The Effectiveness of Technology Integration in a Metropolitan Elementary Mathematics Program: Mad Dog Math

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APPROVAL PAGE

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by

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Abstract

The outcome of American students’ performances during international comparisons consistently scoring inadequately in mathematics exposes the crisis of deficient mathematics achievement thus causing deep concerns. Learners who acquire a strong theoretical foundation in mathematics at the primary level thrived later in more advanced level mathematics curriculum; thus, instructors have pursued methods and techniques to improve mathematics achievement, particularly among primary grade school students.

Research has shown that additional scholastic enhancement beyond conventional classroom instruction is crucial for kindergarten through fifth grade students. The purpose of this study was to determine the usefulness of a specific computer assisted instruction supplemental math program, Mad Dog Math (MDM), on students’ math achievement as compared to students using only conventional teaching methods applied at a local elementary school located in Southern California. A quasi-experimental design was utilized. The study was intended to identify to what degree, if any, the use of the computer-assisted instruction software called Mad Dog Math was beneficial in improving students’ mathematics achievement. Two classes of second and third grades, totaling 81students ranging from seven to nine years old, contributed to the study. An experimental group (*n* = 39) and a control group (*n* = 42) participated in the study. Both pretest and posttest using the California Standard Test (CST), mathematics questions, were administered. To adjust the mean posttest scores for any preliminary difference between the groups on the pretest, an analysis of covariance (ANCOVA) was employed. The findings of this study revealed that after accounting for pretest scores, there was a significant difference between the control and experimental groups on posttest scores, *F*(1, 27) = 14.16, *p* < .0005 with a low effect size, partial eta squared = .15. However, after accounting for pretest scores, there was no significant interaction effect of MDM and gender, *F*(1,76) = 4.14, *p* = .06, with a low effect size (partial eta squared = .001). Recommendations for future research include the incorporation of larger population and stratification of grade levels, examine the effects of Computer- Assisted Instruction (CAI) with students with learning disabilities, and to include qualitative elements such as teacher-student perceptions to expand understanding of CAI findings.

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# Chapter 1: Introduction

Exposing the crisis of deficient mathematics achievement in elementary schools across the nation, the authors of Third International Mathematics and Science Study—Repeat revealed the shortcomings of mathematics in the United States when measured against other developed countries (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2007; National Mathematics Advisory Panel, 2008). Additionally, 20% of elementary students necessitate supplementary academic reinforcement beyond regular classroom education (Burns, Appleton, & Stehouwer, 2005). Traditionally integrated into the kindergarten through second grade curriculum are addition and subtraction number combinations and fact retrieval. By the beginning of third grade, emerging learners are on the road to automatic retrieval of these number combinations (Hudson & Miller, 2006). Then they are ready to move on to becoming automatic in their multiplication and division facts. Consequently, an urgent demand for remediation occurs when learners continue to display great difficulty with number combination and fact retrieval skills at the beginning of third grade level. One approach for remediating fact retrieval inadequacy is computer-assisted instruction.

Computer-assisted instruction (CAI) is a subject of interest in the field of education. It is valuable to many education stakeholders because many students have computers available to use at home and is made accessible to learners who do not have availability of the Internet at home. Computer-assisted instruction has the capability to be a significant tool in developing and enhancing math instruction (Roblyer, 2008). The computer can be viewed as able to perform the task of a specific influential facilitator (Beck, 2005). Interest is increasing about how learners relate to computer-based teaching techniques as CAI becomes progressively integrated into classrooms (Nguyen & Kulm, 2005).

Many educators focus on the use of unconventional instructional methods to enhance math instruction. The use of computers and the Internet make it feasible to increase students’ math academic success utilizing new approaches of instruction delivery (Aydin, 2005; Roblyer & Doering, 2009). Computer-assisted instruction is a practical methodology that is effective in accommodating learner needs as well as improving student math accomplishment (Traynor, 2003). Integrating technology in the classroom stimulates learners to become dynamically engaged in learning thus promotes higher-order learning outcomes (Martindale, Cates, & Qian, 2005; Gayle, 2006).

Moreover, technology can be an inspiring aspect and an effective tool for all learners, especially in elementary grades (Martindale, Pearson, Curda, & Pilcher, 2005). A wide variety of course contents such as exercise, drill, tutorial, practice, and virtual reality are made possible through the use of computer technology (Mahmood, 2004). All of the characterizations of CAI support the idea that the computer takes the part of a teacher and conveys teaching through various modalities and approaches (Lewis, 2010). In this chapter, a historical view of CAI is explored; the framework for CAI is presented, hurdles encountered by educators are identified, and a synopsis of the selected research method and design is described. This quantitative research is designed to evaluate the effectiveness of one CAI program.

## ****Background****

Utilized as a problem-solving instrument in higher education in the U. S., computers were first introduced in the mid-1950s (Reilly, 2004). In conjunction with the prospectus used in engineering science programs, CAI ultimately became a part of the traditional classroom procedure. A decade later, conventions and symposiums were held to discuss the use of the computer instruction in mathematics, science, computer science, undergraduate courses, and secondary school counseling. In the 1960s, the University of Illinois invented a computer system called PLATO, which stands for Programmed Logic for Automatic Teaching Operations, to increase valuable instruction. The substantial system accommodated instructional computing all over the colleges and universities in Illinois all at the same time with up to 1,000 learners.

In January 1963, Stanford University began a computer assisted instruction program in math and reading under the supervision of Richard Atkinson and Patrick Suppes. The daily math drill-and-practice lessons permitted students to amend answers through instant feedback that promoted the individualized instructional approach (Robyler, 2009). In 1973, educational uses of computers started to surface such as drill-and-practice programs, automated and discussion classes, assessments and analysis, instructional games, management and information systems, computation, problem solving, simulation, and graphic display of resources (Zinn, 1973).

In the 1980s, when reasonably priced personal computers were first introduced, the AppleLogo was launched as a user-friendly new platform. To teach computer science concepts, educational revolutionist Seymour Papert sponsored the Logic Oriented Graphic Oriented language programming (Robyler, 2009). During the same time, IBM invented the first personal computer (PC). Not too long, thereafter, because the PC met the educator requirements during instructional delivery, technology received global recognition in the world of education. Computer-based tutorials and instructional games were developed by Apple II Computer in 1983. In 1984, profit-making computer software companies created computer-based educational games and software for PC users. They were suitable in the drill-and-practice approach employed in schools (Science & Technology Communications, 2010).

In the 1990s, compact discs were utilized to promote simulation CAI programs intended for classroom use (Murdock, 2004). For knowledge conduction, conventional lectures are suitable but do not stimulate critical thinking (Bligh, 2000). Instructions that assist in transforming student viewpoints are critical to stimulate interest in the subject matter (Holley & Dodson, 2008). Authors from previous studies revealed that the majority of learners disapproved of traditional classroom lecture in general (Coates, King, Sander, & Stevenson, 2000). Conventional instruction was deemed to be less effective when compared to a more engaging methodology such as simulation games (Caldwell, 2007; Knight & Wood, 2005).

The Internet became popular in 1995 as school systems began to utilize multimedia tools for instructional delivery. The outpouring demand for online instruction emerged due to the instant growth of the Internet, increasing computer use at home, and the declining charges of communication (Volery, 2001). The connection between the Internet and public schools in the mid-1990s grew from 35% to 100%. Likewise, instructional classrooms in public education with Internet access flourished from 14%, 10 years prior, to 94% (Lewis & Wells, 2006). By the year 2014, it is projected that 90% of the U.S. population will be online (Horrigan, 2008).

The features and characteristics of the Internet transformed and magnified access (Cormode & Krishnamurthy, 2008). In the year 2000, Web 1.0 was regarded as an academic source of information, where many users perused, read, and gathered information from a front page or public entry point (Wallace, 2004). Theoretically, the design, process, and results utilizing Web 1.0 represented knowledge amassed by specialists with considerable qualifications in educational domain and specialty (Dede, 2008).

More recently, through the help of groundbreaking technologies, Web 2.0 is both a stage and a space where consumers are as vital as the content disclosed and uploaded. Social networks (Facebook, MySpace, and Twitter), media sharing (YouTube and Flickr), and creative works (podcast and blogs) are part of Web 2.0 design. It supports mixture of learning spaces that journey through physical and cyber space utilizing the theories of teamwork and involvement (DeGennaro, 2008).

A subject that attracts attention at the national level in the field of education, computer-assisted instruction is notable to all education stakeholders due to its ready availability and accessibility features. Convenience and an upsurge in the interest of learners in utilizing computers for interaction and entertainment led educators to discover methods and applications to employ the use of computers as devices to improve learning skills (National Center for Educational Statistics, 2003). The incorporation of CAI as an addendum to conventional classroom instruction is more effective than standard classroom instruction alone as reported by many researchers who investigated the influence of CAI on the mathematical achievements of learners of various capacities, proficiencies, and ages (Brothen & Wambach, 2000; McSweeney, 2003; Nguyen, 2002: Olusi, 2008). Computer- assisted instruction is a procedure by which visible information is conveyed to the students through technology in lucid progression, providing the students the opportunity to learn by viewing the information presented or by reading the text displayed (Mahmood, 2004). All of the characterizations of CAI assent that a computer in the classroom functions as a tutor that conveys instruction through various methods of presentation.

## Problem Statement

Based on research conducted by the National Assessment of Educational Progress, mathematics achievement scores in the United States have decreased (National Center for Education Statistics, 2007). The performance outcomes of American students during international comparisons consistently scoring poorly in mathematics cause deep concerns (President’s Council of Advisor on Science & Technology, 2010). In search of an intervention, the writers of the No Child Left Behind Act (NCLB, 2001) stressed the significance of accountability and evidence-based decision-making requiring that all learners from third through eighth grade be assessed in mathematics yearly.

With aspirations to increase student achievement in mathematics, computer integration in the classroom has escalated. Computer-assisted instruction programs have proven to enhance numerical reasoning, spatial thinking skills, problem-solving abilities, and overall mathematics test scores (Hauptman, 2010; Lazakidou & Retalis, 2010; Silk, Higashi, Ross, & Schunn, 2010). In an effort to improve achievement scores in a local elementary school located in Southern California, school leaders have initiated a supplemental program called Mad Dog Math (MDM) to address deficiency in mathematics.

When investigating educational research, the role that gender differences represent in learning mathematics must be considered (Stultz, 2009). School administrators believe that female underrepresentation in math-related fields is a concern associated with retention even though girls have increased proficiency in mathematics in elementary school (Nagel, 2007). However, an abundance of research has documented significant gender differences in math performance. For example, on standardized university entrance tests, males ordinarily surpassed females (Mullis, Martin, & Foy, 2005; Mullis, Martin, Gonzalez, Gregory, & Garden, 2000). Thus, weaker performance of females on standardized math tests is of pressing concern.

## Purpose

The purpose of this quantitative, quasi-experimental study was to determine the effectiveness of a specific CAI supplemental math program, Mad Dog Math, on students’ math achievement as compared to students using only conventional teaching methods utilized at a local elementary school located in Southern California. Two classes of second and third grades, totaling 81students ranging from seven to nine years old, participated in the study. Using a G\*Power analysis, a total sample size of 80 was needed to detect a larger medium effect. Since the total number of participants was comprised of students enrolled in one private school, the sample size was satisfactory in detecting large effects but was not adequate in disclosing medium size effects. The student population consisted of male and female learners. A pretest and posttest utilizing the California Standard Test (CST) Released Test Questions (California Department of Education, 2011) were administered to learners as part of the study. The independent variable in this study was the treatment of Mad Dog Math while the dependent variable was the posttest scores. For the experimental group, 39 students were solicited to participate in the study utilizing MDM computer-assisted instructional software program in addition to the conventional teaching of mathematics inside the classroom (treatment group). For the control group, 42 students were requested to participate in the study using only the conventional method of teaching mathematics without any supplements (non-treatment group). This research produced valuable information to confront the identified difficulty of learners’ deficient skills in mathematics in primary grades. The outcomes suggested an approach or program that can be utilized as an instrument for enhancing skills in mathematics. The findings may have a policy implication, at a district level, both in the public and private sector, if ascertained to be effective and reliable as a tool for increasing scores on mathematics achievement tests. Results from this study contributed to the body of literature by adding knowledge and information that enhance the teaching of primary students and their learning.

## Theoretical Framework

Learning is a function of time where additional instruction assists in attaining higher measurement of mastery (Carroll, 1963). This study embraced mastery learning as its theoretical framework. The premise of this theory was based on the belief that mastery is attainable for practically every student, on the condition that an appropriate learning environment in the allotted time was provided and that the quality of instruction was maintained at an exceptional level. Specification for enhancement, formative assessment, and feedback should have been integrated in this quality instruction (Bloom, 1981).

Some learners will achieve more than others, particularly students who are engaged in supplemental programs for enrichment. However, when educators are dedicated to accomplish mastery learning for each student, modifications in their methods to deliver instructions and strategies to present classroom procedures and practices are necessary, and then degree of achievement and amount of success in the entire classroom intensify. Math classrooms that underscore mastery objectives accentuating learning and advancement result in heightened learner achievement in mathematics and reduce anxiety when material is challenging or tedious (Furner & Gonzalez-DeHass, 2011). Thus, students who are considered underachievers are inspired to catch up and stay on task to pursue excellence. Personal mastery goals achieved through mastery learning can activate optimistic and inspirational sentiments when performing mathematics (Lau & Nie, 2008; Linnenbrink, 2005).

Advocates of mastery learning stipulate that to get more students to advance to mastery level, individual learner differences must be considered and adequate time spent with the material is essential for student achievement (Cooperman, 2011). The theory of mastery learning by Suppes and Zanotti (1996) is comprised of the following tenets: (a) develop robust organization of curriculum and content presentation that is quantifiable and regularly under evaluation, (b) disseminate instructional delivery based on standardized components, (c) establish learner readiness, (d) apply learning paradigms for assessing mastery, (e) employ forgetting models for assigning reevaluation, and (f) utilize assessment on tutorial management.

Progress in achievement ensues when learners demonstrate the following:

1. Learners focus on the content standards and assessments assigned by the state.
2. Learners place emphasis on theories and proficiencies structured into standardized elements such as sub content areas (word problems, fractions, etc.).
3. Learners receive assigned and approved grade level prior to classwork commencement, as established initially during preliminary series
4. Learners advance at their own speed when robust learning process in a specific content area fulfills required benchmarks.
5. Learners obtain guaranteed tutorial services when signs of struggles in performance arise.
6. Learners receive routine support to increase memory as forgetting brand-new concepts are normal manifestation. This framework will be executed in MDM algorithms to evaluate achievement in mathematics.

Another learning theory that this research adopted was active learning. Active learning was intended to enhance student learning and achievement. Active learning is observed when the following takes place: (a) the student is able to compose his or her own interpretation, (b) present knowledge is established on prior knowledge, (c) the student collaborates with other students, and (d) the learning is constructed based on genuine engagement with learning resources (Cooperstein & Kocevar-Weidinger, 2004). Active learning approach originates from the pedagogy of Pestalozzi’s Object of Teaching, Froebel’s Kindergarten style of teaching, and Dewey’s philosophy of experiential learning (Maher & Tienken, 2008). Active learning embraces a variety of teaching approaches including shared learning, hands-on projects, instructor driven inquiry, small group interaction, and role-playing.

## Research Questions

Integrating the use of technology that offers mathematical questions, context, and practical learning strategies into the curriculum has contributed to increased problem-solving skills in primary school students (Lazakidou & Retalis, 2010). There is a cause and effect relationship inferred amid the utilization of CAI and success in mathematics (Ash, 2004). Assuming that there is a connection, a study was warranted to confirm or contradict a linkage in which the researcher can affect the variable of CAI.

This study was designed to determine the usefulness of a specific computer-assisted instruction math program, Mad Dog Math, on students’ math achievement as compared to students using only conventional teaching methods. The intervention offered the opportunity to incorporate technology as a supplement in increasing mathematics achievement. The pretest and posttest devised to ascertain any discrepancy in mathematics achievement were administered. The test used was the California Standard Tests (CST) Released Test Questions and was published by the California Department of Education.

The following research questions were derived from the correlation that was speculated between success in learning mathematics and the use of technology, more specifically, computer assisted instruction programs, in the classroom. These questions confirmed the process of exploring the effectiveness of technology integration of an elementary mathematics program called Mad Dog Math. Furthermore, they identified the position that gender differences exemplify in student learning mathematics was accomplished by examining the trends using appropriate and acceptable instrumentation.

**Q1**. After accounting for the pretest score, is there a significant difference in the mean posttest score between students who were offered the MDM software supplement program and those who were not?

**Q2.** Is there an interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate?

## Hypotheses

**H10.** There is no significant difference in the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H1a.**  There is a significant difference in the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H20.** There is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

**H2a**. There is a significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

## Nature of the Study

A quasi-experimental study was conducted at a local elementary school in Southern California to ascertain if a correlation exists between the utilization of CAI in the classroom and mathematics achievement. The California Standard Test (CST) was administered to all learners as a pretest. After exposure to computer assisted instruction and conventional math instruction (experimental group), or conventional math instruction only (control group), the CST was readministered. The pretest and posttest measure of dependent variable is a criterion-referenced test developed in 2005 by California educators and test developers particularly for the state of California. Scores were calculated and inputted in SPSS Student Version 20.0 for Windows. Preceding analysis, data were assessed for outliers, skewness, and kurtosis.

Utilizing the Analysis of Covariance (ANCOVA), the two hypotheses in the study were examined. Gender was an independent variable to be investigated as a potential confounding variable for its effect on the posttest outcome. Mad Dog Math was an independent variable, used with the computer, designed to assist students with acquiring mastery of the basic math facts (Kotoff, 2011).

## Significance of the Study

Due to the continuous shift in the global economy and workplace, daily use in decision-making and the association between mathematics and other specialties, proficiency in mathematics is crucial. As one of the major approaches of associating the world intelligently through expressions and numerals, the significance of mathematics is accentuated (Laidlow, 2004). The ability to integrate words with numbers is one of the highest markers of intelligence (Amunga & Masasia, 2011).

For the intellectual advancement and economic readiness of today’s young people, the American institutions of public education are held accountable, especially since the U.S. has undergone a change from an industrialized-based nation to one that overpoweringly delivers services and information. This particular change requires that technological skills be completely incorporated in all school curriculum involving science and mathematics. This integration will prepare the new generation of students to think analytically, infer and reason, and be ready to learn how to gain knowledge (Nathan & Tran, 2010).

Educators are confronted with sustaining the diverse needs of all the learners that they influence in the classroom. It is crucial for educators to make available research-based alternatives including technology application in the classroom, since ascertaining methodologies and techniques can be overwhelming (O’Connell & Phye, 2005). Modifying instructional strategies, specifically where the computer is concerned, can be a complicated undertaking. Integrating technology in classroom curriculum includes challenges but with it emanates thoughtful understanding and effective learning opportunities on how to succeed in educational values (Groff, Haas, Klopfer, & Osterweil, 2009).

Technology applications continuously improve to effectively deliver mathematics thus increasing mathematics achievement through enhancement via the instructional method (Lynch, 2006; Hannafin, Liu, Truxaw, & Vermillion, 2008). Numerous researchers have investigated the influence of technology on student achievement in mathematics. For example, it has been reported that mathematical knowledge advanced when the use of multimedia was integrated in math instruction for primary grade students (Kramarski, Talis, & Weiss, 2006).

Likewise, improved motivation ensued for upper elementary grade learners when computer games were incorporated in their math curriculum (Ke, 2008). A study done involving middle school students revealed enhanced basic skills in mathematical conception and operation with the CAI indoctrination (Tienken & Wilson, 2007). House (2001) reported that the use of CAI produced substantial improvement in the outcomes of national and international math and science assessments.

