcher, as one of their specialist teachers during the normal instructional day, was familiar with all of the students in the club. This relationship allowed for direct interaction with students while they were working through the lesson in *Classworks* or in a small group lesson with the teacher. With respect to observations of gender based "Bobcat Club" classes, the activities between extended day and normal day instruction were similar. Boys' classes were built around a more active environment including small trampolines and basketballs, while the girls' classes held less physical activity between and during instruction. Seven classes were noted as utilizing lamps rather than overhead fluorescent lighting. When asked why, teachers commented that it served a dual purpose in reducing headaches among teachers, and it created a more relaxed atmosphere for cognitive activity.

Answers to Research Questions

Do students attending a computer-based extended day program have higher math achievement than those who do not? The results of the *t*-test show that that a significant difference exists between pretest and posttest scores. The growth sustained supports the possibility that these students will improve their scores, but evidence does not yet exist reporting an actual closing in the gap between state math CRCT scores for those who attended club, and those who did not. What are students' perceptions of the computer-based math curriculum? The qualitative findings support that students learned more through extended computer time and through immediate remediation due to a 4 to 1 student to teacher ratio. What are the teachers' perceptions of effective teaching strategies during the extended day program? The qualitative findings show that teachers enjoy the extended day time period primarily because it is yielding results through a small student to teacher ratio. The teachers think the *Classworks* is engaging and in combination with a hands-on approach to math does facilitate growth in math performance.

Limitations

Prior to the "Bobcat Club," these students were performing at a deficient level in mathematics in class and on the state CRT test. The objective of the club was to raise the performance of these students through a variety of instructional models built around a low student to teacher ratio and through the *Classworks* software. While much data has been collected and analyzed, the true result will not be available until the end of the year when the state CRT test results are made available. The data presented supports that growth has occurred, but the effect of the program cannot be fully confirmed as of yet and will require a follow up study to gain closure on the entirety of success.

Discussions

The results of this research are directly in line with previous research where the combination of computer assisted instruction, proven software, extended time during the learning day, and a small student to teacher ratio can provide for improved student learning and performance. This model has seen success with minor changes in the format. For example, the producer of *Classworks,* Curriculum Advantage, reports that according to a 2011-12 study in Georgia, a cohort of 20,000 students who used the software for at least six hours during the school year saw growth among their CRCT scores (Curriculum Advantage, 2012.) In a similar study where *Classworks* was not used, Burns, Kanive, DeGrande (2010) reported significant gains from 216 fourth grade students through the use of a computer-based fact fluency intervention. Researchers at the University of Massachusetts Amherst assessed 125 fourth graders in three rural communities by using "4MALITY" web based tutoring software (Burns et al., 2010). With respect to students at an economic disadvantage, the minority gap, and differences in performance of specific ethnicities and gender, one common solution for reaching these students is to provide ample opportunities for a low student teacher ratio. According to Slavin & Lake (2008), the most effective studies were developed around cooperative learning, motivation programs, and supplemental tutoring programs, and they showed that as little as three 30-minutes computer based sessions per week as a supplement to the curriculum will show positive results.

As Title I and metro RESA officials respond to the model provided by the "Bobcat Club" and to the other "focus" schools in the area, it will be noteworthy to observe how funding affects acquisition of less expensive software and whether or not an attempt will be made to increase the student to teacher ratio. With the increasing demand to trim from district budgets, the assumption can be made that districts will continue to explore methods for extended day programs. At the same time, the U.S. Department of Education reports that the percentage of economically disadvantaged students has grown from 53% in 2009 to 57% in 2011 (U.S. Department of Education, 2012.) As these students continue to face difficulty in accessing proper resources for improving academic achievement, it will be necessary for schools to remain vigilant in allocating resources that identify precise weak or delinquent foundations in math.

Implications

Implications for Practice

Teaching during the normal instructional day does not allow for extended computer use due to the logistical implication of not having enough resources for teachers in every classroom. While differentiation is necessary to reach students at a highly diverse Title I school, there is still a need for an appropriate technological solution for each deficiency. This is also hindered by a significantly higher student to teacher ratio as compared to the extended day program.

Teachers have access to the *Classworks* software during the normal instruction day, but the time necessary to properly manage each student's progress and maintain all other content areas is simply not logical or feasible. It is therefore only practical to utilize the small group format with the *Classworks* during an extended time of day or during specified tutoring time. It may also be implemented during the normal instructional day on a limited basis with students who are most in need, but do not have the means to attend a tutoring opportunity.

Further implications for practice include the management of technological resources between the instructional and extended day. At times the netbook charging carts could not keep up with the extended use of the computers and dead batteries, user rights, or software glitches would cause problems as well as the fact that a large number of technology use within one concentrated time period can cause a slowing of the communications among wireless access points.

Implications for Policy

The most important implication for policy use by each district is to understand that *Classworks* and the extended day combination is most effective for marginalized students or for those who are not performing on grade level. The composition of the software is designed to bring struggling students up to grade level.

It is also necessary to clearly define a set of instructional models for educators to follow. District and state level academic coaches and curriculum manages should direct schools with extended day low student teacher ratio programs to properly utilize building leaders in monitoring the relationship between students working with technology and their interaction with the teacher. This approach will insure academic growth.

Implications for Leadership

While tutoring companies exist, the benefit of hiring tutors who are already the student's teachers proved to be valuable and effective. The teachers already know the student's learning styles, and there is no lost time with new teachers having to develop a relationship with the students.

As the models for the extended day program emerged, it became necessary not only for teachers to properly monitor student progress, but also for leaders to properly monitor teachers' understanding of the software and to ensure that teachers are not trying to let the computers do all of the work. The "Bobcat Club" has two administrators, and one of their primary duties is to actively monitor the activities of each classroom.

Implications for Research

The data collected in this research revealed several topics for further research to be conducted. From an internal perspective it would be necessary to explore the possible combinations with a direct correlation to student growth. A quantitative analysis could be conducted to study the number of activities versus time on task and how they determine growth. A qualitative approach could explore gender and ethnicities of both students and teachers in a highly diverse environment. Expanding to the district level, a prospective mixed method study could explore various extended day models of instruction that use *Classworks* at different schools of varying grade levels.

Conclusion

The results of the "Bobcat Club" show a significant level of growth between pretest and posttest scores, but as mentioned earlier the final data point will be within these student performances on the CRCT. Unfortunately those scores will not arrive in time for this particular research component, but the data does show growth, and this is an indicator that student content knowledge has grown. The structure of the "Bobcat Club" was created with attention paid to every detail, and we responded to both students and teachers as they reported on their success and failures. Our mission was to grow academically in math performance and meet the annual requirements of a "Focus" school under the CCRPI index per the Georgia Department of Education's ESEA waiver. While a proven model of success is currently in place, we wait patiently and remain diligent as the CRCT approaches. Despite the results, research opportunities will continue to exist concerning the effects of an extended day math program with struggling economically disadvantaged students.

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Appendix A

STUDENT Extended Day Questionnaire – Participant Grade_______ Gender _____ Date_____

Please provide your written answers in the spaces below.

1. What are your thoughts about staying after school to spend more time on math?	
2. How is learning during this time different from learning during normal class time?	
3. In what ways do you learn math best?	
4. What do you like about the way your teacher works with you during this time?	
5. What do you dislike about the way you are being taught?	