This study was significant because outcomes disclosed information concerning the effectiveness of CAI when used as a supplement to conventional math curriculum. It assisted educators to enhance classroom procedures and strategies in generating and cultivating students’ interests in mathematics. It aided in exposing the influences that endorse discrepancies in mathematics achievement. The outcomes from this research have policy implications at a district level. Findings from this study conveyed information to stakeholders, educators, administrators, and state legislators regarding a specific CAI software program that contributed to improving the state’s math curriculum.

## Definitions

For the purpose of this study, the following definitions apply:

**Assessment.**  Assessment is used to ascertain the needs of a student or school district. Summative learner assessments investigate how individual students perform on a learning task compared to cumulative assessments that evaluate how a group achieved at the conclusion of the study (Campolongo, 2008).

**California Standard Test (CST).** California Standard Test is a multiple choice examination that assesses learners’ progress toward achieving California’s state adopted academic content standard in English—language arts (ELA), mathematics, science, and history—social science which describe what students should be able to comprehend and execute in each grade and subject analyzed (California Department of Education, 2011).

**Computer Assisted Instruction (CAI)***.* Computer assisted instruction is a process that provides personalized instruction using computer technology that accentuates the methods of effective learning trials with predetermined outcomes to manipulate precise learner responses (Martindale et al., 2005).

**Courseware.**  Courseware is educational software designed for instruction (Rowley, 2005).

**Curriculum.**Curriculum is a set of decision-making processes and products including knowledge, skills, and performance standards that learners are expected to attain by a specific grade level in a specific area (Campolongo, 2008).

**Integration.** Integration is the process of combining parts of lessons to become

one (Campolongo, 2008).

**Mad Dog Math.** Mad Dog Math is a supplemental math program to any math curriculum for grades kindergarten through fifth grade or for remedial middle and high school students. It is used with computer or traditional methodologies, intended to help learners with increasing mastery of the fundamental math facts which are the building blocks for math (Kotoff, 2007).

**Mastery learning.** Mastery learning is an instructional approach that is centered on the idea that given sufficient time, all learners can learn. Students do not further advance to a new group of problems until a personalized performance benchmark has been mastered (Bloom, 1968; Smith, Marchand-Martella, & Martella, 2010).

**Proficiency.** Proficiency signifies strong scholastic accomplishment and displays expertise above difficult subject matter (NCES, 2007).

## Summary

Computer technology is an effective device that has the ability to support learners in participating in multifaceted mathematical progressions (Blume, Dick, Heid, & Zbeik, 2007). With the presentation of innovative technological advancements, there is an upsurge of awareness in training students to become knowledgeable and skilled, technologically, in preparation for their future involvement in a progressively computer inundated environment. Many schools today are starting to integrate technology as an integral portion of their course outline, thus technology incorporation in mathematics is imperative in education.

To maintain advancement in math achievement, it is crucial to expand the value of math education obtained by all learners (The National Mathematics Advisory Panel (2008). There are numerous components that influence mathematics learning such as instructors’ technical abilities and attributes of learners and their family members. One feature in which the school administration has instantaneous control is the selected math program to be carried out by the instructors (Groff, Lake, & Slavin, 2009).

The purpose of this study was to investigate the effectiveness of the technology integration in an elementary mathematics program, Mad Dog Math, and the position that gender differences exemplify in student learning of mathematics. The quasi-experimental study included two classes of second and third grade, totaling 81students over an eight-week period at a local elementary school in Southern California. The outcomes suggested an approach or program that can be utilized as an instrument for enhancing skills in mathematics. The findings have policy implication, at a district level, both in the public and private sector, and ascertained to be effective and reliable as a tool for increasing scores in mathematics achievement test. Results from this study also contributed to the body of literature by adding knowledge and information that enhance teaching of and learning in primary school students.

# Chapter 2: Literature Review

The intent of the subsequent literature review was to identify research-based literature involving the success of computer assisted instruction in mathematics achievement. This chapter includes the following:

1. Historical perspective of math education
2. Historical perspective of technology integration
3. Computer assisted Instruction
4. Summary

This literature review includes recent studies and publications involving the

history of mathematics education and technology integration as well as the effectiveness of CAI in mathematics advancement. Utilizing conventional libraries and internet-based library databases using EBSCOHost, EBSCOHost OmniFile, Gale Academic OneFile, ProQuest, SAGE Education, ScienceDirect, and Teachers College record, research-based literature regarding the use of CAI in the classroom was compiled.

Searches of the databases regarding types of CAI such as practice and drill sessions, tutorial sessions, simulations, instructional games, and problem solving were especially valuable in finding information that concentrated upon K-12 education rather than postsecondary level. Particularly, the researcher pursued information concerning the history, philosophy, and the availability of computer programs in education. Searches using distinguished learning specialists such as Ash, Dynarski, Fuchs, Hyde, Schoppek, Suppes, and Tullis were contributory for locating articles as well as books through Google Books. To deliver profundity and depth for each topic indicated above, past and present researchers were cited. Concepts and theories associated with effective instructions employing CAI were added.

## Historical Perspectives of Mathematics Education

In the 20th Century, the direction for the prospect of mathematics education was formulated by William Heard Kilpatrick, one of the country’s leading groundbreakers in education. Kilpatrick, an educator at Colombia University, advocated the theory of progressive education. The foundation of progressive education included instruction reserved only for learners who autonomously desired to learn the subject, hence, validating the sluggish stride of learners and limiting instruction to practical skills that promoted restrained scholastic content (Klein, 2003).

In the late 1950s, Sputnik 1was discharged by the Russians, the event that commemorated the beginning of the intergalactic era and the space rivalry between the Americans and the Russians. Pivotal reformation pertaining to “New Math” was prompted in response to apprehension that American students were plummeting in mathematics and science. Although the properties of grammar and phonics, corroboration, and perception were the highlights of this New Math, it was unsuccessful in improving the country’s aptitude and proficiency in mathematics. Later in the 1970s, the Back to Basics movement accenting memorization of procedures and fundamental math facts such as addition, subtraction, multiplication, and division was brought about (Burris, 2006).

The society’s dissatisfaction with public education was amplified in the 1980s when economic challenges prevailed. The public detected the correlation between the recession and the mediocre public education system in the United States. This caused the Department of Education to encounter reproach. The publication of the Nation at Risk: The imperative for Education Reform (NAR) turned out to be the strength for 20 years of standards based formation (Gardner, 1983).

Many studies and debates bade to focus on some of the risks recognized such as instructor credentials and better disbursement for faculty resources. To promote learner access to educational opportunities, classrooms were furnished with technology and devices including state of the art computer and software programs. Consequently, educators and staff members needed to be equipped to integrate technology in the curriculum and be able to apply them in the business world. In relation to the support structure that is required to maintain learners on a reasonable or even beyond sophisticated status in comparison with students from other nations, the impact of this trend are astounding (National Commission on Excellence in Education, 1984). Additionally, the initial set of standards was established in 1989 by the National Council of Teachers of Mathematics (NCTM, 2012).

The campaign for technology integration and the employment of manipulatives in the classroom were the main emphasis in mathematics in the 1990s. The utilization of constructivist methodology and child-development activities was the popular strategies during this period (Burns, 1999; National Association for the Education of Young Children [NAEYC], 2009; Roth, 1992). Acceptance and popularity of The National Council of Teachers of Mathematics (NCTM) Standards on aptitude testing and grade related scope and sequences expanded and numerous states and educators advocated its model programs. Proficiency in content areas such as mathematics for grade level advancement was mandatory in some states as competency examinations became prevalent (NCTM, 1995).

Difficulties in math are evidenced significantly in counting as students with math disabilities fall short in making the transfer to memory-based recovery of number combinations. This is crucial because the ability to recall number combinations is introductory to higher order accomplishments. Knowledge of math facts and mathematical fluency in computation has been recognized by the NCTM as fundamental components of national math benchmarks (NCTM, 2006). Contained in this criterion is the expectancy that by the end of second grade, learners should be able to grasp the fundamentals of addition and subtraction combinations and be confident in adding and subtracting two-digit numbers.

Fluency in basic math skills, crucial for the achievement of learners in primary school, functions as a groundwork for mathematical relevance in areas such as time, money, and problem solving (Codding, Chan-lannetta, Palmer, & Lukito, 2009). Competence in mathematics is a critical objective in primary education. Moreover, proficiency in mathematics explicitly influences the conditions needed to succeed in the many responsibilities that formal education, occupation, lifestyle, service quality, and domestic advancement entail (Ramos-Christian, Schleser, & Varn, 2008).

In a study directed by Cherney and London (2006), with regards to recreational activities such as the use of the computer, television shows, and outdoor activities, gender was an important characteristic. The authors reported that most males spent their recreation time occupied visiting various websites on the Internet, staying outdoors, and playing with their favorite toys, whereas, girls spend most of their leisure time watching television. Traditionally, dynamic, thrill-seeking, and daring tasks have been given to male characters (Bontempi & Warden-Hazelwood, 2003). These gender differences and inclinations have endured and remained in computer software preferences, thus ensued substandard inspiration for females to contribute in more advanced math and science activities. Similarly, physiological factors, family practices, childhood experiences, cultural influences, and scholastic policies alter the enthusiasm of males and females who participated in higher-level study of mathematics and science (Halpern et al., 2007, p.1).

## Gender Differences in Learning Mathematics

Although increasing research outcomes point to the confirmation of gender similarities in mathematics achievement, stereotypes that females have inferior math skills prevail (Bhana, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Kiefer & Sekaquaptewa, 2007). The underrepresentation of women at the utmost concentration of science, technology, engineering, and mathematics (STEM) is an ongoing problem as gender differences in mathematics achievement, viewpoint, and influence continue to be in question (Halpern et al., 2007; National Academy of Sciences, 2007). In part, the gap can be associated with social and educational influences that are viewed as obstacles to women considering STEM fields (Stultz, 2009). However, an even greater portion of the shortage appears to come from the issues of gender differences and learning styles in the perspective of specialized fields such as STEM (Kulturel-Kinak, D’Allegro, & Dickinson, 2011). Learners’ decisions about taking a particular college major are centered on how fitting the norms of the major conform to the students’ learning styles (Kolb, 1976).

Most male students, typically, acquire knowledge from instructors who undertake a commanding position or compelling role. Female learners, on the other hand, may acclimatize to this style of learning but achieve more and relate better with mentors whose instruction style facilitates learning (Barrett, 2006). The idea that learning is also shaped by the student and not automatically contingent on the dissemination of knowledge from mentor to learner is identified as Experiential Learning and utilized today in many universities, and is inefficient in instructing female students (Kolb & Kolb, 2005). Traditional STEM courses are distinctively aggressive but neglect to modify instruction to welcome all learning modalities (Tindal & Hamil, 2003). Adopting various teaching methods including the use of multimedia lectures utilizing technology will accommodate learners who are not responsive to conventional types of education (Baker, 2007).

In a research project conducted by Leder (2004), he conveyed that findings of contradictory outcomes such as feelings of worthlessness among females were especially real with high achievers and girls with high probability of advancing in mathematics. These feelings of uselessness occurred albeit the fact that their success stories have escalated over the years. Other reports, directly or indirectly, regarding gender differences with cohorts pertaining to the academically talented were alarmingly associated with the term labeled as “talented female student resistance to science” (Enman & Lupart, 2000, p.161). Variations in adeptness explain gender differences due to the greater percentage of males with an extremely great talent in the discipline linked with inert sciences rather than their female counterparts (Lubinski, Benbow, & Morelock, 2000). Other possibilities include female issues related to emotional considerations. These sentiments include convictions and affinities as well as social impacts involving gender responsibilities and traditions.

In a research done by Ceci and Williams (2010), they indicated three possible rationalizations for the underrepresentation of females in STEM fields. First rationalization includes the gender disparities in mathematical and spatial skills. One would contend that a surplus of males at the right tail of a quantitative research (Ceci, Williams, & Barnett, 2009) rationalizes females’ underrepresentation in STEM fields: Registrar’s office is more likely to admit men applicants if there are double the amount of male gender in the top 1% of the graduates even if women receive the same grades or even higher grades in mathematics than their male counterparts (Gallagher & Kaufmann, 2005). Although strong report on male gains over female on three-dimensional spatial rotation has been claimed (Little, Lubinski, & Wai, 2007), evidence of absolute correlation that this skill causes reduced involvement of women in STEM fields is lacking (Little, Newcombe, & Terlecke, 2007). Therefore, the possibility of having the 2:1 gender ratio is higher and consistent with lack of gender symmetry (Park, Lubinski, & Benbow, 2008).

The second explanation involves prejudice in publication, subsidy, and employment. In examining attestation for bias against females in hiring and funding, true findings and analysis have been inconclusive in providing rationale for the truncated quantity of women involved in STEM fields (Ginther & Kahn, 2006). Previous research have also concluded that after regulating underlying variables such as prestige of the college campus, field specialty, and existence of little children in the family during term, all of which castigate women unreasonably, proof of intolerant is lacking especially because males in similar conditions perform equally (Corbett, Hill, & St. Rose, 2010).

Finally, the last reasoning involves the preferences of profession and standard of living that decrease females’ involvement in STEM fields. A study performed by Armstrong, Rounds, and Su (2009) revealed that rather than being fascinated in areas encompassing systematizing non-living things like their male counterpart, women are more captivated by careers related to social relations such as policy making and treatment. Conversely, there are fewer women with superior mathematics ability that are attracted to STEM related profession (Lubinski & Benbow, 2006). In the midst of equally exceptional mathematical aptitude amongst both genders, the consideration that women often have superior speaking skills has been discounted (Park, et al., 2008). Whereas more males are aware that their solely intensity is in mathematics, women contemplate on choosing professions from other math- associated areas such as medicine, policy making, civilizations, and social sciences.

Thus prior research has been analyzed that females withdraw from scientific professions after reaching their assistant professor positions at greater rate than males (Ceci, Williams, 2009). When females give up their careers to have children, it is a preference- compelled by biology- that male is not mandated to generate. Therefore, the principal influence in females’ underrepresentation in STEM fields is choices both generously accepted and restricted by biology and culture (Ceci & Williams, 2010).

In two ability tests of mathematical achievement assessed by the instructors and the standardized mathematics test, the boys’ group merited considerably superior test scores but the gender disparities in grades were not present. Gender discrepancies were present and significant in gifted groups to a higher degree than in the regular aptitude groups of students. The hypothesis that gifted learners are more dissimilar when it comes to personal perception, fascination, and inspiration in mathematics than the non-gifted learners was reinforced in this study (Goetz, Kleine, Pekrun, & Preckel, 2008).

In addition, the authors noted that gender-associated disparities in mathematics execution for both regular and gifted students are explicit in task. It was observed that in numerical problem-solving, males scored higher than females. Nevertheless, when it came to cognitive mathematics, females demonstrated a minor edge over their male counterpart. Although girls received higher grades on their report cards from school, for assignments that demanded arithmetic mastery, boys surpassed the girls. Overall, both in regular and talented student populations, boys displayed greater arithmetic-linked aptitude philosophies, a more convincing fascination in arithmetic, and a more robust implementation objective induction in mathematics than girls (Goetz, Kleine, Pekrun, & Preckel, 2008, p. 154).

Based on the findings of this investigation, the researchers endorsed immediate recognition of aptitudes and prompt intervention and treatment programs for females, specifically females with greater proficiency. It is critical to relegate the prospect of females acquiring a damaging self- view and an unfavorable mindset towards arithmetic. Besides emphasis centered on girls, treatments should also concentrate on addressing environmental components such as guardians, educators, friends, and associates. The following are other promising intercessions: a) curriculum for stimulating curiosity on separate sex-education, (b) modifications of pedagogy and classroom syllabus, (c) boosting the amount of mathematics programs for girls, (d) retraining of ascription, (e) establishment of counselors and advisors, (f) parental and educator advocacy (Kleine, Goetz, Pekrun, Preckel, 2008, p. 156).

It has been recorded in the past that female students, from elementary all the way through college take home superior grades on their report cards compared to male students in the majority of their scholastic subjects, including advance placement mathematics (Freeman, 2004; Halpern, 2000). However, the outcomes lack constancy in exhibiting boys or girls being the frontrunners with regards to advancement in mathematics. Freeman (2003, 2004) suggested that the rationale for unpredictable results was associated with ethnic variations and cultural diversities in organizational development, design, and subject matter of school prospectus and pedagogical procedures.

In assessing the gender gap, first, authors Hyde et al., (2008) used two meta-analyses of math skills, 1990 and 2007. The findings included negative gender disparities generally, d=.05; and approximately identical male and female inconsistencies, VR = 1.08. Next, sizeable data were evaluated centered on the likelihood selection of American juveniles over the two decades. During the study, the researchers observed a low effect size differences between males and females. The gender gap effect sizes varied between -0.15 and +0.22 and variance ratios fluctuated from 0.88 to 1.34. Opposed to the destructive typecast that is broadly embraced by young girls that females are inadequate in mathematics skills, professional adults, and parents (Cavanaugh, 2008), the authors of this cross-sectional investigation on standardized math scores continued to demonstrate no gender distinctions in mathematics performance (Hyde et al., 2008). The 10 states involved in the assessment of second through eleventh grades standardized math scores included: California, Connecticut, Indiana, Kentucky, Minnesota, Missouri, New Jersey, New Mexico, West Virginia, and Wyoming.

In the preceding era, one of the key rationalizations for higher male scores on standardized exams in secondary schools included the scenario that females infrequently registered for advanced placement mathematics and science courses (Meece & Eccles-Parsons, 1982). Albeit girls continued to trail after the boys in taking physics classes, by the year 2000, the number of girls registered in calculus courses in secondary schools was equal to the number of the boys (National Science Foundation [NSF], 2006). Currently, while it has been documented that gender disparities in the fields of engineering and physics still exist, 48% of the undergraduate degrees in mathematics are acquired by females (NSF, 2004). Thus, after assessing the gender gap using two meta-analysis of math skills issued between 1990 and 2007 and data from U.S. youngsters, the authors endorsed the understanding that mathematics skills of boys and girls are alike (Hyde et al., 2008).

In an attempt to duplicate the study done by Hyde, et al., (2008), Scafidi and Bui (2010) utilized national data from grades eight, ten, and twelve. The replicated research involved samples of students nationwide. The goal of the study was to assess whether gender equivalences in math skills would be altered by social status, economic position, race, and mathematics ranking from middle all the way through high school. Since learners’ mindsets and impressions concerning their future professions inspire the courses that they will register for, the authors of the study chose students from middle school and secondary school as participants. The rationale persisted that students would relinquish the prospect to chase occupations that compel intense math aptitude if learners lacked perseverance in pursuing advanced mathematics placement in junior and high schools.

The longitudinal part of the investigation started in 1988. At that time, the eighth graders throughout the U.S. were evaluated utilizing data from the National Education Longitudinal Study (NELS). The NELS organized a sequel of assessments when the participating students entered tenth grade in 1990 and in twelfth grade in 1992. Two years later, after high school graduation, the same evaluation was conducted as part of the longitudinal inquiry.

The writers of prior studies (Hyde, Fennema, & Lamon, 1990; Hedges & Nowell, 1990; Kimbal, 1989) have corroborated that their research resulted to minimal gender differences in mathematics skills. In addition, the findings, contingent on the effect and model of experiment, at times bolstered girls and at times bolstered boys. The concern of the intricacy of intellectual progression as an inquiry of item challenged as well as the complexity of understanding needed to decode a specific question are intellectualized by present mathematics scholars. To distinguish the intellectual complicatedness of math items on standardized evaluation, depth of knowledge levels 1- 4 were created (Webb, 1999). To measure the intellectual requirements of the examinations that determine math skills, this depth of knowledge agenda was applied.

The instrumentations used comprised of test elements assembled together by the degree of complexity (Rock & Pollack, 1995): (a) Math Level 1measured competency in executing straightforward numerical procedures with whole numbers, (b) Math Level 2 assessed aptitude in implementing uncomplicated application with number fractions, square roots, and decimal operations, (c) Math Level 3 analyzed basic knowledge of simple arithmetic concepts applied in unsophisticated problem solving, (d) Math Level 4 examined skills in the usage of higher level numerical theories and solving word problems applying numerous steps to find solutions, (e) Math Level 5 checked adeptness in unraveling multifaceted word problems utilizing multi-step ways to find the answer. Although the result in this study was not altered by social status, economic position, race, or math proficiency, the researchers submitted outcomes that displayed gender resemblances throughout all the grade levels measured. Overall, the findings presented pragmatic proof and confirmation for parents and professionals to inspire girls of all age to pursue and acquire superior skills in mathematics.