APPENDIX B

Interview Protocol Template

I. Information about the Interview:

Interviewee: ____________________ Grade: __ Interviewer: ____________________

Date: ______________ Time: ______________ Place: ____________________

II. Consent and Introduction

- Introduce yourself. My name is William Dryden and I am from Kennesaw State University
- This interview should take about 10 minutes. The purpose of the study is to help me learn about the effectiveness of an extended day format for improving achievement in math through small group and computer assisted instruction. You do not have to participate in this study and you do not have to answer any question you don't want to answer. You are being asked to take part because you are a participant in the "Bobcat Club."
- I plan on audio recording this interview. Is this acceptable to you? All identifying information will be converted to a pseudonym and your information will remain anonymous and confidential.

III. Ice Breaker Question

1. For the purposes of anonymity, what would you like you pseudonym to be?

IV. Interview Questions

1. What differences do you see between your normal class time and Bobcat time?
2. Which of the following appears to be most effective for student's learning math during Bobcat time:
   - Work on the computer
   - Work with your teacher
   - Work with a small group
   - Work in a group on the computer
3. What do you like about the way you get to work with your students during this time?
4. What are the things you like about Bobcat Club?
5. What are the things you don't like about Bobcat Club?
6. Is your teaching more effective with students you know well or with students you don't know in a small group environment? Please explain.

   Additional Teacher Questions:
7. In what ways do you think your students will learn math best?
8. How are your teaching strategies in extended day different from normal instruction time?
9. What are some words that come to mind with regards to the Classworks software?
10. What are your thoughts on improving student achievement who are at an economic disadvantage?
11. Is there anything else you want to tell me about Bobcat Club?

V. Wrap Up and Thank Participant for Time

- Thank you very much for your time today. I appreciated hearing your insights on this topic.

Table 1

Paired-Samples *T*-Test for Pretest versus Posttest

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MathPRE	343.0952	84	65.65658	7.16372
	MathPOST	375.5952	84	57.81881	6.30855

Table 2

Paired-Samples *T*-Test for Significance of Pretest versus Posttest

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MathPRE - MathPOST	-32.50000	29.57021	3.22637	-38.91713	-26.08287	-10.073	83	.000

The Effects of "Classworks" in the Classroom

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Abstract

The purpose of the study was to examine the effects of computer-assisted instruction (CAI) in the classroom. Specifically the impact of "Classworks", a computer-assisted instructional program, effect on student achievement. The study also examined teachers' attitude toward using "Classworks" with their students. The quasi-experimental study involved 30 third grade students and two teachers over a 14 week period at a selected elementary school in Texas. The students who participated in the experimental group increased their posttest mean 9.06 percentile points more than the control group's mean. This study has shown that "Classworks" increased student achievement in math and impacted teachers' attitude toward CAI.

Table of Contents

The Effects of "Classworks" in the Classroom

The need for improvement of student achievement has been the focus in education for years. Many plans have been developed to increase student achievement. For example, legislators, administrators, and educational experts have improved school environment, curriculum, instruction methods, and strengthened teacher standards in hopes of improving students' academic level.

According to Lowe (2001), the computer was widely introduced to the educational setting in the 1980's. This new technology in the classrooms was going to be the cure for all educational problems. Schools have since spent billions of dollars installing, maintaining, and upgrading computer technology with the goal of increasing student achievement.

Efforts by federal and state governments, along with institutions of learning, are being made to introduce and integrate computers into school. An estimated 4.4 million computers are now currently installed in America's classrooms. The ratio of students to computers has dropped from 125 students per computer in 1984 to the current ratio of 10 students per computer (Coley, Cradler, & Engel, 1997).

During the 1990's, schools increasingly relied on computers for instructional purposes. Computer-assisted instruction (CAI) improved students' academic achievement by exposing learners to a variety of instructive and interactive learning-based lessons (Tzuriel & Shamil, 2002). CAI provides students with immediate feedback, ongoing guidance, and instruction allowing students to access instant research information along with current information.

CAI involves students, teachers, and administrators in the ever growing process of making schools exciting and challenging places to work and to learn. Students are thus involved in thought-provoking activities that connect academic learning with practical, real world projects (Middleton & Murray, 1999). CAI learning prepares students for productive work, learning and responsible citizenship in the 21st century (Sherry, Billig, Jesse, & Watson-Acosta, 2001).