In comparison, authors of both studies, Hyde et al., (2008) and Scafidi and Bui (2010) reported results of gender similarities in mathematics on standardized mathematics testing. In the experiment performed by Hyde et al., (2008), however, the exception to gender likeness was when beginning in high school males favored complex problem-solving, which may contribute to the gender disparity in STEM careers. The authors, therefore, resolved that their assessment for learners from second through eleventh grades demonstrated that girls now score just as well as the boys.

The integration between education and technology embraces practical foundation in methodologies concerning learning and instruction. However, despite the sophisticated procedures available today, learners are still the principal controller in the learning process. Only through the learners, the central component, can full potential in learning occur. Technology in itself cannot mechanically unleash learning. Conversely, a mentor still portrays a vital function as the external influence in learning (Ru-De, 2010).

Many schools are welcoming technology as an important component of their educational programs. Integrating the use of the computer in mathematics classroom is essential in today’s education as society becomes more progressive, innovative, and contingent upon technology. Numerous educational technologies that advocate a variety of teaching and learning purposes and approaches can be integrated into math programs. For example, technology devices such as computers, laptops, hand-held devices, graphic calculators, interactive white boards, and immediate response gadgets, and web-based applications are significant in math classrooms and have considerable influence on teaching and learning in primary and secondary schools (International Society of Technology Standards [ISTE], 2005).

## Historical Perspective of Technology Integration in Education

Developed on university grounds, the first computer in operation was employed in 1944 at Harvard University to execute the implementation of basic math (Reilly, 2004). Concurring with the resoluteness of computer integration in the classroom, it continues to have intense influence in education. The innovative function of computer- assisted instruction is one of the groundbreaking operations of computers in education (Suppes, 1996).

The instruction of binary mathematics utilizing the computer was established by IBM in the 1950s and soon after, the first CAI project, the PLATO, was inaugurated at the University of Illinois. In its primary phase, Plato was also applied in the nursing department and for library explorations. Consecutively, CAI projects were introduced in computer programming, mathematics, chemistry, physics, and health education courses at the University of Texas and at Florida State University. In Utah, during the Time-Shared period, Brigham Young University used the computer as the principal instruction in junior colleges (Boyer, Dalgaard, & Lewis, 1984).

In 1967, the Logic Oriented Graphic Oriented (LOGO) programming was invented by Papert and Feurzig. It was originally intended for the instruction of mathematical concepts to increase analytical thinking skills in elementary and secondary education. In the 1980s, the employment of LOGO, combined with other content areas independent of mathematics, was soon uncovered. For initial programming courses, LOGO used the “language for learning” which specialized in easy and perceptive grammar and composition to attract its juvenile customers (Rusev & Solomon, 2008).

To investigate the role of computers at the collegiate level, the President’s Science Advisory Committee (PSAC) chairperson, John R. Pierce, construed that in the absence of sufficient computing, higher education was lacking as higher education would be incomplete in the absence of satisfactory library support. Whereas promoting the concept of using computers in the corporate and economic worlds was complex, convincing educators of the functionality of computers in the classroom was just as uncertain. The application of the computer in research was meager and the concept that computer use in the classroom was imperative and essential in education was still unusual (Molnar, 1990).

During the 1990s, researchers discovered the constructive influence of computer enrichment and tutorial programs (Kulik, 2003). Numerous investigators reported the affirmative impacts of computer use on math and science and the quality of student composition with the use of student laptops (Adonri & Gittman, 1998; Gardner, Jarman, & Morrison, 1993; Geban, Ozkan, & Yalcinalp, 1995). From 1997 to present, with the evolution of the Internet, magnified with high speed, it soon became the leading source of information (database), graphics, and streaming video.

The Internet, with its downloadable programs, is a priceless resource for many educators, in spite of the threats of unforeseen computer viruses and other problems. Various educational applications and bigger computer memory make the use of the personal PC for teacher and student extremely useful and indispensable. The use of multimedia tools for communication, distributing information, and delivering instructions utilizing search engines such as Bing, Yahoo, WebCrawler, and Google have transformed ways of communication and interaction between people worldwide (IGI Global, 2008).

A concept where technology is a continuous segment of classwork, assisting activities and experiences that allow students to participate in motivating, engaging, applicable, profound, and logically inspiring practices is known as technology integration (Bransford, Brown, & Cocking, 2003). However, technology employment in the classroom remains elusive despite its popularity with the students. This is deemed to be due to the increased school activities and experiences, with regards to schedule and description of usage (Bakia, Mitchell, & Young, 2008).

In an effort to concentrate on problems related to the absence of effective technology integration, the information and communication technology (ICT) specialists have suggested the following features be considered: (a) competency with the use of computer, (b) acceptance concerning its usefulness, (c) personal preference with teaching, (d) accessibility, and (e) availability of technical support (Straub, 2009). On the other hand, there is substantial proof indicating that computer integration can assist in training learners to be technologically informed and efficient for this century (Crooks, Fan-Harrington, Tomas, & Underwood, 2010). Rationale including enthusiasm concerning familiarity, ability, and certainty in operating the computer fosters technology integration in the classroom (Inan & Lowther, 2010; Ward & Parr, 2010).

To accentuate dynamic learning, thoughtful perceptions, and applicable treatments, many educators are enhancing their conventional lectures with the use of technology (Armington, 2003; Hall & Pantoon, 2005). One of the main objectives of scholastic research today is uncovering how students learn successfully (Larwin & Larwin, 2011). In the past 50 years, the impact of information and communication technology has contributed to the momentum in educational reformation.

To increase math achievements, educators are primarily involved in executing procedures that have displayed score advancement in mathematics for all students. Technology integration in the classroom, such as the use of CAI, is an educational technique that embraces individualized learning theory. To reinforce the method of instruction and learner enthusiasm, the computer can be utilized as a podium for acquiring education. Integrating the use of computers in classrooms such as math is commonly used for enhancement. With the capability to assess each student’s mathematical skills, CAI programs can prepare drill-and-practice exercises designed to fit individual requirements.

## Computer Assisted Instruction (CAI)

Computer-assisted instruction utilizes technology to improve learners’ mathematics achievement scores. After learning a lesson from a math textbook, students can then visit the computer, either stationed inside the classroom or go to a computer center, to gain supplementary instructions in mathematics. The instruction can be in the form of a drill or exercise. It usually involves basic math family facts progressing into more challenging questions related to current and past lessons. Computer-assisted instruction can assist in identifying learners’ level of accomplishment as well as offer daily practice drills based on computer analysis and from the students’ previous score. Individualization and the computer’s ability to analyze the learners’ advancement in the program and to be able to uninterruptedly meet the students’ needs are the main features of the program (Slavin & Lake, 2008).

From a restricted drill and exercise series to a merged state-of-the-art technology assessment and instruction, computer-assisted instruction has progressed over time. Normally utilized as an extension to a curriculum, CAI is now consistently part of the classroom agenda for up 30 minutes weekly. The computer’s expertise to pinpoint learners’ upside and downside and to provide the students opportunities to practice independently to advancement is showcased in CAI. This feature is significant in a content area like mathematics, particularly when it comes to basic math facts like addition, subtraction, multiplication, and division.

One of the outstanding social verities of the 20th Century is the endeavor to deliver uniformity and mass schooling worldwide (Suppes, 1988). The use of CAI can deliver an echelon of consistency and standardization that elevate the level of pedagogy. Opportunities for curriculum to be customized and individualized with the absence of intimidation to one’s self-determination and autonomy are achievable with the employment of CAI.

The following are among the many functions of the computer-assisted instruction in the classroom: (a) provides professional graphic visualization, (b) serves as a tutorial service which demands constant interaction with the learner and the modification of the content designed to match the skills and abilities of the learners, (c) generates tests and quizzes linked to the syllabus provided by the institution (mastery learning can be easily attained by posting replacement questionnaires of each exam not fully grasped), and (d) offers a program management system that allows learners to have immediate feedback and access to their records.

In 2000, the NCTM endorsed the integration of computer application in mathematics. Due to the heightened availability, CAI has been suggested as a convenient and functional supplement to teacher-delivered instruction (NCTM, 2006). Computer-assisted instruction has been successfully utilized by students with or without learning disabilities. Its success is mainly due to increased time concentrated on reading materials or exercises on the computer. It offers productive practice and time management and is an effective tool when used as a supplement to provide drills (Beeland, 2002).

One of the main advantages that the CAI provides inside the classroom is one-on-one exercises with minimal supervisory time involving the teacher. In many cases, instant feedback to students allows mistakes to be rectified immediately. Certain programs offer features that monitor speed and accuracy of answers and the regularity of instruction for subject mastery (Wong, 2008). Computer-assisted instruction offers one potential opportunity for education leaders to prevail over or attend to the issues of low achievement in mathematics.

In a study conducted by Fuchs, Hamlet, Powell, Capsize, and Seethaler (2006), the researchers deemed that CAI should assist learners to assign the matching number combination to long-term memory for habitual recovery thus enhancing number combination skills among learners with assenting risk for math disability. The use of CAI in mathematics programs was successful in advancing addition but not subtraction number combination skills and that transfer to math word story problems took place. One recommendation was that the teachers supervise learners so that correct usage of the software was guaranteed (Fuchs et al., 2006).

By examining the influence of two CAI programs on the math academic success of two groups of scholastic at-risk middle school learners compared to a group of learners who were not at-risk in a conventional instructional program, Neil and Matthews’ (2009) research revealed only a minor breach between the two groups following the first year of the CAI interventions. The educators and administrators at the middle school credited the victory to CAI involvement as a diagnostic device utilized to increase learner accomplishment for each of the testing phases. The study, however, did not employ a true experimental design with an arbitrary mixture and assignment of participants. Instead, it presented outcomes that allowed the investigators to ascertain the strong points and the course of the relationship between different collections of data (Borg, Gall, & Gall, 2007).

Implementing well-targeted supplementary materials to increase mathematics advancement is a plan with robust indication of success. CAI offers a unique benefit of diagnosing learners’ mathematical skills and delivering personalized exercises that students are required to learn and master but have not yet learned and mastered. Supplementary curriculums that are created to transform everyday instructions and procedures were reported to be more effective in promoting mathematics advancement when compared to programs that are designed to adhere predominantly with prospectus or technology (Slavin & Lake, 2008).

## Effectiveness of CAI in Mathematics

Technology has been voted as “fundamental” in education and its usage is

greatly approved in instructing mathematics, specifically in the areas of grids, graphics, and calculations (NTCM, 2006). Authors of numerous studies revealed mixed findings on the influence of technology integration on learners’ achievement. For example, in his research on the impact of CAI and software programs on students’ degree of success, Almeqdadi (2005) reported an increase in levels of achievement. In contrast, Buykkoroglu et al. (2006) reported non-significant results between learners who incorporated technology in their education versus non-technology users. The motivation to utilize technology in the classroom is contingent on the routine to which it will be employed (Sheehan & Nillas, 2010). Thus, investigators and educators need to analyze the rationale behind utilizing technology in the classroom.

In applying the use of technology to increase mathematics achievement, numerous learners veered towards technology for assistance far beyond their own understanding on how to solve math related problems (Galbriath, 2006). In a study done on the improvement in learners’ enthusiasm and participation in studying mathematical reasoning in junior high school, Fies (2007) pointed out that technology integration was the culprit. On the contrary, Muir (2007) indicated that the absence of scholastic influence during computer integration in middle grades math and science classrooms was due to the marginal use of the equipment that gave way to inadequate computer skills for both mentors and learners.

The use of interactive mathematics software programs by middle school age students directed learners to infer geometric configurations prior to formulating evidences that validate their hypothesis as a group (Vincent, 2005). The author construed that the software program assisted in increasing students’ comprehension and appreciation for geometric patterns. Whereas, Sher (2005) recounted that student-centered expositions and thoughtful discussions steered learners to more profound theoretical perception of the mathematical concepts presented with the incorporation of computer software. Computer proficient educators discovered that the incorporation of computer assisted instruction in the classroom epitomizes the perspectives of constructivist teaching and collaborative learning methods that highlight student-led activities (Funkhouser, 2002; Serhan, 2004).

The inconsistencies that exist between the group that utilized computer-assisted instruction and the group that was pencil and paper based could be due to the integration of multimedia teaching programs (Ortega-Tudela & Gómez-Ariza, 2006). The programs enhanced the effectiveness of learning mathematics for individuals with developmental disabilities. Additionally, the strategy and methodology utilized to teach developmentally disabled children had influence in their learning capacity. Thus, the author suggested that the use of an approach that assists the understanding of specific theoretical perceptions such as number and measurement permits the acquisition of such abstract concepts for people with psychological disabilities (Gersten, 2000). When compared to conventional, teacher-led drills and exercises, Traynor (2003) discovered that CAI enhanced mathematics achievement scores of regular and special education as well as ESL proficient middle school students on their math pretests and posttests. The learners who the author examined included intact groups arranged into exploratory classes by the junior high school administrators.

The necessity to comprehend and the ability to utilize mathematics in daily situations and in the workplace continue to rise (NCTM, 2006). In the world that is constantly changing, individuals who comprehend and are capable of performing mathematical functions will have considerably increased probabilities for influencing the future. Based on the research done by NCTM (2006), technology is crucial in explaining and studying arithmetic because it shapes the subject that is communicated and heightens student learning.

When students comprehend the value of math in everyday living, they are more apt to participate in learning mathematical concepts. Technology assists learners in understanding the relationship between mathematics and the world that they live in. Through association and exploitation of various numerical representations, technology provides the learners the opportunity to concentrate on absorbing mathematical theory in place of computations alone. Computer integration supports analytical thinking skills development essential for advancement in mathematics and in life. The continued investigation of technology application in the classroom such as evaluating several methods of usage to assess their success is significant as modern technologies develop at fast speed.

## Types of CAI

Through the work of Atkinson (1968) and Watson (1072), computer assisted instruction were originally apportioned into groups. However, since CAI software programs continue to vary in procedures, styles, and characteristics, they are currently categorized based on their delivery systems: (a) drill-and-practice sessions, (b) tutorials sessions, (c) simulations, (d) instructional games, and (e) problem solving programs (Robyler & Doering 2009).

**Drill-and-practice.** The first category of CAI is drill-and-practice sessions. As a supplement to conventional classroom instruction, technology can be used to add drill-and-practice procedures as appropriate exercises. With numerous benefits over the traditional class worksheet, drill-and-practice training offer the following advantages: (a) reduce time needed to complete a lesson by providing spontaneous score and immediate feedback, (b) repetitive exercises on a lesson taught at an earlier time, (c) increase variety of questions at the appropriate educational level, and (d) increase in the amount of test questions presented for each unit (Ash, 2004).

The pedagogical function for drill-and-practice programs involves any subject where mastery learning of fundamental skills is preferred. During the implementation of the drill-and-practice program, the computer poses a question to the student, the student provides a reply, then the computer will give feedback concerning whether the response is accurate or inaccurate (Robyler, 2009). Some examples of the suitable usage of drill-and-practice software include memorization of math fact families, terminology practice, grammar exercises, and foreign language training. A type of compensation or reward usually follows an accurate response from a student during drill-and-practice.

**Tutorials.** The second category of CAI is tutorial software. The employment of

interactive multimedia tools provide students the opportunity to discover and create their own individual knowledge dynamically. It can assist in making learning more enjoyable (Moreno & Mayer, 2007). The tutorial software can render a productive and interactive learning atmosphere that encourages a variety of learning approaches (Birch & Sankey, 2008).

Integrating multimedia software treatment can enhance graphic, vocal, and dynamic learning. This process enables the students to regulate the progression and speed of the material that is advantageous to them. When learning is student-centered wherein they have some influence over the rate of instructional exercises, individuals may obtain learning more effectively (Mayer, 2006).

The utilization of online tutorials was deemed to have a constructive effect and overall increase on learners’ ability to grasp the content. A substantial correlation between expediency, degree of knowledge, and a non-linear navigation was recounted by Mitchell, Chen, and Macredie (2005). Thus, online interactive learning offers an unconventional technique of conveying directives that can be modified to assist various learning approaches.

In the state of Nevada, one metropolitan school district received a state grant to pilot and implement an examination and a corrective web site. The research was conducted by Biesinger and Crippen (2008) and 64 students from10 various high schools concurred to join in the experimental study. Each school was represented by one educator who participated in a two-hour workshop prior to applying the interactive tutorial program in their own domain. Using the program as a supplement to a traditional classroom, every educator who signed up for the pilot study was a math specialist with a forte on remediation. The participants in the pilot study comprised of students in 12th grade who had yet to pass the Nevada High School Proficiency Examination in Mathematics (NHSPEM). The subjects for the implementation study consisted of 10th grade students taking the test as first timers.

The goal was to assist learners in preparation for the NHSPEM, thus increase student performance. The intervention was aimed to offer learners a supplemental activity that provided access to mathematical education using technology inside and outside the classroom. In their findings based on the data gathered from both studies, the authors specified that students who accessed the interactive tutorial gained from the supplemental activity.

More specifically, in favor of the study cohort, the implementation group findings revealed a statistically substantial difference in advancement. With the prospect to become acquainted with the standardized test questions and the delivery of precise and constant feedback, the tutorial program proved advantageous to learners taking the test for the first time. The interactive tutorial website was best utilized as an additional practice for learners with explicit need for individual intensive tutoring (Biesinger & Crippen, 2008, p. 13).

**Simulations.** The third category of CAI is simulation software. Simulation games represent directives that engage individuals in exercises that call for personal assessment of mocked situations to adequately learn the magnitudes of their resolve. This type of instruction is conveyed using technology and is inherently exciting and stimulating (Griffiths, Parke, & Wood, 2007). In explaining the concept of interactive cognitive complexity, Tennyson and Jorczak (2008) proposed that simulation games are progressively successful than other directives because they instantaneously involve emotional and intellectual development.

Engaging its subjects to the tenets of dynamic learning and recreation is the principal approach when simulation games are utilized. The dynamic learning philosophy offers the participants two imperative responsibilities: firstly, vital decision-making opportunities and secondly, dependence on inductive knowledge when surveying the assignment to extrapolate the procedures for successful execution. On the other hand, the recreation concept continually occupies the participant in learning practices that heightens subject impetus (Bell & Kozlowski, 2008). By promoting helpful prompts of self- worth, simulation games endorse mastery learning to transpire by allowing subjects to go through the following experiences: use familiarity and ability, enrich rational and intellectual activities as one enthusiastically connects with the concept, and advocate constructive and expressive stimulation (Kozlowski & Bell, 2006). This conception is in harmony with the beliefs that promote simulation games as a source of increased self-worth when studying how to handle autistic youngsters (Bizo, Hall, Randell, Remington, & 2007).

In the meta-analysis performed by Vogel et al. (2006) concerning the scholastic efficiency of simulation games for instructing students, the authors denoted superior improvement for subjects that received simulation games versus conventional classroom instruction (*z* = 6.05, *n* = 8,549). Similarly, in the meta-analysis conducted by Sitzmann (2011), the researcher disclosed the following outcomes with favorable results for the group that received simulation games: (a) in the area of declarative learning, 11% advancement, (b) in the level of technical learning, 14% progression, (c) in memory or recollection capacity, 9% superior, (d) in delivery method, 17% more successful, and (e) in classroom interaction, 5% more applicable than the conventional classroom procedure. Based on these outcomes, the researcher concluded that the recent findings are consistent with other meta-analyses on computer-assisted instruction. Therefore, the author submitted that when appropriately applied, technology can increase student learning achievements.