The Meridian Independent School District, a small rural school in central Texas, has spent over a million dollars of grant and local funds over the past decade toward computer technology. Meridian Elementary recently dedicated funds to replace their outdated network software. The elementary goals were to address objectives set by the 2003-2004 Meridian Elementary Campus Improvement Plan. Three strategies to be met were: 1) technical training assistance for teachers 2) increase and integrate classroom technology 3) attain 90% or above for all students in the area of the Texas Assessment of Knowledge and Skills (TAKS) Math test.

A technology committee was formed which spent months researching and sampling computer-assisted instructional software to be installed for the campus. In January of 2004, the Meridian School Board accepted the recommendation of the committee to purchase "Classworks" designed by Curriculum Advantage. The school's objective was to integrate technology into the curriculum, promote computer literacy for its students, and improve student achievement through the process.

Review of Literature

After providing a foundation of the definition of computer-assisted instruction, this review of literature will examine its impact on student achievement and teacher attitudes toward CAI.

CAI was developed for students to examine a class subject in more detail. CAI is designed to serve as an expansion of subjects discussed in class and allows students more time to use and validate the knowledge taught (Cooper, 1998). With the appropriate software, the computer has the ability to teach students interactively (Brown, 2000).

According to Curriculum Advantage's research consultant, D. Nicholas (personal communication, April 26, 2004), there are two types of CAI; stand-alone products and integrated learning systems. Stand-alone products offer a variety of activities from skill and practice software to content-based tutorials. However, full benefits are lost by a lack of a built-in management system that monitors and reports a student's progress and performance.

Integrated learning systems (ILS) provide curriculum within a carefully designed management system. ILS can provide instruction, usually in the basic skill areas of reading and math, at different grades levels. It maintains records of student progress on networked computer systems. The system can also use adaptive strategies to adjust the activities that are made available to the student, deciding not only what kind of remediation or enrichment is appropriate, but also when to deliver it (Kulik, 2002; D. Nicholas, personal communication, April 26, 2004).

Student achievement

Four meta-analyses studies (Bayraktar, 2001; Blok, Oostdam, Otter, & Overmaat, 2002; Christmann & Badgett, 2003; Kulik & Kulik, 1999)found CAI positively affected student achievement. For example, Kulik and Kulik's (1991) meta-analysis examined 254 controlled evaluation studies. They found 81% of students who participated in the CAI setting had higher examination scores than students who did not participate. The average effect size was 0.30 standard deviations in performance higher for CAI students than for students in the control group. The effect size was defined as "the difference between the mean scores of the two groups divided by the standard deviation of the control group" (p.78). The results showed a significant increase of student achievement.

Christmann and Badgett's (2003) meta-analysis examined 68 studies involving the effectiveness of CAI with elementary students. They found students who received CAI attained higher academic achievement than did 63% of those students who received only traditional instruction.

Another meta-analysis (Blok, Oostdam, Otter, & Overmaat, 2002) examined the effectiveness of 42 studies of CAI programs with beginning reading instruction. The results showed that CAI had a small, but positive effect on beginning readers. Bayraktar's (2001) meta-analysis investigated the effects of CAI on student achievement with science education. The study found that the typical student moved from the 50^{th} percentile to the 62^{nd} percentile in science when CAI was used.

Individual studies (Boling, Martin, & Martin 2002; Brown, 2000; Middleton & Murray 1999; Traynor, 2003; Wilson, Majsterek, & Simmons,1996) support the findings of the meta-analyses that CAI increased student achievement. For example, Boling, Martin, & Martin (2002) found that CAI had a substantial impact on student achievement. Their results suggested the use of CAI served as a motivating medium that enhanced good instruction. They concluded by recommending moving students from traditional dependent instruction toward independent learning facilitated by differing uses of technology in the classroom.