**Instructional games.** The fourth category of CAI is instructional games. The theory of conventional classroom learning is continuously altered and modified by the expansion of technology and communication. This advancement offers the confirmation of learning without the constraints of schedule and location. Computer-assisted instruction software programs render inspiration and promote profound learning experiences to students (Hung-Pin Shih, 2008). Students’ enthusiasm during regular classwork exercises and testing is at a low level because exercise represents repetition of work. In many cases this results to declining output, thus, utilizing methods that intensifies motivation is in order (Allessi & Trollip, 2001).

Instructional games have numerous factors that provide impetus and the aspiration for achievement is most vital (Yee, 2007). A study conducted by Bekir Celen (2009), which included 157 high school learners, was intended to assess the effects of scoring high and seeing the student’s name on the top of the list after web-based drills. The author reported the website with the greatest competitive characteristics yielded the most progressive outcomes. The process steered to transform the learners’ intentions to explore the website and the occurrence of their visit. It was concluded in this research that there was no discrepancy in enthusiasm between male and female genders in instructional games.

It was denoted in the research performed by Kula and Erdem’s (2005) that although quantifiable effort was not measured, the value of motivation in learning was detected. In their study, the authors declared that the following are the attributes present in the instructional games that attracted the learners: to collect bonuses, to accumulate points, pointers and cues, amenities, obtain tallies, discard numbers, procedures, to enhance knowledge, songs, influence, and facade. In contrast, in a study presented by Tezel (1999), it was pointed out that an extreme competitive disposition of learners had zero influence on scholastic attainment. The researcher mentioned that competitive and spirited driven individuals prefer to be compelling and be regarded as such. Recognition is highly significant to them. The practicality of the instructional games discloses its appealing and academic elements (Prensky, 2001). It is proposed by Malone (1980) that the intrinsic stimulus that is an essential part of motivation in the environment that formulate successful learning includes creativity, inquisitiveness, and challenge.

**Problem solving.** The fifth category of CAI is problem solving. The ability to provide instantaneous feedback to learners and as well as immediate scoring on learners’ classwork, tests, and projects are some of the benefits of CAI problem solving method. Besides furnishing spontaneous feedback to learners, pointers and suggestions to assist in solving problems can be rendered (Heffernan, Mendicino, & Razzaq, 2009).

When the concentration is on problem solving as a compilation of minor element abilities and not as solitary academic skill, problem-solving programs are deemed to be at its highest success (Mayer, 2008). In preparation for students to be successful in utilizing the problem-solving approach, appropriate training includes educating learners about the process of problem solving prior to mastering the concept, explicit problem-solving abilities, interaction regarding problem-solving method, and drills concerning procedures involved in problem-solving. Accordingly, its delivery in an organized and controlled procedure and not in slow process is more applicable.

Utilizing the computer-assisted instruction problem-solving method, independently, is inadequate in cultivating learners’ elemental and theoretical intelligence. Allowing students to solve problems through trial-and-error instead of using only distinct and precise procedures is appropriate. This method will incite students to shift their mathematical abilities to tangible applications. The merit of the problem-solving programs can be beneficial to learners with unpredictable skills in problem solving, from the amateurish to the more seasoned problem solver. After conducting a pilot study involving 35 individuals using the Learning Online Network with a Computer Assisted Personalized Approach (LON-CAPA) program, a methodical problem-solving program that offers instantaneous feedback on the tactic usability, Gok (2010)

accounted that learners should distinctly comprehend the mathematical theory and problem-solving skills to increase mathematical achievement.

## Differences between Traditional Classroom and CAI

Traditional classroom instruction differs from CAI in three areas: (a) style

of communication, (b) mentor-learner interactions, and (c) learning atmosphere (Lewis, 2010). In CAI, small amounts of oral communication exist as the computer corresponds in visual approach. The most significant feature of traditional instruction is the interaction between the mentor and the learner (Steinberg, 1991). A mentor can evaluate student learning and understanding of the subject matter through inquiries, reviewing progress, and providing feedback.

The use of computer-assisted instruction can be carried out in numerous arrangements and functions through various conceptual instrumentations. With opportunities of daily drills and prompt response in a stimulating and inspiring setting, technology can assist in reaching intellectual objectives (Kaput, Hegedus, & Lesh, 2007). Utilizing software designs can encourage learners to create numerical procedures that promote knowledge and expertise by gradually tracking the formula on a question, a step at a time, prior to interceding when execution disagrees with the correct procedure (Corbett, Koedinger, & Hadley, 2001; Roschelle, 2003). Technology validates systems that already exist in the classroom such as developmental evaluation and social practices (Roschelle, 2003).

One of the most celebrated methods for learning recognized to be educationally sensible and cost effective is the integration of computer-assisted instruction in the classroom (Lim, Petty, & Zulau, 2007). Nevertheless, the need for individualization and differences in ways of knowledge acquisition must be taken into consideration when integrating technology into the curriculum. Similarly, understanding the personal requisite and the impact of technology on each learner needs to be reflected in the development and production of new software programs.

To solely investigate based on the technology element is to neglect the most crucial element of this interface between mortal and machine (Smith, 2009). In an experimental study of CAI versus traditional classroom curriculum done by Smith (2009), he proposed that the increased scores from pretest to posttest were due to the dynamic learning of the students and the repetitive exercises extended daily through the assimilation of wireless networks. The researcher concluded that outcomes with constructive bearings toward the practice of computer integration in the classroom revealed that the success of the lesson was not automatically based on the method of technology used but by the treatment of the technology to the content area that caused the directive to be successful (Smith, 2009).

Traditional instruction is distinguished by guided teaching which applies the educator-focused approach of delivering instruction while taking on the position of professional, specialist, and ideal (Spradlin, 2009). Utilizing similar instructional procedures with which the teachers have been trained and feel at ease is the inclination for many educators when delivering instruction. While the educator lectures, the learners pay attention and take notes.

After explaining the lesson and the stage-by-stage processes, the educator will support the lesson with exercises. Collaboration between the students is not practiced and interaction is reduced to learners replying to the teacher’s inquiry. Traditional instruction is entirely lectured and has not been successful in teaching mathematics advancement (Spradlin, 2009, p.33). On the other hand, the use of computers and the Internet allow for innovative ways to convey instruction that offer the learners choices of what time to learn, where to learn, and how to learn mathematics. As a substitute to traditional instruction, CAI promotes individualized instruction, controlled exercises, spontaneous feedback, and all day access (Bottge, Grant, Rueda, & Stephens, 2010).

## Implementing CAI in the Curriculum

To promote progression amongst the series of proficiencies, the majority

of educators today would concur with the essentials for expounding instructing stratagems and prospectuses. But the inquiry continues concerning what mathematical concepts are valuable (Roschelle, Singleton, Sabelli, Pea, & Bransford, 2008) as well as the features of the type of studying activities would advocate this learning (Greeno & Collins, 2008). Many instructional approaches are localized in a gamut of steering learners through a progression of prearranged technical measures or requiring learners to work out answers but conveying energetic teaching that esteems theoretical comprehension while encouraging practical fluency is the pivotal pedagogical concern (Lesh, Yoon, & Zawojewski, 2007). Thus, better-quality learning transpires when instructional activities implicate associating theories with distinct depiction of conceptions (Pashler et al., 2007).

Based on the reported data, learners who received traditional math instruction plus CAI displayed considerable gains compared to the control group. This outcome is indicative of the effectiveness and efficiency of the methodology of the intervention used for these particular fourth grade mathematics students. According to the theory of mastery, learning for mathematics by Suppes and Zanotti (Institute of Education Sciences, 2009) traditional instruction in mathematics supplemented by CAI would result to advanced levels of student success.

Similar to the findings of a study conducted by Wood (Pearson Digital Learning, 2006), CAI had an explicit impact on student learning. A group of 18 learners participated in the research study for over two years and another group of 28 learners participated for over a year. Utilizing SuccessMaker math program, both groups spent 16 minutes every day and at least 80 minutes every week. At the end of first year, 88% of the participants displayed improvement.

After studying the effects of CAI on mathematics in two Tennessee middle schools, Ash (2005) reported that there were substantial gains noted on the achievement scores of students who participated in traditional math instruction plus the CAI program. For one hour weekly, the experimental group received additional CAI using the Orchard Math Software as an intervention. The control group, however, received traditional math instruction only. The research was conducted for over 11 weeks utilizing a pretest and posttest both of which were “criterion-referenced tests” produced by Prentice Hall.

In studies reviewed by Clement and Sarama (2009), they confirmed affirmative outcomes of CAI programs on learner performance. Additionally, computer integration in the classroom provides instructors with the opportunity to finalize individual analysis, categorize instruction, adjust pacing, offer broad drill and exercise, and give immediate feedback (Flippo & Caverly, 2008). Utilizing the SuccessMaker CAI package, Powell, Aeby, and Carpenter-Aeby (2003) found that scholastic results of troublesome subjects could be increased after mentor-assisted intervention.

The authors of three studies that assessed the SimCalc methodology concentrated on student learning of advanced mathematics in junior high school and disclosed significant numerical results (Roschelle et al., 2010). The SimCalc method is a technology-based approach to higher mathematical theories and proficiencies. It was projected to assist students to acquire cutting-edge mathematical skills without neglecting one’s advancement in fundamental math facts. This approach was created to work with existing curriculum and educator workshops and training. To strongly assimilate software programs, curriculum, and professional development is a strategic factor that supported the mentors and learners to experience similar intervention.

In general, the conception that technology by itself has an intense influence on learning has been abandoned by the researchers. More accurately, as an alternative, the authors endorsed exploring interventions that combine dynamics such as instructions, curriculum, technology, educators’ workshops and training , evaluations, and educational management (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Overall, it was reported that increased achievements confirmed that the implementation of CAI in the curriculum such as the example of SimCalc was successful in empowering an expansive group of instructors in a diversified venue stretching students’ learning of higher mathematical concepts and skills (Roschelle et al., 2010).

Following one year of exposure, learners who received pedagogical activities that reinforced fundamental math facts in the framework of realistic challenges surpassed students who did not receive math subsidized technical instructional activities (Alfeld, Jensen, Lewis, Pearson, & Stone, 2006). The advancement was due to the technological instruction of basic mathematics skills and applied problems proficiency methods. The procedures were entrenched in the daily instructional activities that were carefully designed by professional/technological specialty educators and mathematics instructors brought together by the National Research Center for Career and Technical Education (Bottge, Grant, Stephens, & Rueda, 2010). Educators in the state-of-the-art technology education courses engaged computers and proactive presentations (International Society for Technology in Education, 2007) unlike their counterparts, in a traditional classroom where “tool skills” were simply accentuated (Frank & Barzilai, 2006).

School principals are more familiar undertaking language arts illiteracy than tackling mathematics innumeracy, hence, decision-making concerning how best to present math education turns out to be challenging (McEwan, 2000). Understanding and sensitivity in adapting techniques to execute innovative computer applications that guarantee to enhance acquiring knowledge in mathematics is a priority (Shelly, 2002). Ultimately, respect and compassion must be considered when devising suitable pedagogy for slow learners who frequently demonstrate antagonism towards traditional classroom mathematics instruction (Hand, 2010).

The employment of CAI offers unlimited amount of data that can provide significant information in assessing students’ knowledge of the subject at hand. The time required to complete the assessment using CAI is considerably curtailed. Any issues pertaining to the availability and accessibility of data and information of each student are simply reduced and easily identified by the teacher. Subsequently, after mastering each concept, each learner can move on to the succeeding section of the content. The mastery learning of a specific unit can be obtained effortlessly with the use of computers.

## Mastery Learning and Active Learning

Systematically arranging the concepts and skills that the instructor aspires

to teach the students, normally requiring five to ten days teaching time, the strategy of mastery learning is to provide a concise developmental evaluation. The concept of mastery learning is concentrated on the objectives of the previously learned ideas and skills. The goal of the evaluation is to offer constructive information to the students regarding their learning. This leads to supporting learners in ascertaining what has been learned thus far and what other knowledge can be discovered and acquired excellently from the unit instead of indicating unit completion (Bloom, Hasting, & Madaus, 1971).

The developmental evaluation includes detailed and precise remedial materials that are customized allowing learners to work only on concepts or skills that are needed to be mastered. Averting inconsequential learning difficulties from becoming complicated learning challenges, the employment of the remedial activities is necessary. Becoming proficient by learning the course objectives and obtaining criterion knowledge needed to achieve in the succeeding units, increases student learning.

Utilizing the developmental evaluation procedure followed by the application of remedial activities will deliver relevant and more superior pedagogy which is not always achievable in a conventional classroom setting. The process will inspire the belief that all students will comprehend competently and accurately master the course objectives, hence, condensing the disparity of leaners’ proficiency and diminishing the achievement breach. One of the core foundations for computer-assisted instruction is the philosophy that all students can learn with the provision of adequate time and sufficient individual consideration (Bloom, 1984). Concentrating on the procedure of mastering the content and not giving attention solely to the content is the main objective of mastery learning.

The Keller’s Personalized System of Instruction with four differentiating attributes is another model of mastery learning that can be applied when integrating computer-assisted instruction in the classroom curriculum (Keller, 1968). Initially, instead of using the verbal approach to teaching, the instructor chooses and produces relevant written activities with appropriate learning goals and reading comprehension. This activity communicates the increased use of written and printed resources that may not be always the priority method used in a conventional classroom set up. Secondly, learners are given the opportunity to complete their classwork without the pressure of time. Thirdly, evidence of mastery learning must be exhibited prior to moving on to the next stage. Conclusively, through the availability of educational materials, learners can utilize an abundant supply of resources to their advantage to prevail over their inadequacies (Keller, 1968).

The integration of CAI in education heightens the theory of mastery learning. The opportunity to use the computer in the classroom allocates individualization allowing each learner to function distinctively on his or her rate, which is one of the keystones of mastery learning (Vockell, 1990). Established on the principle of skill acquisition (Anderson, Douglass, & Fincham, 1997) and on the actuality that learners vary in their ability, proficiency, and skill advancement, an affirmation of the system must be confirmed then converted into performance of gradual and construed procedures.

Once students mastered their classroom procedures, it steers learners to automaticity. At this stage, only educative comments from the teachers are required. One-on-one guidance is not crucial. However, repetition and continuous practice are vital (Schoppek & Tullis, 2010). This approach gives the instructor a chance to focus on the learner’s weakness. With the help of the computer, every student can be assessed prior to the introduction of a lesson and during the culmination of a lesson.

Much like the manner in which technology is revolutionizing the direction that the U.S. is carrying out business worldwide, the use of technology in the classroom is shifting the methods in which American schools are handling pedagogy that will promote student-learning achievement. Through the use of the mastery learning, a paradigm shift in student achievement can be expedited. The use of the mastery learning approach combined with exercises that enhances critical thinking will generate a learning atmosphere that is thought provoking and progressive (Strange, 2007). He challenged educators to utilize concepts that promote mastery learning strategies to stimulate and inspire students to learn beyond the fundamentals.

While it is true that the ease of fundamental mathematical procedures is a prerequisite for problem solving, the preparation of acquiring mathematical abilities and skills has a vital role in current mathematics. Research conducted by Schoppek and

Tullis (2010) indicated that a significant increase in mathematical skills and problem solving was linked to individualized repetition when applied in an adequate amount of time, even after a follow-up episode of 12 weeks. As a method to advance its effectiveness while minimizing time spent in instructing skills, to alleviate instructors from the overwhelming task of analyzing each student, choosing problems, and instantaneous corrective feedback, the authors propositioned individualization of drill and practice.

In the study, students from four third grade classes, totaling 113 students, from three primary schools participated in the experiment. The study involved 57 participants in the training sessions while the control group consisted of 56 remaining students. The authors indicated that greater advancement was noted in the trained group more than the untrained group albeit, various classes had diverged pretest levels.

Overall, the trained group displayed gains from the pretest to the posttest as determined and computed by Analysis of Variance (ANOVAs) with the aggregate scores in pretest and posttest as repeated measures. According to the authors, it was anticipated that substituting individualized exercises in place of some arithmetic units would provoke a significant progress in learners’ mathematics skills, which was one of the hypotheses in this study. The rationale that working with the computer delivers a compounded amount of scholastic commitment as a function of educational acquisition time, which is a vital provision for learning explains their projections.

Computer-assisted instruction acknowledges the application of manifold sensory approaches that allows for prospects to allocate scholastic subject matter into reduced portion, focusing on specific goals, emphasizing crucial details, and encountering instantaneous response or advice (Du Paul & Weyandt, 2006). The researchers of an experimental study who arbitrarily chose 40 participants that formed two groups, experimental and control, from two adjacent scholastic institutions in Pakistan indicated that the integration of CAI inside the classroom validated its advantage over the usage of classroom lecture alone. The study included a pretest, which was distributed to all cohorts prior to the commencement of the experiment. The same exact test was administered as a posttest after the intervention. The outcomes included a 60-70% student improvement in the overall reasoning and critical thinking achievement for the experimental group subjected to classroom instruction plus CAI supplement over the control group.

With a high probability to support learners to participate in intricate mathematical procedures, computer technology is commonly known as an appealing device (Zbiek, Heid, Blume, & Dick, 2007). In training learners to become technologically knowledgeable in preparation for the space-age future, the public is stimulated by the launching of innovative technological advancements. Although, except for the use of calculators and greater computer accessibility, researchers from the past publicized that there is a need for technology to propagate in approaches that will encourage learners to participate in critical thinking exercises (Becker, 2001; U.S. Department of Education, 2008; Wenglinsky, 2005).

In an organized setting and by endorsing active learning, the use of computer-based programs can empower learners to manage information to be able to associate them to their previous experience (Berger, Mary, Shaw, & Sosa, 2011). Integrating the use of CAI software programs with real description of comparable concepts increase student

engagement in learning the assignment and promote avenues that incorporate and prepare their grasping of theories (Bottge, Grant, Rueda, & Stephens, 2010, p.101). Interactive technology programs offer learners the opportunity to manage how resources are expounded, thus enhancing the student involvement with course material and content (Correador, Larreamendy-Jones, Leinhardt, 2005).

## Computer Software Programs

Computer-assisted instruction software varies in approaches and types as

well as in quality. It is essential for educators to understand the significance, features, and delivery methods of each software program to ascertain what style is suitable for each educational setting. Consisting of a set of computer–based courses, the SuccessMaker program is utilized to supplement the conventional K-8 classroom in reading and mathematics (Pearson Digital Learning, 2005). The producers of SuccessMaker aspire to increase understanding in mathematics by utilizing adaptive lessons customized to the learner’s math level.

After a computer analysis of the learner’s skills development, exclusive sections of the program are allocated to each individual with new skills introduced as they become appropriate. Performance is calculated by the probability of the learner responding correctly to the next question as the learner advances through the program. This establishes the next stage of the lesson (Pearson Digital Learning, 2005). SuccessMaker has been used with at-risk individuals and overachievers, general and special education students, as well as English as a second language (ESL) learner. It has been utilized in over 1,700 institutions all over the world (Suppes & Zanotti, 1996).

The fluency of fundamental math processes is a prerequisite for math problem solving and the preparation of skills takes part in current mathematics instruction (Schoppek & Tulis, 2010). The authors believed that in order to curtail the time consumed with the training of skills, personalization of practice is utilized as a measure to increase effectiveness. They created training software called Merlin’s Math Mill (MMM) to use as a device to relieve educators of the overwhelming task of individual analysis, selection of challenges, and immediate feedback.

Culminating the study, the investigators concluded that increased advancement in math skills and problem solving were associated with a reasonable amount of individualized practice. However, the training software, MMM, presented an assortment of glitches involving multiplication, division, and multiple step problems. Evaluating the justification of choosing and conducting word problems using MMM needs to be reconsidered to create more appealing word problems and proportioned computation problems (Cheng, Harter, Ku, Liu, & Thompson, 2007).

A single-subject study for six primary grade students with cognitive and learning disabilities on CAI and mathematics to examine the efficiency of multimedia software was conducted by Irish (2002) utilizing Memory Math program. The outcomes signified that increased time spent in utilizing the software equaled greater gains, thus CAI was successful for improving learners’ accuracy with fundamental skills. Strategies that students learned from performing computer evaluations of basic information were applied to paper-and-pencil examinations.