One commonly used math-based CAI program is "Accelerated Math" (AM). AM is an enhancement to regular mathematics instruction in general education classes that consistently demonstrated significantly higher math achievement gains than students in the same math programs who did not receive the AM enhancement. The implementation of AM led to students' spending more time on classroom activities identified as contributing to positive academic outcomes (Ysseldyke, Spicuzza, Kosciolek, & Boys, 2003; Ysseldyke & Tardrew, 2002).

Spicuzza and Ysseldyke (1999) researched and studied the effects of AM on student math performance during a six-week summer school program in an urban school. Results indicated students using AM showed an average gain of 5.75 Normal Curve Equivalents (NCE) units on the Northwest Achievement Levels Test, a district math achievement test.

Ysseldyke and Tardrew (2002) conducted a large nationwide experiment that examined the extent to which the use of AM enhanced achievement outcomes for students in Grades 3-10 in 67 classrooms in 47 schools in 24 states. The elementary students using AM had an NCE gain difference of 10.75 over the students that did not receive AM.

The benefits of using CAI include the need to learn technology, the movement of students from knowledge and comprehension into application and analysis, and the development of student computer literacy by applying various computer skills as part of the learning process (Dockstander, 1999). CAI also has a profound affect on students' attitudes toward their classes and their computer use (Kulik & Kulik, 1991).

Teacher attitude

Despite the calls for the inclusion of technology in instruction and the evidence that technology enhances students' learning, technology tools are not widely used in K-12 classrooms. In fact, research indicated that many teachers are not using technology tools for teaching (Huang & Waxman, 1996; Manoucherhi, 1999). For example, Manoucherhri (1999) found that teachers have limited views regarding the use of technology and that approximately 20% of teachers reported that technology has no relevance to their curriculum.

Most teachers have difficulty integrating computers into classroom instruction. Only 43% of elementary teachers assign computer work frequently. As a result, teachers tend to use computers as an "extra" for students who finish their written work or who need supplemental practice (Becker, Ravitz, & Wong, 1999).

One possible explanation for the lack of CAI in classrooms is the limited number of computers and a lack of training. These underlying barriers that the traditional instructional model was not designed to accommodate computer-enhance learning. Traditional elementary teachers teach all subjects for a relatively short amount of time. Becoming knowledgeable and keeping current with the wide array of instructional software for all areas of the curriculum is a daunting task for an elementary teacher. When the computers are competing for the teacher's attention in a lecture/seatwork instructional model, the teacher prevails (Iding, Crosby, & Speitel, 2002; Vannatta & Fordham, 2004)

Statement of the Problem

In efforts to improve student achievement, schools are merging computer-assisted instruction into their curricula. More research is needed to validate the spending of funds toward implementing CAI. The results of this study will provide vital information for administrators when deciding the future of CAI for their districts.

Purpose of Study

The purpose of this study was to determine the impact of "Classworks", a computer-assisted instructional program, on student achievement. The study also examined teachers' attitude toward using "Classworks" with their students.

Research Questions

1) Does "Classworks" impact student achievement for third grade mathematics students at a selected elementary school in Texas?

2) Does "Classworks" impact teachers' attitude toward computer-assisted instruction at a selected elementary school in Texas?

Definition of Terms

1) "Classworks"- For the purpose of this study, "Classworks" was a comprehensive computer learning system developed by Curriculum Advantage. It contained over 1,650 units of instruction, drawn from 190 software titles in Language Arts and Mathematics (Classworks Reference Manual, 2003).

2) Mathematics curriculum- For the purpose of this study, mathematics curriculum followed Saxon's Math 3 (Larson, 2001).

3) Pretest and posttest- For the purpose of this study, the pretest and posttest was the Stanford Achievement Test, Ninth Edition (SAT 9). SAT 9 was developed by Harcourt Assessment, Incorporated and is a computerized multiple-choice assessment that was included in the "Classworks" program. Only the math portion was taken in this study.