Among studies, similar research work (Fuchs et al., 2006; Xin, 1999) investigated the application of CAI software programs such as Math Keys Fraction and Decimal Maze and Math Shop Jr. The evaluation compared the use of the software programs as a group-collaborative learning exercise versus the entire classroom activity without the use of the software programs. The study involved 118 students with and without disabilities. Xin (1999) discovered an upsurge in mathematical skills as assessed by the Stanford Achievement Test (SAT) for all learners using the programs through a pretest-posttest design. Nonetheless, with or without disability, learners in the cooperative learning condition, outshine the learners in the whole class situation. Fuchs et al., (2006), however observed that CAI enhanced learners’ addition skills but not subtraction skills and their performance did not translate to mathematics story problems. Their data and statistics were gathered on a CAI software program to instruct the skill of number combinations with 33 first graders with low accomplishment in reading and arithmetic.

In the St. Lucie County Public Schools in Florida, both Destination Reading and Math programs were utilized as an enhancement to supplement the primary curriculum either as reinforcement for learning, exercise, remediation, enhancement, advancement, or as ways to offer modified or group education in a differentiated paradigm (Roberts, 2009). The objective of including the instructional technology in education was to improve learner success and accomplishment by incorporating into, and supplementing the application of the curriculum, instruction, and learner evaluation in classrooms. It was hypothesized that CAI programs provide benefits such as personalized education, access to advanced level content by creating multifaceted concepts simpler, and additional links to a comprehensive selection of learning opportunities, which all support sound pedagogy and the ventures that teachers want to offer to their pupils.

In addition, the research also put emphasis on the learners and their overall school performance in St. Lucie Public School District over the past five years with the emphasis on the value and usefulness of the Destination Reading and Destination Math Solution programs. The findings included extensive comparison between the number of instructional days that students spent on Destination Reading and Math Solutions learning activities in reading and mathematics in the 31sampled schools. According to the investigation, schools where learners devoted nominal time and frequency on CAI learning tasks revealed an inclination of decreased performance in math and reading on the Florida Comprehensive Assessment Test (FCAT) than institutions that had considerably increased CAI time-on-task.

The results in this study supported the hypothesis that CAI is a practical approach that must be integrated in the collection of scholastic involvement that is offered to learners and is a valuable tool of educators in meeting the diverse needs of the students. It also confirmed the belief that the implementations of a well-designed Computer-Assisted Instructional program such as Destination Reading and Math Solutions could present the opportunity to simplify the instructional templates for math and reading to other scholastic venues (Roberts, 2009). Research regarding the effectiveness of the CAI programs in relation to the usage of software products was led by Campuzano, Dynarski, Agodini, and Rall (2009). A group of investigators carried out an experimental project in which educators in the same schools were unsystematically designated to utilize a software product while the researchers gathered test scores and other applicable statistics to measure the success of the software products.

In April of 2007, a report on the findings was published with results from the school year 2004-2005 indicating that after one academic year of using the CAI software products, distinction in student test scores was not statistically noteworthy (Dynarski et al., 2007). However, the data gathered in the 2005-2006 scholastic year wherein educators who persisted with the research had fresh cohorts of learners and one year of familiarity using the software products, revealed mixed results (Dynarski et al., 2007). For algebra I, influence on the student SAT test scores revealed considerably greater scores in the second year versus the first academic year. This study is partially consistent with the findings conducted by Robert (2009). The product’s effect on learner test scores, for sixth grade math, was notably inferior in the second year than in the first year.

The drawbacks of the research precluded straightforward assessment of product impact. Product efficiency may have been directly related to specific product features and variations due to an assortment of choices agreed to be used by schools and districts. The model of the study did not eliminate the likelihood that a product that the research found to be incompetent could be successful if executed by other schools. In addition, gathered data, which was limited, in the second year prevented the research from investigating how educators had possibly utilized the CAI software products another way in the second year in comparison with the first year, and from examining how classroom procedures and experiences may have changed between products.

In a research performed by Beal, Adams, and Cohen (2010), a group of 442 ninth grade students all enrolled in an algebra class, were subjected to a computer assisted instruction program. The population included 209 English Language Learners (ELL) and 233 students whose initial language is English. Hoping for the learners to advance to more sophisticated algebraic problems, educators in the study opted for students to review a pre-algebra online tutorial. An online-based tutorial program called AnimalWatch that includes basic math fact families, fractions, measurement problems, decimal numbers, ratios and proportions, and percentages, was utilized as the CAI software.

Based on the previous score from the preceding set of questions but within the learner’s skill to solve the problem, the computer software designated mathematical expressions that were predicted to be thought provoking. As the learner established ability to compute questions concerning a specific proficiency, the problem complexity intensified. Progressing from basic calculation problems (add, subtract, multiply, and divide), the learners would be approved to advance into a set of questions with fractions prior to pre-algebraic expressions. For data sources and scoring, the following combination of test modules were applied: (a) using the California Standard Test-Math (CST-Math), the performance groups based on the scale scores included over 80% far below and below basic, (b) study-specific-pre-and-posttests (software integrated) revealed overall low performance, pretest = 30% and posttest = 34%, (c) word problem solving graded by math instructors indicated that 40% of the learners were incompetent in Algebra 1.

The findings are in harmony with other authors (National Clearinghouse for English Language Acquisition, 2007; California Department of Education, 2007) who reported that learners who are not able to comprehend questions offered in English curriculum will also have less success in mathematics in comparison with students who are proficient in reading English. In addition, not passing Algebra 1 in secondary school in Los Angeles, California, seems to be a compelling forecaster of dropouts since over half of ELL students registered in Algebra 1 course did not succeed in passing the class the first time (Helfand, 2006). There is a flourishing corroboration that mathematics achievement for students in secondary schools is associated with inadequate English competency (California Department of Education, 2007).

## The History and Characteristics of the Mad Dog Math Program

A **supplementary program to any math curriculum, MDM is utilized in any**

**classroom or home school venue. It has taken the fundamental facts of mathematics and reduced them down into bite-sized pieces by fact families that any learner can master. The program is intended to complement the efforts of conventional classroom educators through paper and pencil drill-and-practice as well as implementing a corresponding computer software program (Kotoff, 2011).**

**In 2010, three educators from a private sector in Central California evaluated the effectiveness of the program during its implementation with a combined 63 students in their three classrooms. The study was performed to ascertain if MDM provides substantial increase in multiplication and division scores as a supplement to traditional methods. Every day, the three classes used an identical math curriculum and completed the same lesson at precisely the same time. One group was marked the MDM group (21 students); and the two others were marked Control Group1 (22 students), and Control Group 2 (20 students), respectively.**

**During the school year of 2009-2010, the MDM group‘s teacher administered a pre, mid, and posttest to all three groups using the same instructions. The pretest was given in October 2009, the mid-test was dispensed in February 2010, and a posttest was distributed in May 2010. The two tests presented were as follows: a multiplication fact test with 100 problems in random order, and a division fact test with 100 randomly placed problem. On both tests, learners had one minute to complete as many questions as possible. In addition to the traditional curriculum, only the MDM group received a 10-minute paper-pencil drill sheet every day that began one day after the pretest was implemented. Whereas MDM was utilized daily until the end of the school year by the MDM group, the two control groups did not employ MDM.**

**Based on the data of the study, when compared to control groups, the researchers concluded that MDM succeeded, largely, by total increased math tests scores in both the areas of multiplication and division over both the control groups. The test scores represented both multiplication with 117% test improvement and division 146 % test improvement. The authors reported improvement over control groups for normalized test scores (Kotoff, 2011).**

## Summary

The intention of the literature review was to identify the literature-based investigations involving the success of CAI in primary grades. The review entailed information about (a) Computer-Assisted Instruction, (b) the effectiveness of CAI in mathematics, (c) the differences between traditional classroom and CAI, (d) implementation of CAI in the curriculum, (e) computer software programs, and (f) gender differences in learning mathematics. There were ample endorsements from literature that substantiated the hypothesis that computer assisted instruction enhances learning. Nevertheless, there is a demand to further investigate how the use of technology inside the classroom promotes student learning (Trenholm, 2006). In particular, the Mad Dog Math program, which includes a set of computer-based progressions that allows learners to function individually, at their own speed, in an attempt to assist students’ understanding while boosting mastery of basic math facts (Kotoff, 2007).

The above literature review evaluated a variety of past practices utilized by school administrations and educators. The studies reviewed include information pertaining to elementary school learners and the methodology used to assist in the delivery of mathematics in the classroom and to aid learners in becoming proficient in mathematics. The variations considered in terms of insufficiency and inadequacy of the various research reviewed lead to the need for additional research within the scope of understanding the use of computer-assisted instruction in mathematics in the primary grade levels.

In an attempt to expand the present literature on computer assisted instruction, the outcomes of this research can be appended to the studies accessible on the efficiency of CAI. Consequently, the results from the study assisted to explicate the varied findings on the value of CAI on student achievement in mathematics. The study also offered statistically sound information to the insufficient quantity of literature available on the effectiveness of computer-assisted instruction.

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# Chapter 3: Research Method

The purpose of this research was to determine if the integration of CAI in a mathematics education program at a local elementary school in Southern California generated a considerable effect on the differences in mathematics achievement. The method of this study was based on an examination of the influence of CAI on student achievement conducted by Lewis (2010) and Ash (2004). This chapter commences with a discussion of the explicit method and design of the study including reasoning as to why a quantitative method design with mastery learning and active learning theoretical framework had been chosen. To ascertain any possible gains in math achievement, a pretest and posttest design was implemented. The tests were provided by the California Department of Education. The strengths and weaknesses for the chosen design were described in this section.

The materials and instrumentation used as well as the description of the participants were also addressed. Operational defining of the independent variable, MDM, the dependent variable, CST Posttest, and the covariate, CST pretest were indicated together with references as to how confounding and intervening the variables. In addition, both materials used and participants obtained during the study were identified. Specifics relating to data gathering and analysis, methodological assumptions, ethical assurances, delimitations, and the summary bring the chapter to completion. The outcomes of the investigation are particularly significant to the school and the school system in this study.

Current studies have been performed on the influence of computer-assisted instruction on learner mathematics achievement in elementary school from kindergarten through twelfth grade. In this particular study, the author endeavored to fill the gap in literature by investigating the following research questions and hypotheses:

**Q1**. After accounting for the pretest score, is there a significant difference on the mean posttest score between students who were offered the MDM software supplement program and those who were not?

**Q2.** Is there an interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate?

The following hypotheses were examined:

**H10.** There is no significant difference on the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H1a.** There is a significant difference on the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H20.** There is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

**H2a**. There is a significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

## Research Method and Design

For this study, the researcher chose the quantitative method, as it was appropriate for investigating the effect of educational interventions (Ash, 2004; Lewis, 2010). Quantitative studies utilize populations to produce numerical information in relation to social phenomena in conjunction with statistical methods to evaluate the data. Such studies can be experimental or non-experimental, having descriptive, causal-comparative, or correlational designs (Borg, Gall, & Gall, 2006). The investigator used a quasi-experimental, nonequivalent control group design, which was an appropriate substitute to an experimental design when randomization was not feasible (Gall et al., 2006). The classes were already composed; therefore, random allocation of students was not practical or ethical.

Generating an unbiased assessment of the experimental group with the control group, four equivalent classrooms were selected to indicate groups that were comparable as possible. The investigator chose second and third grade classes; each class was comparable in number of learners and gender. To have as close and realistic comparison as possible so that any inequalities could be attributed to the intervention was the objective of the class selection.

This study employed a multiple-variable, quasi-experimental design. The posttest scores served as the dependent variable while the treatment of Mad Dog Math and gender served as the independent variables. The pretest scores served as the covariate. Data were collected to address research question one, which investigated if a difference existed in achievement between students who participated in the MDM software supplement program and those who did not. Mad Dog Math was geared to give students additional learning skill instruction and to assist them in increasing their ability to retrieve addition, subtraction, multiplication, and division number combinations from memory.

The main features of MDM included standards-based content and instructional design, individualized instruction, continuous progress evaluation, resources, and tools for learners and teachers to use (Kotoff, 2007). Data were gathered to address question number two, which examined if an interaction existed between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores were used as a covariate. The learners provided their age and gender on each test.

## Participants

For the purpose of this research, learners from second and third grade classes were the target population. The second and third grade students were chosen because they represented early grade levels where children are beginning to learn math facts and because remediation is more difficult with learners in later grades (Hasselbring, Lott, & Zydney, 2005). Participants were recruited from a K-8 elementary school in Southern California. The January 2012 student enrollment data specified that 300 students were present in the school. The student population was diverse. Second and third grade students totaled 81, or approximately 27% of the student population. At the time of this study, 17 regular classroom educators worked in the school, with responsibilities varying from kindergarten through eighth grade (Gardena Valley Christian School, 2012).

For the experimental group, one third grade class and one second grade class, totaling 39 students altogether, were solicited to participate in the study utilizing MDM computer-assisted instructional software program in addition to the conventional teaching of mathematics inside the classroom. For the control group, one second grade class and one third grade class, totaling 42 students altogether, were requested to participate in the study using only the conventional method of teaching mathematics without any supplements. The student population within the sample included black, white, Hispanic, and Asian ethnicities. All learner ages ranged from seven to nine years old. The sample was representative of the student body in a local elementary school in Southern California where the research study took place.

Apriori analyses was calculated for the F-test ANCOVA with fixed effects, main effects, and interaction. The α for these tests was set for .05. To attain power of .80 and a large effect size (*f* = .40), for a 2 x 2 ANCOVA, an overall sample size of 52 was needed to identify an effect. However, a sample size of 128 was required when the power analysis was calculated with a medium size effect (*f* =.25). Regrettably, due to the limited enrollment that existed in many private schools, the researcher was not able to obtain 128 students. Consequently, assigning the power analysis for medium effect size, the 81students secured as participants potentially caused the study to be underpowered to identify group differences. Using the sensitivity analysis, the researcher determined the effect size (0.32) needed to achieve a 0.81 power with the given parameters.

## Materials/Instruments

The following section includes an account of the instruments, description of the data collection and analysis process, and concludes with a discussion concerning what is considered to be the overall validity of the proposed study. The California Standard Tests (CST) pretest was administered in the beginning of the study and the California Standard Test posttest was administered at the end of the 10 week treatment to measure students’ achievement in the experimental and control groups. The pretest and posttest measure of dependent variable was a criterion-referenced test developed in 2006 by California educators and test developers particularly for the state of California. The CST was intended as the “end-of-grade”/ “end-of- course” evaluation of the content standards. Defining what learners should recognize and be able to accomplish in each grade and field of study tested, the test measures learners’ advancement toward achieving California’s state adopted academic content standards in English—language arts (ELA), mathematics, science, and history- social science.

The CST pretest and posttest were centered on the math course objectives. For the second grade students, the following academic content standards were included in the test: number sense strand (including place value, addition, subtraction, multiplication, division, and fractions), algebra and functions, measurements and geometry, statistics, data analysis, and probability. For the third grade students, the academic content standards included in the test were as follows: numbers sense (including place value, fractions, decimals, addition, subtraction, multiplication, and division), algebra and functions, measurement and geometry, statistics, data analysis, and probability.

Identical to the pretest assessment scoring procedures, the posttest was handled in a similar manner. All math probes were graded by the researcher and a trained research assistant utilizing scoring procedures determined by Shinn (2004). In this scoring process, a learner was awarded credit for each question answered correctly. The researcher and research assistant re-scored the probes collected from each of the two administration points (pretest and posttest) for all four classes.

The pretest and posttest measure of the dependent variable was a criterion-referenced test developed in 2006. The items chosen for each California Standards Tests were authored by distinctive groups of item writers with proficiency in the California Content Standards. The California Standards Tests were developed to assess the California Content Standards as well as to attain psychometric measures for difficulty and reliability. Representative of the comprehensive content areas such as mathematics, each CST items were created to support the California Content Standards. Therefore, the content-related proof of validity concerns the degree to which the test items signify these quantified content areas and cognitive elements (CST Technical report, 2006).

The construct of mathematics achievement was defined as scores on the California Standard Test (Appendix A), which was the pretest and posttest. The CST is given to all the students in public school annually, more specifically for the benefit of this study, all second and third graders in the state of California. The exam evaluated the performance of the California education system and its learners’ advancement toward succeeding at California’s state-adopted academic content standards in mathematics and other subject matter. The exam corresponded to what the learners should recognize and be able to execute in each grade level and content area tested (CST, 2012). The validity of the posttest was the extent to which it measured mathematics achievement. The exam was a collection of test items representative of the various content areas.

The CST was created by California teachers and test creators exclusively for California students. It is equivalent to the mathematics course objectives in comparison to the importance rendered to each lesson during the year. This presented face validity. The test questions were evaluated by California teachers and exam producers. This conveyed content validity. The reliability of the CST as a posttest was the extent to which scores are free of arbitrary error, that is, the extent to which the test produced reliable results.

## Operational Definition of Variables

The study had the following variables: (a) gender, (b) Mad Dog Math, (c) student math scores on the pretest and posttest. An operational definition of each variable is explained below.

**Gender**. This independent variable was operationalized as male and female to be investigated as a potential confounding variable for its effect on the posttest outcome.

The following representatives were coded in this research: F =1, M = 0 to evaluate significance.

**Mad Dog Math**. This independent variable was defined as a supplemental math program to any math curriculum for grades kindergarten through fifth grade. It was used with computer or traditional methodologies, designed to assist students with improving mastery of the basic math facts (Kotoff, 2011). The MDM dummy was coded E =1 and C = 0.

**Student math scores on the pretest and posttest**. Student test scores were obtained from the pretest, coded as Y1, given prior to the experimental manipulation. The posttest, coded as Y2, was assigned 10 weeks after the learners received conventional math instruction or conventional math instruction plus the Mad Dog Math supplement. The test scores were submitted as raw scores, which fluctuated from 0 to 50 number of correct. The covariate was the pretest scores. The posttest was considered as the outcome or dependent measure. All test scores were normally distributed and parametric statistics were appropriately applied.

## Data Collection, Processing, and Analysis

Designating the power analysis for medium effect size, the 81students secured as participants potentially caused the study to be underpowered to identify group differences. Using the sensitivity analysis the researcher determined the effect size (0.32) needed to achieve a 0.81 power with the given parameters. The overall number of participants included students registered in one private academic institution.

To provide a reasonable comparison of the experimental group with the control group, four distinctive classrooms were chosen in an effort to select groups that were as comparable as possible. The experimental group received traditional math instruction along with CAI while the control group received only traditional instruction. Both groups received the CST math pretest.

After 10 weeks, at the completion of the intervention, the posttest was presented to both groups. Student math posttest scores were compared across groups, controlling for CST released test questions math pretest scores using statistical analyses. For all major and demographic characteristics of the subjects, descriptive statistics were obtained.

The study was conducted during the second semester of 2011-2012 school year. Advantages and benefits to participation were explained to the students including the option to decline without penalty. Intact classes were randomly allocated to either control or experimental groups, because participants in this quasi-experimental research design were not randomly distributed.

All four classes received the CST released test questions that served as a pretest prior to the commencement of the conventional math classroom instruction by itself or the conventional math classroom instruction plus MDM as a supplement. Each learner’s current level of performance was assessed using the pretest consisting of 50 items. This pretest served as a baseline assessment and was scored by the researcher and a research assistant. All participating classrooms executed group testing in a single day. The 50-question pretest was divided into three sections lasting about 32 minutes per section. The implementation of the posttest was a replica of the 50-question pretest given at the start of the research project.

The statistical analysis was completed via the use of IBM SPSS 20 statistical software. Utilizing a one-way ANCOVA, the mean of the experimental group’s CST posttest was evaluated against the mean of the control group’s CST posttest utilizing the CST pretests as a covariate to monitor any variations in ability before the MDM treatment was introduced. Thus, only one factor was utilized in testing the first hypothesis (experiment group versus control group). However, a two-way ANCOVA was employed for the second hypothesis where two factors such as treatment (experiment versus control) and gender (male versus female) were tested. The analysis of the interaction effect ascertained whether males or females reacted inversely to the treatment.