4) Student achievement- For the purpose of this study, student achievement was the degree of growth of percentiles from the pretest to the posttest on the SAT 9.

4) Teacher attitude- For the purpose of this study, teacher attitude toward CAI was measured using a questionnaire.

5) An elementary school- For the purpose of this study, an elementary school consisted of grades kindergarten through six.

Limitation

The limitation of this study was the time period of 14 weeks.

Methodology

Participants

The participants in this study included 30 third grade students at a selected elementary school. Of the 30 students, 57%(N=17) were Anglo, 37%(N=11) were Hispanic, and 6%(N=2) were African-American. Furthermore, 60%(N=18) of the students were females and 40%(N=12) were males. Fifty seven percent (N=17) of the participants were identified as economically disadvantaged, 23%(N=8) were in the Gifted and Talented program, and 23%(N=8) are in the English as Second Language program.

The participants in the teacher attitude questionnaire consisted of two Anglo females teaching third grade.

Procedure

Of the total population, 15 (50%) students were assigned to a control group and received the traditional Saxon mathematics instruction. The remaining 15 (50%) students received the traditional Saxon mathematics instruction with the addition of "Classworks" one hour per week.

The participants were randomly placed in classes at the beginning of the school year. The pretest was given the first week of the school year in August. Both groups received the same traditional instruction following the Saxon mathematics curriculum and sequence. In addition, the experimental group used only the mathematic portion of "Classworks" in the computer lab for one hour per week. The experimental group used "Classworks" for 14 weeks. To keep the study ethical, the control group used the language arts portion of "Classworks".

At the conclusion of 14 weeks, all participants retook the pretest to serve as the posttest. The standardized mean difference of percentiles was calculated to determine growth in student achievement.

In order to determine teacher attitude, the researcher created and designed a survey questionnaire. This three, unstructured item question survey was administered to two teachers at the selected elementary school who used "Classworks" for the first semester. The questions involved the performance of "Classworks". The information determined the teachers' attitude toward using "Classworks" with their students.

Data Analysis

The Statistical Package for Social Science (SPSS), version 11.5 was employed to determine the results of the study. Results for research question one were found by computing the percentile point increase or decrease for each student between the mathematic pretest and posttest. The percentile point increase was found for both the experimental group and control group. An independent t-test comparing the mean scores of the pretest and posttest between the experimental group and control group to determine if a significant difference exsisted.

The Pearson product moment correlation was computed to determine the magnitude of the relationship between the pretest and posttest. This Pearson product moment correlation was also used to determine the degree of relationship between scores to students' gender, ethnicity, social economic status (SES), and class (experimental/control).

The results for research question two were qualitative. The survey examined teacher attitude toward "Classworks". The two teachers involved in the study completed a post experimental survey questionnaire. The questionnaire, developed by the researcher, consisted of 3 questions.

Results

The purpose of the study was to 1) investigate the impact of "Classworks" on student achievement for third grade mathematics students at a selected elementary school in Texas and to 2) determine the impact of "Classworks" on teachers' attitude toward computer-assisted instruction at a selected elementary school in Texas.

Research Question #1

Does "Classworks" impact student achievement for third grade mathematics students at a selected elementary school in Texas? Descriptive statistics were computed for all students' pretest and posttest. The means and standard deviations (SD) for the pretest and posttest are reported in Table 1. The overall mean for the students' pretest was 35.83 (SD=9.649) with scores ranging from 15 to 59. The overall mean for the students' posttest was 47.43 (SD=11.643) with scores ranging from 24 to

67. Table 1 indicates that an overall increase of student achievement was made by the whole population participating in the study.