## Methodological Assumptions, Limitations, and Delimitations

**Internal validity.** The features of internal validity were associated with the

representation of the all-inclusive content areas such as mathematics that each of the CST questions signifies to promote the California Content Standards. Thus, the content-associated evidence of validity affects the strength to which the test questions indicate these measured content areas and intellectual components (CST Technical report, 2006). The validity of the posttest was the degree to which it measured the learners’ achievement in mathematics.

**External validity.** In terms of external validity, the computer laboratory as the

venue. The setting was maintained daily for a period of 10 weeks utilizing the same location and time frame. It was vital to maintain the same setting and timing so as to prevent decreasing the external validity of the study due to various activities such as unit tests or class parties just before or after the experiment that could have affected the daily regimen of drill and practice and confidence of the participants.

The ultimate limitation of this investigation included a sample size that was adequate for identifying larger medium effects only. However, due to the limited number of participants, the study was not substantial in revealing medium size effects. More specific and noteworthy effects, such as interaction between groups and ethnicity, can be identified if the sample size is much larger thus creating a higher power. The ethnicities of the population within the samples included students with black, white, Hispanic, and Asian background. However, since it is evident that one specific race dominated the second and third grade classes at the time of the investigation, the issue concerning race was not disaggregated. The sample was descriptive of the student body where the investigation transpired.

Delimitations were also apparent in this research study. Limited subjects from one private school located in a metropolitan area of Southern California imposed a time and geographic constraints on the experiment. Having only one researcher was also a delimitation of this study. Limited amount of resources and time availability were evident.

This study was conducted using second and third grade students delivered by two methods of instruction: traditional classroom instruction only and traditional classroom supplemented with CAI. The outcomes did not generalize to another institution that utilized CAI in a distinct manner, including using the classroom computers versus utilizing a laboratory setting. The number of learners in this study was restricted to those enrolled in the second and third grade classes for school year 2011-2012. As many components as conceivable were regulated in the design of the study. This research accounted only for disparities in student mathematics achievement as evaluated by the CST pretest and posttest and did not account for elements that may conceivably affect performance including student attendance, after school activities, socio-economic standing, ethnicity, parent education, or fear of mathematics.

## Ethical Assurances

Significant portions of the research design included research assumptions. Thus, every effort was attempted to guarantee outcome validity and reliability. All participants were trained the year before, therefore, the researcher assumed that every learner was familiar and knew how to access the MDM software program. The investigator did not ascertain cause and effect association due to the absence of random assignment, which is the nature of the quasi-experimental research design. The nonexistence of the placebo treatment from the control group can ensue disparities during the actual investigation as a consequence from the actual involvement of the CAI and the reality that the experimental group had something exclusive that was absent in the control group.

There are four categories of ethical issues that were strictly observed in this

dissertation: First is the issue of protection from harm. The second category includes the informed consent. The third category is the right to privacy. The fourth category involves honesty with professional colleagues.

Firstly, the outcomes of this research has the potential to contribute meaningful

information to current literature in the field of education while presenting minimal risks or harm to all participants. The released test questions were taken from the Grade 2 and 3 Mathematics Standards Tests (see attachment appendix D and E). These tests are California Standards Tests administered as part of the Standardized Testing and Reporting (STAR) program under policies set by the State Board of Education. The CST assessments coincided with the content standards and requirements for the accepted level for the minimal risk to participating children or instructors. The second and third grade CST mathematics aligned assessment pretest and posttest, MDM, and conventional math instruction were similar to daily academic classroom activities.

The possibility that students may experience discomfort at not knowing the answers on the pretest/posttest questions were considered. To assure that the risks involved were minimized, the students were encouraged to do their best when answering math combination questions. However, when they came across a combination that they did not recognize, they were instructed to skip the question and move on to the next one. The utmost ethical standards were maintained to protect the children’s identities as the leading participants in the study.

To ensure that the second category was integrated, a letter giving details about the research and its significance was mailed to the parents of each student involved in the study. Attachments enclosed with the letter were as follows: a parent informed consent form (Appendix B), a guardian/researcher commitment agreement (Appendix C), and a student assent form (Appendix D). The letter carried out two purposes: (a) informed the subject that he/she was chosen to participate in the study and (b) provided a way to explicate the pertinent informed consent required by NCU. Collected consent and assent forms were in safekeeping and put in a locked cabinet separated from other data.

The third category covers the right to privacy. Parents were notified that their child’s identity would be handled with confidentiality. No private or recognizing information was divulged to any individual or entity in any method at any occasion without a written permission from the participant. Participation was the single decision of the participant. Except for grade level, gender, and age, participants were not compelled to furnish any identification, unless he or she chose to provide an e-mail address for the stated request to obtain his or her posttest results.

When a student agreed to participate, he/she was free to terminate participation at any time without any notification given to the researcher, penalties or harmful effects to themselves. However, immediately after data have been recorded and processed, it could not be removed until the conclusion of the study had been finalized unless the participant had provided an identification number to the researcher in the form of an email address during the involvement procedure. The same student identification numbers that were used by the school were utilized in the study to protect students’ identities.

The last category encompasses honesty with professional colleagues. Prior to launching the study, a series of procedures took place. The researcher contacted the principal of the targeted school in person and presented a letter to obtain permission to conduct the investigation within the school campus. The formal letter of approval was submitted to the Northcentral University (NCU) Review Board (IRB), together with an application to carry out the research study. An approval was acquired in terms of maintaining ethical benchmarks throughout the research procedure comprising, but not restricted to, the compilation, assessment, and documentation of data as well as the treatment of participants. The participant recruitment began once approval from the participating educational institution and the NCU IRB was received.

The research data were analyzed in total honesty utilizing SPSS 20. Data underwriting specific conclusions were genuine and not fabricated. All data collected during the experiment such as pretest and posttest scores were secured in a separate locked cabinet. All data were downloaded to a safeguarded file on the personal, private laptop of the researcher. The researcher was the only one who had access to the data. The researcher was the only one who had access to the data. All electronic information related to the study was saved in the investigator’s private laptop computer under a password security. This considerably deterred access to the data by anyone except the researcher.

## Summary

The research design and methodology used in this study were intended to ascertain the effectiveness of the Mad Dog Math program in second and third grade levels at GVCS. The above section encompassed the research method and design. In addition, student demographics and selection, research instrumentation, data collection, processing, and data analysis methods are presented. The quantitative data gathered from the pretest and posttest represented the means through which the topic was investigated and documented.

An operational definition of variables, measurement, limitations, and ethical assurances were also discussed. Using G\*Power 3.1.2 and SPSS 20.0 Windows software for statistical analyses were utilized for the research measurement method. The quantitative data were disaggregated and the two hypotheses in the study were tested utilizing ANCOVA. Data was checked for normality and logarithmic transformation was carried out on any set of data that was skewed so that only conventionally distributed data were analyzed. To date, the current research regarding the use of CAI in mathematics in elementary school indicates that educators who utilize CAI as a supplement to conventional math instruction in their classroom procedures noticed progressive student advancement (Ash, 2005).

# Chapter 4: Findings

The purpose of this quantitative quasi-experimental study was to determine the effectiveness of a specific CAI supplemental math program, Mad Dog Math, on students’ math achievement as compared to students using only conventional teaching methods utilized at a local elementary school located in Southern California. The treatment of Mad Dog Math and gender were considered the independent variables. While the posttest scores served as the dependent variable, the pretest scores served as the covariate. The possible connection between the variables was examined quantitatively through the use of a pretest and posttest.

This chapter provides the outcomes of the study. The participant demographics are described first followed by an indication of the statistical method utilized. The statistical overview is followed by the statistical outcomes categorized into two sections, one for each of the two research questions. The statistical outcomes are followed by an assessment of findings and a chapter summary.

## Results

**Sample descriptive statistics.** Participants were recruited from a K-8 elementary school in Southern California. The January 2012 student enrollment data specified that 300 students were present in the school. The student population was diverse. Second and third grade students totaled 81, or approximately 27% of the student population. At the time of this study, 17 regular classroom educators worked in the school, with teaching responsibilities varying from kindergarten through eighth grade (Gardena Valley Christian School, 2012).

A priori analysis was calculated for the *F* test ANCOVA with fixed effects, main effects, and interaction. The alpha for these tests was set for .05. To attain power of .80 and a large effect size (*f =* .40), for a 2 x 2 ANCOVA, an overall sample size of 52 was needed to identify an effect. However, a sample size of 128 was required when the power analysis was calculated with a medium size effect (*f =*.25). Regrettably, due to the limited enrollment that existed in many private schools, the researcher was not able to obtain 128 students. Consequently, assigning the power analysis for medium effect size, the 81students secured as participants potentially caused the study to be underpowered to identify group differences. Using the sensitivity analysis, the researcher determined the effect size (0.32) was needed to achieve a 0.81 power with the given parameters.

To ensure that no inconsistencies existed in the data, which might affect the

outcomes, data were examined using various testing, such as the descriptive statistics displayed in Table 1. The descriptive statistics in Table 1 indicate 81 participating students with 42 students in the control group without the help of MDM as a supplement and 39 students in the experimental group with the help of MDM as a supplement. All students participated in the CST pretest and posttest assessment. As clearly shown in Table 1, the mean and standard deviation scores are presented and will be discussed later in this chapter in details.

Table 1

Descriptive Statistics of Pretest and Posttest Scores

|  | Mad Dog Math | | Statistic | Std. error |
| --- | --- | --- | --- | --- |
| Pretest Score | Control | Mean | 17.55 | 1.049 |
| 5% Trimmed Mean | 17.49 |  |
| Std. Deviation | 6.801 |  |
| Skewness | .190 | .365 |
| Kurtosis | .067 | .717 |
| Experimental | Mean | 14.21 | 1.119 |
| 5% Trimmed Mean | 13.98 |  |
| Std. Deviation | 6.989 |  |
| Skewness | .493 | .378 |
| Kurtosis | -.326 | .741 |
| Posttest Score | Control | Mean | 23.95 | 1.320 |
| 5% trimmed mean | 23.78 |  |
| Std. deviation | 8.554 |  |
| Skewness | .370 | .365 |
| Kurtosis | -.483 | .717 |
| Experimental | Mean | 29.08 | 1.560 |
| 5% Trimmed Mean | 29.34 |  |
| Std. Deviation | 9.742 |  |
| Skewness | -.181 | .378 |
| Kurtosis | -.878 | .741 |

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Prior to analysis, the data were examined through a variety of tests, such as descriptive statistics for skewness and kurtosis to ensure no discrepancies existed in the data which might influence the results. There were no discrepancies found that would unjustifiably affect the outcomes. Table 2 demonstrates the descriptive statistics for the

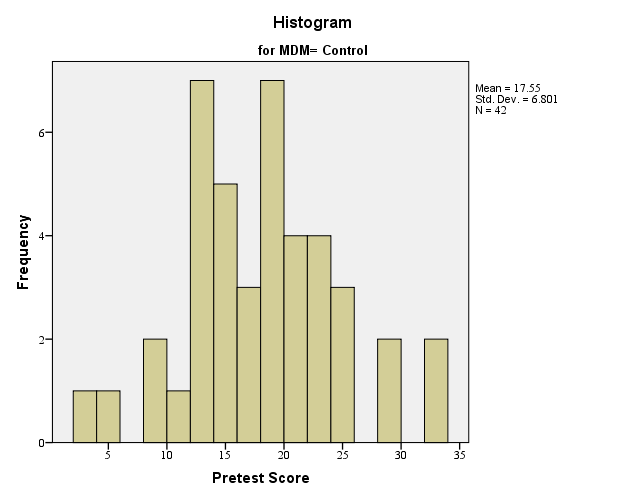
experimental and control groups of both second and third grades. If skewness and kurtosis values range from -1 to +1, the assumption of normal distribution is not violated (George & Mallery, 2009). In Table 2, the skewness and kurtosis values of the dependent variables were .147 and -.869 (within the range from -1 to +1), the normal distribution of the variable was supported.

Table 2

Descriptive Statistics for Experimental and Control Groups

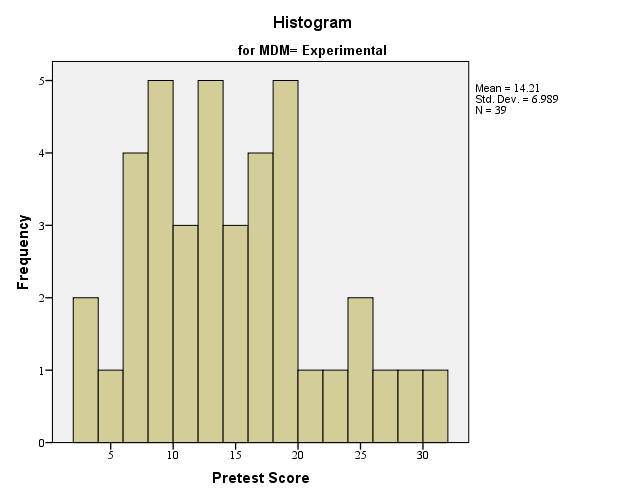
|  | Skewness | | Kurtosis | |
| --- | --- | --- | --- | --- |
| Statistic | Std. error | Statistic | Std. error |
| Posttest Score | .147 | .267 | -.869 | .529 |

Data were examined prior to conducting the main analyses to make certain that the statistical assumptions were sensible. By acquiring histograms, data were screened for the normality assumption. Information from each histogram reports included the mean, standard deviation, skewness, kurtosis, and number. Histograms for the control and experimental groups were acquired for the pretest and posttest scores on the CST aligned assessment. For an average normal distribution, the data distribution should roughly take the shape of a bell curve. Thus, the normality assumption was not violated.



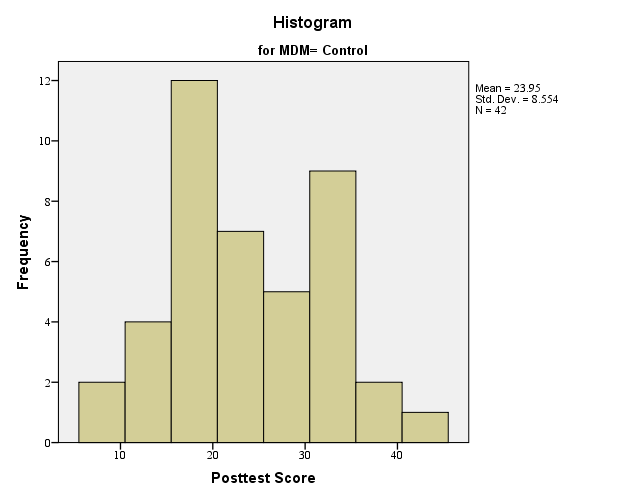
*Figure 1*. Control group mathematics pretest score distribution histogram.

As demonstrated in Figure 1, the distribution of the data displays approximate normality of the pretest score for the control group. The information shown above includes the following: mean = 17.55, standard deviation = 6.801, N = 42. The normality assumption was not violated.



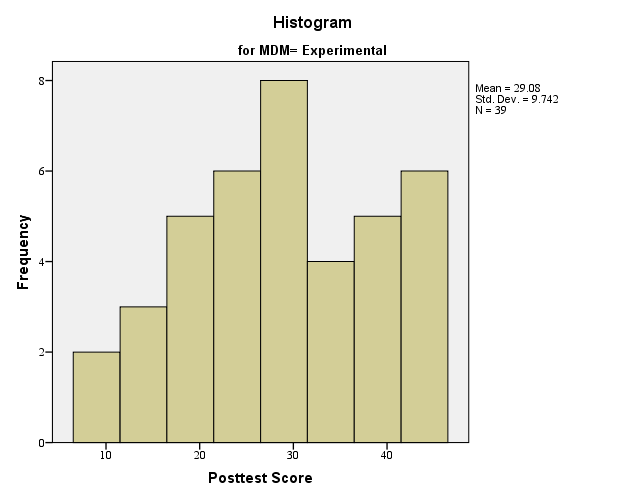
*Figure 2.* Experimental group mathematics pretest score distribution histogram.

As illustrated in Figure 2, the distribution of the data shows approximate normality of the pretest score for the experimental group. The information given above includes the following: mean = 14.21, standard deviation = 6.989, N = 39. The normality assumption was not violated.



*Figure 3*. Control group mathematics posttest score distribution histogram.

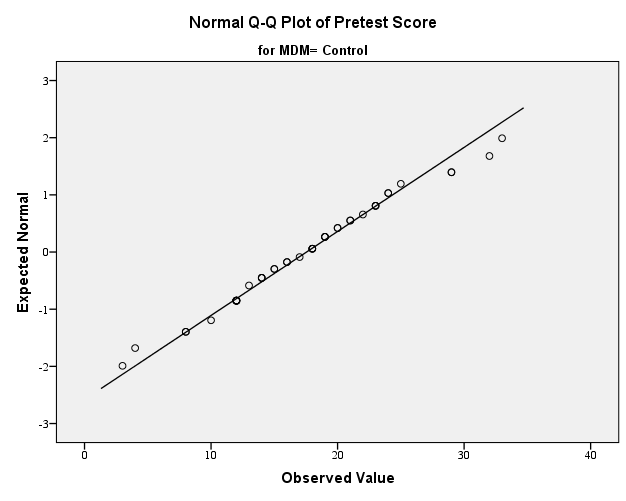
As displayed in Figure 3, the distribution of the data illustrates approximate normality of the posttest score for the control group. The information provided above includes the following: mean = 23.95, standard deviation = 8.554, N = 42. The normality assumption was not violated.



*Figure 4*. Experimental group mathematics posttest score distribution histogram.

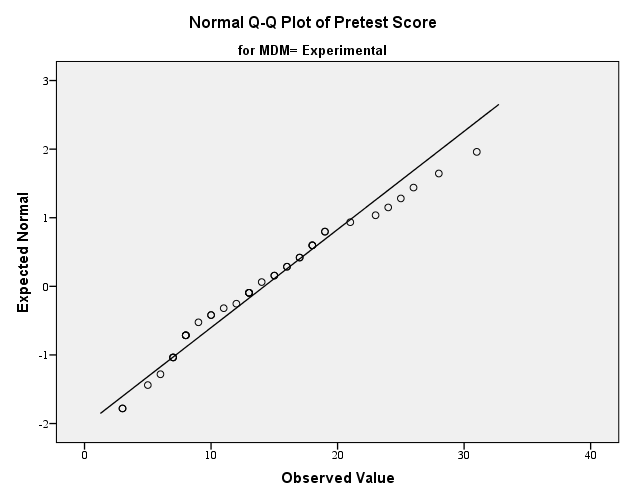
As shown in Figure 4, the distribution of the data reveals approximate normality of the posttest score for the experimental group. The information presented above includes the following: mean = 23.95, standard deviation = 8.554, N = 39. The normality assumption was not violated.

Secondly, the data were examined for data normality by securing the Q-Q plots for the pretest and posttest of both the control and experimental groups as presented in Figures 5-8. The Q-Q Plots are displayed as follows: pretest for control group, pretest for experimental group, posttest for control group, and posttest for experimental group. The dots did not reveal significant deviation from the straight line. Therefore the Q-Q plots corroborate that the scores were normally distributed.



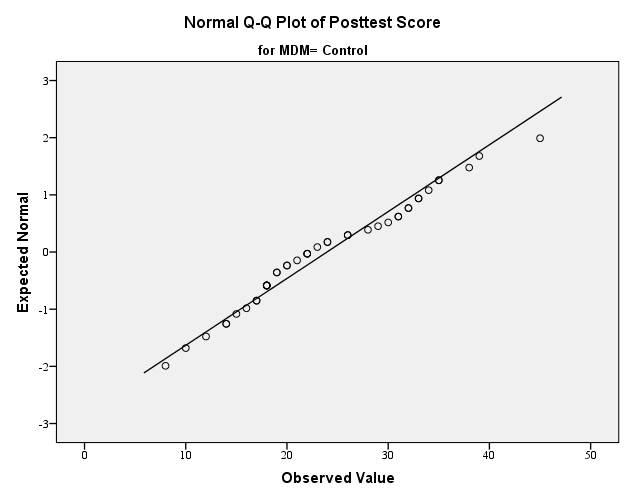
*Figure 5*. Normal Q-Q Plot of control group pretest.

The Q-Q Plot shown above represents the pretest scores for the control group. The dots did not disclose significant deviation from the straight line. Thus, the Q-Q Plot substantiates that the scores were normally distributed.



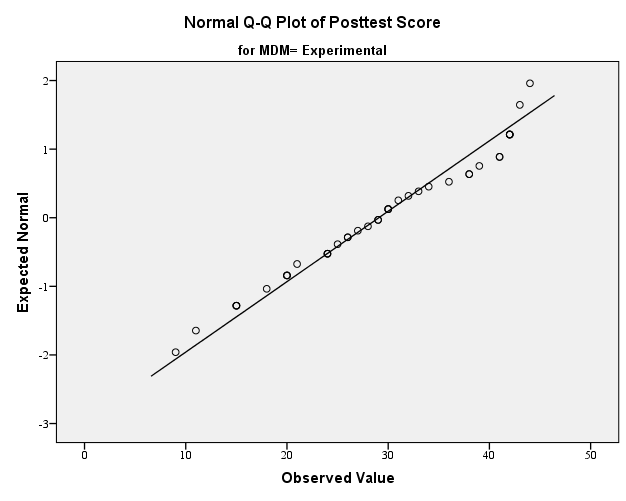
*Figure 6*. Normal Q-Q Plot of experimental group pretest.

The Q-Q Plot illustrated above shows the pretest scores for the experimental group. The dots did not reveal significant deviation from the straight line. Therefore, the Q-Q Plot validates that the scores were normally distributed.



*Figure 7*. Normal Q-Q Plot of control group posttest.

The Q-Q Plot shown above reveals the posttest scores for the control group. The dots did not depict significant deviation from the straight line. Hence, the Q-Q Plot verifies that the scores were normally distributed.



*Figure 8*. Normal Q-Q Plot of experimental group posttest.

The Q-Q Plot illustrated above demonstrates the posttest scores for the experimental group. The dots did not show significant deviation from the straight line. Thus, the Q-Q Plot authenticates that the scores were normally distributed.

Table 3 displays the Kolmogorov-Smirnov and Shapiro-Wilk tests of posttest score variable of the study. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used as the numerical means of assessing normality. The Kolmogorov-Smirnov and Shapiro-Wilk test were used to check the normality of the dependent variable of this study. The results of the tests showed that the observed significance level was greater than .05 *(p>* .05*).* The null hypothesis that the dependent variable was normally distributed could not be rejected. The statistical tests showed that the assumption of normal distribution of posttest score (dependent) variable of this study was not violated.

Table 3

Kolmogorov-Smirnov and Shapiro-Wilk Normality Tests of Posttest Score

| Variable | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
| --- | --- | --- | --- | --- | --- | --- |
| Statistic | Df | Sig. | Statistic | df | Sig. |
| Posttest score | .085 | 81 | .200 | .973 | 81 | .089 |

**Q1**. After accounting for the pretest score, is there a significant difference on the mean posttest score between students who were offered the MDM software supplement program and those who were not?

The hypotheses for this question were:

**H10.** There is no significant difference on the posttest scores between the students who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H1a**. There is a significant difference on the posttest scores between the students who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

Table 4 displays the results of the Levene’s test of equality of error variances. The Levene’s equality test was used to check the assumption of equality of variance. Since the significance value (.20) was greater than .05, the variances were not equal and the assumption of equality of variance was not violated.

Table 4

The Levene’s Test of Equality of Error Variances

| *F* | df1 | df2 | Sig. |
| --- | --- | --- | --- |
| 1.598 | 3 | 77 | .197 |

The results of the ANCOVA are given in Table 5. The covariate (pretest score) was measured before the experiment began, so the treatment did not affect the covariate. After accounting for pretest scores, there was a significant difference between the control and experimental groups on posttest scores, *F*(1, 27) = 14.17, *p* < .0005 with a low effect size, partial eta squared = .15. The null hypothesis that there is no significant difference in the posttest scores between the students who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate was rejected. After accounting for the pretest score, there is a significant difference in the mean posttest score between students who were offered the MDM software supplement program and those who were not.

Table 5

Test of Between Subjects

| Source | Type III sum of squares | Df | Mean square | *F* | Sig. | Partial eta squared |
| --- | --- | --- | --- | --- | --- | --- |
| Corrected model | 1842.53a | 2 | 921.26 | 13.57 | .000 | .26 |
| Intercept | 3689.39 | 1 | 3689.33 | 54.35 | .000 | .41 |
| Pretest score | 1311.47 | 1 | 1311.47 | 19.32 | .000 | .20 |
| MDM | 961.65 | 1 | 961.65 | 14.17 | .000 | .15 |
| Error | 5295.20 | 78 | 67.89 |  |  |  |
| Total | 63676.00 | 81 |  |  |  |  |
| Corrected total | 7137.73 | 80 |  |  |  |  |
|  | | | | | | |

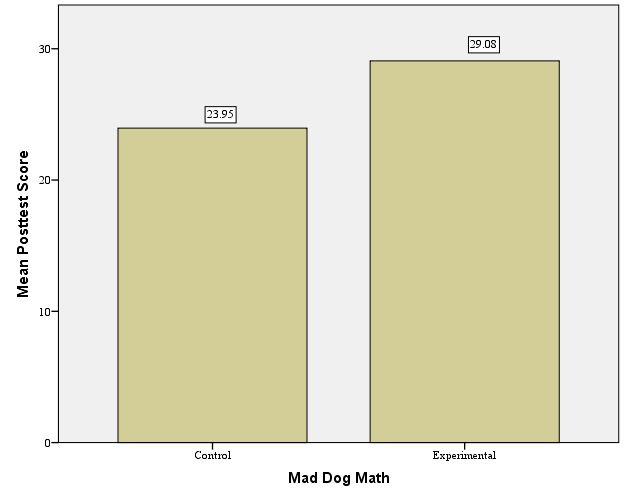
*Note: a. R Squared = .258 (Adjusted R Squared = .239)*

The pretest and posttest results of the control group and experimental groups are presented in Figures 9 and 10.



*Figure 9*. G Graph Mean pretest scores of control and experimental groups.

The bar graphs represented by Figure 9 displays the mean pretest scores of the control and experimental groups. The mean pretest score of the control group =17.55. The mean pretest score of the experimental group = 14.21.



*Figure 10*. G Graph Mean posttest scores of control and experimental groups.

The bar graphs represented by Figure 10 displays the mean posttest scores of the control and experimental groups. The mean posttest score of the control group = 23.95. The mean posttest score of the experimental group = 29.08.

The students from the control group completed the pretest with a mean pretest score of 17.55 or 35.10 %. After 10 weeks of curriculum based, regular mathematics instruction, the control group had a mean posttest score of 23.95 or 47.90%. This is a positive difference of 6.4 or 12.80%. The outcomes indicate a significant change over time after 10 weeks of curriculum based, regular mathematics instruction. The students from the experimental group completed the pretest with the mean pretest score of 14.21 or 28.42% and a mean posttest score of 29.08 or 58.16%. This is a positive difference of 14.87 or 29.74%. Based on the results displayed on Table 5 and Figures 9 and 10, enough evidence existed to reject the null hypothesis in which it was assumed that difference in mathematics achievement existed between the experimental and control groups as measured by the CST aligned assessment.

**Q2.**Is there an interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate?

The above question addressed whether the instruction influenced males and females differently as specified in the hypotheses reiterated below. To test the statistical hypothesis (H0), a 2 X 2 ANCOVA was utilized. With regards to H1, added to the ANCOVA model were two levels of instruction (Experimental and Control) with two levels of gender (Males and Females).

**H20**. There is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

**H2a.** There is a significant interaction between gender (male versus female) and treatment(MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate?

Table 6 demonstrates the posttest means for the control and experimental groups. The gender variable provided an additional source of variation to the model. The central emphasis of H2 was the possible group by the gender interaction.

Table 6

Descriptive Statistics: MDM Gender - Dependent Variable: Posttest Score

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MDM Gender | Mean | Std. error | 95% Confidence Interval | |
| Lower bound | Upper bound |
| Control Female  Male | 20.811a  24.939a | 1.851  1.735 | 17.126  21.483 | 24.497  28.395 |

*Note: a covariates appearing in the model were evaluated at the following values Pretest Scores = 15.94.*

After accounting for pretest scores, there was no significant interaction effect of MDM and gender, *F*(1,76) = 4.14, *p* = .06, with a low effect size (partial eta squared = .001). The main effect of MDM and posttest score was significant, *F*(1,76) = 16.15, *p* = .0005, with an effect size of .17. The effect of gender and posttest score was also significant, *F*(1,76) = 4.04, *p* = .27 with a low effect size (partial eta squared = .05). These results suggest that male and female did not respond differently to the treatment. The null hypothesis that there is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores and when pretest scores are used as a covariate was not rejected. There was no interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

## Evaluation of Findings

The theory of mastery learning posits that mastery is attainable for pragmatically every learner, on the stipulation that a suitable learning atmosphere in the apportioned time was arranged and that the superiority of instruction was maintained at an outstanding level (Cooperman, 2011; Furner & Gonzalez-DeHass, 2011; Lau & Nie, 2008; Linnenbrink, 2005; Suppes and Zanotti, 1996). Specification for improvement, developmental evaluation, and constructive feedback should have been assimilated in this quality instruction (Bloom, 1981). Active learning theory was another philosophy that this research has adopted. Active learning was to improve student learning and accomplishment (Cooperstein & Kocevar-Weidinger, 2004; Maher & Tienken, 2008). Therefore, based upon other studies and recommendations of other researchers (Berger, Mary, Shaw, & Sosa, 2011; Bottge, Grant, Rueda, & Stephens, 2010; Du Paul & Weyandt, 2006; Schoppek & Tullis, 2010; Strange, 2007), it was reasoned that there may be a relationship between mastery learning, active learning, and improving mathematical achievement.

Based on the reported statistical data, students receiving conventional mathematical instruction supplemented with Mad Dog Math, a CAI software program, exhibited significant gains compared to the control group. This outcome revealed that conventional mathematical instruction accompanied with a CAI was a successful and proficient approach of intervention for second and third grade mathematics learners. It would be projected, based on Suppes and Zanotti’s theory of mastery learning for mathematics (as cited in Pearson Digital Learning, 2005), that conventional instruction in mathematics complemented with CAI would steer learners to advanced levels of mathematics achievement. The results corroborated prior research works that ascertained CAI had a constructive influence on student achievement in mathematics (Bekir Celen, 2009; Birch & Sankey, 2008; Hung-Pin Shih, 2008; Neil & Matthews, 2009; Smith, 2009).

To examine hypothesis 2, as to determine whether males and females responded differently to math instruction when taught using conventional instruction with or without the supplement of a CAI program was investigated. The outcome of the ANCOVA revealed no significant gender difference in the influence of CAI on mathematical achievement for students. This result on the study of gender difference corresponds with the outcomes of Lewis (2010) and Spence (2007), based on their evaluation of studies on gender and CAI. However, a research performed by Spradlin and Ackerman (2009), discovered that males were surpassed by females in both conventional instruction and conventional instruction accompanied with CAI. Therefore, it may be ascertained that the employment of CAI improved the performance of both male and female learners. There is a probability that the low achieved power of .80 provided by the medium effect size of the 81participants represented the research underpowered to expose the gender effect.

Comparable to Neil and Matthews (2009) and Smith (2009), as well as the theories of mastery and active learning (Cooperman, 2011; Furner & Gonzalez-DeHass, 2011), the result of this research denotes the concept that there is a relationship between the use of conventional math instruction supplemented with the CAI and improved mathematical achievement for students. This study offers additional support to the recommendation of Fuchs, et al (2006) that the instructors oversee students so that appropriate practice and treatment of the software is ensured. The outcome also reinforces the postulation that computer interactive learning provides an exceptional strategy of communicating instructions that can be customized to support diverse learning techniques (Mitchell, Chen, & Macredie 2005). This information could possibly influence increased technology integration in the classroom to enhance mathematical achievement for learners. Hence, the suggestion that employing a CAI program as a supplement to conventional mathematical instruction allows learners to answer mathematical problems through trial-and-error instead of utilizing only distinctive and defined methods is appropriate. This approach may stimulate learners to modify their mathematical skills to tangible functions.

## Summary

The outcomes of this study rejected the null hypothesis stating that there is no significant difference in the posttest scores between the students who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate. In addition, after accounting for the pretest score, the results indicated that there is a significant difference in the mean posttest score between students who were offered the MDM software supplement program and those who were not. The results of this research are consistent with mastery and active learning theories. The Mad Dog Math CAI program resulted in higher posttest scores following a 10-week period working only 10 minutes daily. In formulating decisions on how to successfully assist learners who struggle in mathematics, it is imperative for educators, school administrators, and school districts to have information regarding effective interventions.

# Chapter 5: Implications, Recommendations, and Conclusions

The fact that American learners constantly and steadily score poorly in mathematics during global-wide assessment prompts intense alarm (President’s Council of Advisor on Science & Technology, 2010; National Center for Education Statistics, 2007). The problem this study endeavored to address originated from the national yearning to increase scholastic achievement (Algozzine, Chuang, & Violette, 2010; Ehrich, Kimber, Milwater, & Cranston, 2011; Lee, 2010; Schussler, Stooksberry, & Bercaw, 2010). A continuous attempt has been in place to improve scholastic achievement in mathematics in a local elementary school located in Southern California. Therefore, the purpose of this quantitative, quasi-experimental study was to determine the effectiveness of a specific CAI supplemental math program, Mad Dog Math, on students’ math achievement as compared to students using only conventional teaching methods. Additionally, this study investigated the differences in scholastic achievement of students in mathematics utilizing a CAI program with male and female gender.

To provide an impartial assessment of the control and experimental groups, self-contained classrooms were selected. The advancement of the two groups was evaluated after 10 weeks. The progress of the two groups was compared to ascertain whether a significant difference in mathematics achievement ensued. The limitations of this investigation have been submitted as to the manifestation of other components, both internal and external, that would likely influence the effectiveness of MDM on scholastic math achievement of learners. The ultimate drawback of this study comprised a sample size that was acceptable for identifying larger medium effects only. However, the research was not considerable in disclosing medium size effects due to the restricted number of participants. More notable and explicit outcomes, such as relationships between groups and ethnicity, can be ascertained if the population size is greater thus causing a higher power.

The utilization of a convenience population sample constraints the generalizability of the results of the research. The participation of learners from a single private school would not be representative of the sizeable population of students in the public school or in the district or the state. Unbeknownst to the researcher, both groups perhaps were diverged in features therefore influencing the results because the participants were not arbitrarily dispersed to condition. There was a possibility that detected differences in the posttest scores were due to the prior differences that existed in the group. Furthermore, the acquired outcomes may manifest distinctive traits from the participants that may not be embraced by students from other schools.

The quasi-experimental disposition of the study did not permit the researcher to ascertain cause and effect relationships which is another limitation of this research. Since the participants in the control condition were conscious that they were not getting special consideration, it may have diminished their enthusiasm to achieve. This could inflate the posttest score difference between the two groups. Moreover, participants in the experimental group may have sensed that they were receiving exclusive attention and expected to score higher than those in the control group. With this mentality, learners in the experimental group perhaps performed better, thus scored higher during the posttest evaluation. The absence of diverse demographics in the selected school eliminated the opportunity for the researcher to evaluate other important variables such as race, attention span, behavioral difficulties, and socio-economic status of the participants. There was a possibility that the research was declared underpowered to reveal effects of gender due to the limited sample size of 81 student participants.

Throughout the entire research, ethics were asserted particularly in terms of issues for confidentiality and privacy. To guarantee that the rights of all the participants were secured, a formal request to perform the investigation and an approval from the NCU IRB were obtained. Informed consent and assent were acquired from every participant and their parents or guardians. A cover letter with a complete account of the researcher’s identity, a detailed description of the study, the values and gains to the education system, and how to receive the outcomes of the research was provided. Information regarding the participant’s name, age, and grade level were the only personal information requested from the learners. Consequently, participants who were willing to receive their pretest and posttest scores were asked to provide their email address as well.

The quantitative research questions and corresponding hypotheses will be reviewed and discussed within the implication section. Additionally, the inclusion of limitations that became obvious during the research process, specifically in the view of how they possibly influenced the explanation of the outcomes, will also be delineated. Recommendations concerning utilization of the information, facts, and awareness gained as well as suggestions involving future studies will be defined.

## Implications

The following were the research questions examined in the study:

**Q1**. After accounting for the pretest score, is there a significant difference in the mean posttest score between students who were offered the MDM software supplement program and those who were not?

**H10.** There is no significant difference in the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

**H1a.**  There is a significant difference in the posttest scores between the students

who receive mathematics instruction using conventional math and MDM as a supplement and students who receive conventional math instruction without the MDM supplement when using pretest scores as a covariate.

This specific question was addressed through the data collected from the pretest and posttest. Based upon the ANCOVA between group analysis of *F*(1, 27) =14.15, *p <* .0005 with a low effect size, partial eta squared = .15, the null hypothesis was rejected. However, the main effect of MDM and posttest score was significant, *F*(1, 76) = 16.15, *p* = .0005, with an effect size of .17. The covariate (pretest score) was measured before the experiment began, so the treatment did not affect the covariate. Therefore, after accounting for the pretest score, there was a significant difference in the mean posttest score between students who were offered the MDM software supplement program and those who were not.

**Q2.** Is there an interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate?

**H20.** There is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

**H2a**. There is a significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate.

The second question was also addressed through the data gathered from the pretest and posttest. Based upon a 2 X 2 ANCOVA between group analysis of *F*(1,76) = 4.14, *p* = .06, with a low effect size (partial eta squared = .001), there was no significant interaction effect of MDM and gender after accounting for pretest scores. These results suggested that male and female did not respond differently to the treatment. The null hypothesis that there is no significant interaction between gender (male versus female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores are used as a covariate was not rejected. There was no interaction between gender (male or female) and treatment (MDM supplement versus no MDM supplement) when evaluating posttest scores when pretest scores were used as a covariate.

The primary reason for using ANCOVA is to lessen the error variance in random allocation of subjects. However, since this study used nonrandomized design, the principal purpose of ANCOVA was to adjust the posttest means for differences among the control and experimental groups on the pretest (Dimitrov & Rumrill, 2003). It is imperative to assert that the intervention can be critically influenced with intact groups when pretest is not reliable. Another possible setback with ANCOVA includes the differential growth of the nonrandomized subjects on the dependent variable. Systematic bias such as pretest differences between the control and experimental groups can alter the analyses of posttest differences.

Overall, the outcomes fit the purpose of the study and yielded some information to attend to the identified problem of the learners’ deficient mathematical skills. Numerous studies have been previously reported that significant improvement in math skills were associated with the use of CAI and other computer-based intervention as a supplement to conventional math instruction (Burns, Kanive, & DeGrande, 2012; Springer, Pugalee, & Algozzine, 2007; Ysseldyke & McLeod, 2007). Others considered the implications that confirm the use of new technologies as an assistive technological tool that can be employed successfully to enhance learning (Nordess & Haverkost, 2011; Fuchs, et al., 2006).

The significance of this specific research resulted in enlightenment and awareness that while reports revealed the shortcomings of mathematics in the United States when measured against other developed countries (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2007; National Mathematics Advisory Panel, 2008), there are studies that have proven to be efficient and effective in improving students’ math achievement skills. In a research done by Huang, Liu, and Chang (2012), the findings revealed that CAI functioned as an enhancement tool that assisted educators in improving the problem-solving skills of struggling students as well as used for remedial instruction. This study complemented their findings by indicating that the use of computer-assisted instruction can aid proficiently and successfully as a device for teachers engaged in improving learners’ skills in mathematics achievement.