Table 1

Descriptive Statistics for Pretest and Posttest

Test	N	Minimum	Maximum	Mean	SD
Pretest	30	15	59	35.83	9.649
Posttest	30	24	67	47.43	11.643

A paired sample t-test was computed to determine the paired differences between the pretest and posttest. Table 2 shows the mean of the paired differences was -11.60 (SD=8.846). The difference showed a t value of -7.183 with a p value of <01. The data results show there was a statically significance difference between the pretest and the posttest.

Table 2

Paired Samples test for Pretest and Posttest

		Mean Difference	SD	t	Sig.(2-tailed)
Pair 1	Pretest-Posttest	-11.600	8.846	-7.183	.000

A Pearson product moment correlation was used to determine if there was a relationship between the overall group's pretest and posttest. This Pearson product moment correlation was also used to determine the degree of relationship between scores to students' gender, ethnicity, social economic status, and class. The results are presented in Table 3. The Pearson product moment correlation showed that there was a strong relationship (r=.669) between the pretest and the posttest, which was significant at the .01 level. A strong relationship (r=.706) between social economic status and ethnicity was found, which was significant at the .01 level.

The most important information that Table 3 reveals, is the relationship of the posttest scores between the experimental and control class. The correlation of -.381 was found and is significant at the .05 level.

Table 3

Correlations between Pretest, Posttest, and Students

Variables	Pretest	Posttest	Gender	Ethnicity	SES	Class
Pretest	1.00					
Posttest	.669**	1.00				
Gender	-.265	-.177	1.00			
Ethnicity	-.145	-.233	-.110	1.00		
SES	-.235	-.355	-.027	.706**	1.00	
Class	.018	-.381*	.000	-.162	.067	1.00

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

An independent t-test was used to determine the difference between means of the pretest and posttest of the experimental group verses that of the control group. Table 4 shows that the experimental group had a pretest mean of 35.67 (SD=8.966) and a posttest mean of 51.80 (SD=12.399). The control group had a pretest mean of 36.00 (SD=10.603) and a posttest mean of 43.07 (SD=9.285).

The experimental group had a 16.13 increase from pretest to posttest. The control group had a 7.07 increase from pretest to posttest. There was a 9.06 difference between the increases of the experimental over the control group. Table 4 reveals that the experimental group, which used "Classworks", had a statistically significant increase of student achievement compared to the control group.

Table 4

Mean Differences between the Experimental and Control Group

Class	N	Pretest Mean	SD	Posttest Mean	SD	Mean Differ.	t	Sig. (2-tail)
Experimental	15	35.67	8.966	51.80	12.399	16.13	-7.485	.000
Control	15	36.00	9.285	43.07	9.285	7.07	-3.936	.001

Research Question #2

Does "Classworks" impact teachers' attitude toward computer-assisted instruction at a selected elementary school in Texas? The two teachers involved in the study completed a post experimental survey questionnaire. The unstructured item questionnaire, developed by the researcher, consisted of 3 questions.

The teachers' responses were positive in regards to the question concerning the advantages of using "Classworks". One teacher thought "Classworks" provided reinforcement of skills and concepts taught in the classroom setting and provided students with extra practice time outside of the scheduled math instructional period. The same teacher stated that "Classworks" helped with the remediation of math concepts. The reports generated by "Classworks" were helpful and used as a diagnostic tool for analyzing the students' strengthens and weaknesses.

The other teacher expressed that one of the advantages of "Classworks" was the ability to practice math and reinforce keyboarding skills at the same time. She also stated that the flexibility of "Classworks" allowed her to individualize each student's curriculum and goals.

The second question on the survey asked teachers the disadvantages of using "Classworks". Both teachers thought "Classworks" should be used as a supplement to previous teacher instruction. They were concerned teachers would rely on "Classworks" to replace teacher instruction in the classroom. Both felt concepts should be first taught by the regular classroom teacher and then students should be exposed to the concept using "Classworks".

The third question asked teachers their feelings about the amount of time "Classworks" took in their instructional schedule. One teacher responded there was not enough time devoted to using "Classworks". The other teacher stated that every minute using "Classworks" was valuable. She stated "Classworks" gave each student individualized instruction thus giving her time to conference and/or observe individual students.

The overall attitude of the teachers involved in the "Classworks" study was positive. They felt "Classworks" was one the best computer-assisted instruction products available for educational use. They stressed, however, that while "Classworks" was a great CAI product, it was no substitute for teacher instruction.

Discussion

The purpose of this study was to examine the impact of "Classworks", a computer-assisted instructional program, on student achievement. The researcher in this study wanted to determine if third graders in a selected Texas elementary school were able to increase student achievement using "Classworks" versus third grade students not using "Classworks". Along with this question, the question of teacher attitude toward computer-assisted instruction was addressed.

The results of this study were consistent with previous studies noted in the review of literature. The students who participated in the experimental group increased their posttest mean 9.06 percentile points more than the control group's mean. This suggests that CAI had a significant impact on student achievement.

While the results were extremely powerful, there are some issues to consider when interpreting them. The sample size of both groups were small, thus it is difficult to determine whether or not the results accurately represent a larger population. Another issue would be the short period of time in which the project was studied. The 14 week study may have shown different results if conducted over a longer period of time.

There were several factors that may have contributed to the positive results of this study. The students having extra mathematic practice on the computer was a key component resulting in student achievement. When students are reinforced with additional CAI instruction time, the probability of concept and objective comprehension and retention will be increased for the students.

"Classworks" provided an alternative instructional method that impacted student performance. An instructional objective or concept was presented in a variety of formats with continual reinforcement. Classroom instruction is usually presented from one viewpoint based on curriculum standards. Students spent more time on task with "Classworks" because they enjoyed the variety of instruction and technology.

One benefit the researcher discovered in "Classworks" was an accessible form of monitoring student progress toward the completion of instructional objectives. The student automatically moved on to the next objective after they demonstrate mastery of the previous one. Without "Classworks" it is difficult to see whether teachers monitored the progress of student growth over curriculum objectives. "Classworks" automates part of the process of evaluating progress toward mastery of the classroom curriculum objectives.

Based on the data presented in the study the researcher has two recommendations. The first recommendation would allow more computer time with "Classworks". Students need to increase CAI time from one hour per week to two hours. Increasing student CAI use would facilitate and increase the growth of student achievement.

The second recommendation would allocate more time for teacher inservice to facilitate understanding of "Classworks". Teachers were given an eight hour introduction prior to the study. Teachers did not have the expertise to manipulate the curriculum scope and sequence of "Classworks" to coincide with the classroom curriculum. Additional inservice time would allow teachers to become accustomed to the dynamics and structure of "Classworks" and utilize it to the fullest potential for student achievement.

Future studies need to be conducted to strengthen the claim that CAI has a positive impact on student achievement. The researcher suggests that the scope and sequence of the classroom curriculum align with objectives presented in "Classworks". At times during the use of "Classworks", teachers would have to teach new objectives that previously were not introduced in the classroom. Matching the scope and sequence of the two curriculums would maximize student achievement and lessen teacher frustration.

Based on the results of this study, teachers and administrators need to be aware of the positive benefits that CAI can provide. Teachers would have a better attitude if researched and successful CAI programs were mandated and scheduled by administrators.

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Classworks®

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DIFFERENCES IN MATH ACHIEVEMENT: UTILIZING SUPPLEMENTAL COMPUTER-BASED INSTRUCTION AND TRADITIONAL INSTRUCTION

by

Todd Christopher Clark

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A Dissertation Presented in Partial Fulfillment

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DIFFERENCES IN MATH ACHIEVEMENT: UTILIZING SUPPLEMENTAL COMPUTER-BASED INSTRUCTION AND TRADITIONAL INSTRUCTION

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 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 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).

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, &

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 50^{th} to 73^{rd}. 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 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.

Classworks®

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