Furthermore, most recent studies such as those conducted by Lewis (2010) and Hyde, et al. (2008) indicated that the use of CAI employment had an equal influence on both genders. Their findings disclosed that gender gap in mathematics were not significant provoking queries concerning whether gender gap in mathematics achievement still exist today. This research supported their findings when the outcomes for the CAI intervention group revealed comparable posttest scores for both genders.

This research may have implications at a district level. When offering teacher in-services and guidance to parents, computer-assisted instruction can be incorporated as a supplement to the curriculum based on outcomes. Additionally, findings can be utilized by the policymakers and school officials as a catalyst for the continuing interchange of information to increase statewide math program and provide resources for the use of CAI. By increasing the awareness and providing knowledge to fill the void that may help enhance teaching and learning mathematics, the outcomes of this study may contribute to the body of literature involving this topic.

## Recommendations

The data provided by the assessment points to a number of realistic and functional recommendations to assist learners, educators, stakeholders, and parents. Instructors are endorsed to utilize an assortment of instructional approaches with students (Joyce, Weil, & Calhoun, 2009). The section contains the recommendations for the practical presentation of findings to the educational system as well as suggestion for future studies. The conducted literature review for this research specified that computer assisted instruction was often examined for its efficacy in assisting students in improving math skills. The findings of previous studies including this dissertation indicated that the integration of CAI in the classroom is effective in enhancing students’ mathematical achievements. This is possibly due to the numerous practice opportunities offered by the technology program. Additionally, as reinforced through the findings of this dissertation, the utilization of CAI is appropriate to math instruction perhaps due to some of its positive features such as timely feedback, self–pace effort, and availability. Due to its findings, CAI may be a candidate for consideration to be integrated in a variety of content areas.

The following recommendations with some modifications and additions are suggested for future studies on computer-assisted instruction intervention. The first recommendation is to increase the sample population and stratification of grade levels. Enlarging the sample size by including other elementary grade levels may adjust the generalizability of the outcomes. As numerous school district representatives are exploring methods to improve scholastic achievement on standardized tests, a research into NCLB subgroups may also reveal significant information.

The second recommendation is to assess the effects of CAI with students with learning disabilities. By the time learners completed their high school education, between 5 - 10% of students will be identified with some type of learning disability (Bailey, Geary, & Hoard, 2009). Basic elementary mathematical skills is one of the most compelling predictors of future academic success in general (Claessens, Dowsett, Duncan, Klebanov & Magnuson, 2007).

The third recommendation is to incorporate the use of qualitative data collection with quantitative method. Data gathered from a mixed method study works to remove bias and misrepresentation by strict adherence to solitary conventional concept (Pinto, 2010). Utilizing interviews from individual learners and instructors concerning technology integration in improving mathematics achievement scores can be used as a support mechanism for the quantitative data.

Lastly, the fourth recommendation is to increase the duration of the intervention. Based on literature reviewed, about 50% of the experiments transpired with the duration longer than two academic quarters or one semester. The length of time for the treatment involved in a study could influence the findings, even though in research, no absolute appropriate study duration exists. The duration of a study should be designated based upon multiple considerations such as population, treatment, variables, and methods (Meline, 2006).

## Conclusions

The focus, purpose, and goal of the research was to determine the effectiveness of a specific CAI supplemental math program, Mad Dog Math (MDM), on students’ math achievement as compared to students using only conventional teaching methods utilized at a local elementary school located in Southern California. Additionally, this study examined for disparities in mathematical achievement utilizing CAI with gender. This final section includes the following: (a) implications, (b) recommendations, and (c) conclusions.

The outcome of the qualitative research showed evidence that the Mad Dog Math treatment revealed significant difference in mathematical achievement on the CST aligned assessment. Inclusively, the findings matched the objective of the research and generated some information to focus on the pinpointed struggle of the students’ unsatisfactory mathematical skills. The outcome of the ANCOVA revealed no significant gender difference in the influence of CAI on mathematical achievement for students. The result of this research corresponded with the study outcomes of Lewis (2010) and Spence (2007) demonstrating that the use of CAI as a supplement to conventional classroom instruction has an equivalent influence on both genders.

In the current study, the findings indicated that the use of computer-assisted instruction such as MDM has a significant effect on second and third grade students’ mathematics achievement. By and large, the findings matched the objective of the research and generated some evidence to focus on the characterized dilemma of the students’ inadequate mathematical skills. Additionally, based on the literature reviewed and the result of the present study, the integration of technology in instructing mathematics using the conventional classroom instruction was beneficial in increasing scholastic achievement in mathematics.

Technology integration in classroom curriculum continues to be one of the objectives in many school districts despite the current decline of the economy. For future studies, several areas may be taken into consideration based on the outcome of the present quantitative quasi-experimental research. Several practical and reasonable suggestions to support learners, educators, administrators, and parents are derived from the sufficient data supplied by the evaluation.

The following were the recommendations for future study of CAI: (a) to increase generalizability of the outcomes, future studies can include increasing the number of population and inviting other grade levels to participate, (b) to examine the effects of CAI with students with learning disabilities, (c) to offer progressive implementation, future studies such as teacher-student perceptions and effectiveness can include qualitative elements to their research, and (d) increase the duration of the treatment.

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# Appendices

## Appendix A:

Math Pretest/Posttest

Released Test Questions Math Grade 2

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. A NUMBER HAS NINE ONES, SIX TENS, AND EIGHT HUNDREDS. WHAT IS THE NUMBER?
2. 869
3. 896
4. 968
5. 986

1. WHAT IS THE VALUE OF THE FIVE IN FIVE HUNDRED TWENTY-SIX

(526)?

1. 5
2. 50
3. 500
4. 5000

1. LOOK AT THE NUMBER 926. WHICH DIGIT IS IN THE TENS PLACE?
2. 2
3. 6
4. 9
5. 10
6. WHICH DIGIT IS IN THE ONES PLACE IN THE NUMBER TWO

HUNDRED THIRTY-FOUR (234)?

1. 1
2. 2
3. 3
4. 4
5. WHICH NUMBER HAS A SEVEN IN THE HUNDREDS PLACE AND A

THREE IN THE ONES PLACE?

1. 37
2. 73
3. 347
4. 743
5. WHAT IS ANOTHER NAME FOR 400 PLUS 48?
6. 4408
7. 448
8. 400408
9. 4048
10. WHAT IS ANOTHER WAY TO WRITE 987?
11. 900 + 87 + 7
12. 980 + 70 + 0
13. 700 + 80 + 9
14. 900 + 80 + 7
15. WHAT IS ANOTHER WAY TO WRITE 370?
16. 3 + 70
17. 30 + 70
18. 300 + 7
19. 300 + 70

1. WHICH NUMBER SENTENCE IS TRUE?
2. 359 < 375
3. 359 > 375
4. 359 < 359
5. 359 > 359
6. WHICH NUMBER GOES IN THE BOX?

386 < 🞎< 521

1. 297
2. 334
3. 410
4. 528
5. WHICH SIGN MAKES THE NUMBER SENTENCE TRUE?

22 + 10 🞏 32

1. =
2. +
3. >
4. <
5. WHICH NUMBER GOES IN THE BOX?

91>🞏

1. 90
2. 92
3. 93
4. 94
5. WHICH SIGN MAKES A TRUE NUMBER SENTENCE?

6-2🞏

1. >
2. =
3. <
4. –
5. WHICH NUMBER SENTENCE IS TRUE?
6. 307 = 370
7. 307 > 307
8. 370 < 370
9. 307 < 370
10. SOPHIE DID THIS SUBTRACTION PROBLEM. WHICH ADDITION

PROBLEM SHOWS THAT SHE GOT THE RIGHT ANSWER?

85 – 44 = 41

1. 41+ 85
2. 44 + 85
3. 41+ 44
4. 44 + 44
5. WHICH OF THESE CAN BE USED TO CHECK THE ANSWER TO THE

PROBLEM?

4 +=3 7

1. 7 + 3 = 10
2. 2 + 5 = 7
3. 7 – 4 = 3
4. 10 – 3 = 7

1. WHICH NUMBER SENTENCE IS AN OPPOSITE NUMBER SENTENCE

FOR EIGHT PLUS SIX EQUALS FOURTEEN?

86 +=14

1. 21+ 2 = 14
2. 7 + 7 = 14
3. 8 – 2 = 6
4. 14 − 8 = 6

1. LOOK AT THE TWO PROBLEMS IN THE BOX. THE SAME NUMBER IS

MISSING IN BOTH OF THEM. WHAT IS THE MISSING NUMBER?

65 – 🞏 = 60 60 + 🞏 = 65

1. 125
2. 15
3. 5
4. 0
5. WHAT IS THE SOLUTION TO THIS PROBLEM?

419 – 12 =

1. 431
2. 421
3. 417
4. 407
5. 123 + 7 =
6. 50
7. 140
8. 144
9. 150
10. TONI HAD SEVEN HUNDRED FIFTY-NINE (759) CUCUMBERS. SHE

SOLD FIVE HUNDRED SIXTY- THREE (563) OF THEM. HOW MANY CUCUMBERS DOES TONI HAVE LEFT?

1. 116
2. 196
3. 216
4. 296
5. WHAT IS TWO HUNDRED FIFTEEN PLUS FIFTY-SEVEN?

215 + 57

1. 158
2. 262
3. 271
4. 272
5. WHAT IS THE SOLUTION TO THIS PROBLEM?

410 + 94

1. 514
2. 504
3. 494
4. 404
5. WHICH DRAWING SHOWS THREE TIMES FIVE?

3 X 5

🞏🞏🞏 🞏🞏🞏🞏 🞏🞏🞏🞏🞏 🞏🞏🞏

* 🞏🞏🞏🞏 🞏🞏🞏🞏🞏 🞏🞏🞏🞏🞏
* 🞏🞏🞏🞏 🞏🞏🞏🞏🞏

🞏

🞏

A B C D

1. DAVID READS TWO PAGES EVERY

FIVE MINUTES. HOW MANY PAGES

WILL DAVID HAVE READ AFTER

TWENTY-FIVE MINUTES?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | |
| Minutes | | 5 | 10 | 15 | 20 | 25 |
| Pages | | 2 | 4 | 6 | 8 |  |

1. 9 PAGES
2. 10 PAGES
3. 11 PAGES
4. 12 PAGES

1. WHICH CHOICE IS THE SAME AS THE NUMBER SENTENCE

SHOWN?

5 + 5 + 5 + 5 + 5 + 5 + 5 + 5 = 🞏

1. 6 x 5
2. 7 x 5
3. 8 x 5
4. 9 x 5
5. KAYLA HAS FIFTEEN STRAWBERRIES. SHE WILL GIVE FOUR

STRAWBERRIES TO EACH OF HER THREE FRIENDS. HOW MANY STRAWBERRIES WILL BE LEFT FOR KAYLA?

1. 1
2. 2
3. 3
4. 4
5. IF THERE ARE TWELVE COOKIES, HOW MANY CAN THREE CHILDREN

SHARE EQUALLY?

1. 4
2. 3
3. 5
4. 6

29. THERE ARE TWENTY- ONE SHELLS. THE SHELLS ARE EQUALLY DIVIDED AMONG THREE STUDENTS. HOW MANY SHELLS WILL EACH STUDENT GET?

1. 6
2. 7
3. 8
4. 9
5. THREE FRIENDS HAVE EIGHTEEN JELLY BEANS ALL TOGETHER.

THEY WANT TO SHARE THE JELLY BEANS EQUALLY. HOW MANY JELLY BEANS SHOULD EACH FRIEND GET?

A. 3

B. 4

C. 5

D. 6

1. THERE ARE NINE BENCHES IN A PARK. THERE ARE TWO PEOPLE

SITTING ON EACH BENCH. HOW MANY PEOPLE ARE SITTING ON THE NINE BENCHES ALL TOGETHER?

A. 11

B. 14

C. 16

D. 18

32. THERE WERE TEN FROGS IN A POND. EACH FROG HAD FOUR

LEGS. HOW MANY FROG LEGS WERE THERE ALL TOGETHER?

A. 14

B. 40

C. 50

D. 104

1. WHICH NUMBER SHOWS THE ANSWER TO FIVE TIMES SIX?

A. 11

B. 25

C. 30

D. 35

1. ONE BEACH BALL COSTS TWO DOLLARS. HOW MUCH WILL FIVE

BEACH BALLS COST?

1. $10
2. $12
3. $14
4. $16
5. WHAT FRACTIONAL PART OF THIS FIGURE IS SHADED? ▼▽▽▽▽▽▽▽

A. 1

8

B. 1

7

C. 1

4

D. 1

2

1. WHICH OF THE FOLLOWING FRACTIONS IS THE GREATEST?

A. 1

9

B. 1

2

C. 1

5

D. 1

10

1. LOOK AT THE FRACTION BARS. WHICH FRACTION BAR SHOWS ONE-

SIXTH SHADED?

1. ▼▽▽▽▽▽
2. ▼▼▽▽▽▽
3. ▼▼▼▽▽▽
4. ▼▼▼▼▼▽
5. CHOOSE THE LETTER IN WHICH ONE-FIFTH OF THE TRIANGLE IS

DARKENED?

1. ▼▼▼▼▼▼▽
2. ▼▼▼▼▽
3. ▼▽▽▽▽
4. ▼▽▽▽▽▽

1. WHAT FRACTION OF THIS SHAPE IS SHADED?

●●○

1. 1

2

B. 2

3

C. 3

2

D. 3

1

1. WHAT FRACTION OF THE STICKERS ARE HAPPY FACE STICKERS?

☺ ☺ ☺ ☹ ☹ ☹ ☹

A. 3

5

B. 5

3

C. 3

8

D. 8

3

1. WHAT FRACTION OF THE CIRCLE IS SHADED?

●●●○

1. 1

4

B. 1

3

C. 3

4

D. 4

3

1. WHICH FRACTION IS EQUAL TO ONE WHOLE?

A. 1

3

1. 1

8

1. 2

3

D. 8

8

1. A TEACHER DIVIDES A WHOLE CLASS INTO GROUPS TO WORK ON A

CLASS PROJECT. EACH GROUP HAS ONE-SIXTH OF ALL THE CHILDREN IN THE CLASS. HOW MANY GROUPS ARE THERE?

A. 2

B. 6

C. 7

D. 12

1. LOOK AT THE TRIANGLES. WHICH GROUP OF TRIANGLES IS SHADED TO SHOW ONE WHOLE?
2. ▼▽▽▽
3. ▽▼▽▼

C. ▼▼▼▽

D. ▼▼▼▼

1. WHICH FRACTION IS EQUAL TO ONE?

A. 1

12

B. 6

12

1. 12

12

1. 100

12

1. MONIQUE HAS FOUR QUARTERS, TWO DIMES, AND ONE NICKEL.

HOW MUCH MONEY DOES SHE HAVE?

1. $1.25
2. $1.05
3. $0.75
4. $1.45
5. JENA HAS ONE DOLLAR AND FORTY CENTS. WHICH AMOUNT OF

MONEY IS GREATER THAN WHAT JENA HAS?

1. $1.30
2. $1.50
3. $1.25
4. $1.05
5. SHAMIKA IS SAVING MONEY TO BUY A BOOK. SHE HAS SAVED ONE

FIVE-DOLLAR BILL, THREE ONE-DOLLAR BILLS, ONE QUARTER, THREE DIMES, AND FOUR NICKELS. HOW MUCH MONEY DOES SHE HAVE SO FAR?

1. $7.95
2. $8.75
3. $8.55
4. $7.75
5. A PAD OF PAPER COSTS TWENTY-FIVE CENTS. TAMI GAVE THE

CLERK THREE DIMES TO BUY A PAD OF PAPER. HOW MUCH CHANGE TAMI SHOULD GET BACK?

1. $.01
2. $0.25
3. $.05
4. $1.00
5. COURTNEY HAS ONE DOLLAR AND TEN CENTS. IF SHE GIVES THE

CLERK FIFTY CENTS, HOW MUCH MONEY WILL SHE HAVE LEFT?

1. $0.60
2. $0.80
3. $0.90
4. $1.10

## Appendix B:

Math Pretest/Posttest

Released Test Questions Math Grade 3

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. How is eight thousand, seventy-six written in standard form?
2. 8067
3. 8076
4. 8706
5. 8760
6. Which of the following is the same as 8024?
7. eight hundred twenty-four
8. eight thousand twenty-four
9. eight thousand two hundred four
10. eighty thousand two hundred four
11. Which set of numbers is in order from greatest to least?
12. 147, 163, 234, 275
13. 275, 234, 163, 147
14. 275, 163, 234, 147
15. 163, 275, 234, 147
16. Which number has a 4 in the tens place and a 4 in the hundreds place?
17. 6424
18. 6244
19. 4462
20. 6442
21. Which digit is in the hundreds place in the number 3174?
22. 1
23. 3
24. 4
25. 7
26. What does the 3 represent in the number 3051?
27. 3
28. 30
29. 300
30. 3000
31. Which of these is eight hundred seven?
32. 8007
33. 870
34. 807
35. 8070
36. Which number has the same digit in both the ones place and the hundreds place?
37. 3308
38. 4118
39. 5977
40. 6242
41. What is 1413 rounded to the nearest hundred?
42. 1000
43. 1400
44. 1410
45. 1500
46. Sophie has 527 seashells in her collection. Which of these equals 527?
47. 5 + 2 + 7
48. 5 + 20 + 700
49. 500 + 20 + 7
50. 500 + 200 + 70
51. Which number is 4000 + 80+5?

1. 458
2. 485
3. 4085
4. 4805
5. Which number means 1000 + 600 + 8?
6. 168
7. 1068
8. 1608
9. 1680
10. Which fraction below is equal to 1?

4

1. ▼▼▼▽▽▽▽▽ = 3

8

1. ▼▼▽▽▽▽▽▽ = 2

8

1. ▼▼▽▽▽▽ = 2

6

1. ▼▽▽▽▽▽ = 1

6

1. 1 + 2 =

4 4

1. 6

6

1. 2

6

1. 2

3

1. 3

4

1. A pie was divided into fifths. Emily ate 1 of the pie. Tony ate 2 of the pie.

5 5

Jenny ate 1 of the pie. How much of the pie was left?

5

1. 4

5

1. 3

5

1. 2

5

1. 1

5

1. Jorge is making gelatin. He adds of a 2 cup of hot water to a bowl. Then he adds 1

3 3

of a cup of cold water. How much water does he add all together?

1. 1 of a cup of

3

1. 3 of a cup of water

6

1. 1 cup of water
2. 3 cups of water
3. What is the difference?

5 – 4

6 6

1. 1

6

1. 1

3

1. 1

2

1. 5

6

1. Reggie compared the prices of two radios. The table below shows the prices.

|  |  |
| --- | --- |
| Brand | Cost |
| A | $31.47 |
| B | $34.71 |

How much more does Brand B cost than Brand A?

1. $3.24
2. $3.26
3. $3.34
4. $3.36
5. Adam has $5.00 to buy an airplane that costs $4.28. How much change should he get back?
6. $0.70
7. $0.72
8. $0.75
9. $0.82

1. Carmen bought these three things.

One rag doll---$4.10

One box of crayon--$3.45

One tennis ball--$1.75

1. $9.30
2. $9.20
3. $8.30
4. $8.20
5. Lisa rented 4 videotapes for $4.80. How much did each tape cost to rent?
6. $1.20
7. $8.80
8. $12.00
9. $19.20
10. Four children earned $50 from selling cookies. They decided to divide the money equally. How much money did each of the four children get?
11. $10.00
12. $12.50
13. $46.00
14. $125.00
15. If each ball costs $1.54, how much must Kyoko pay for three balls?
16. $4.62
17. $15.40
18. $31.53
19. $46.20
20. Donna shaded 1 of the figure.

10

●○○○○○○○○○

A. 0.01

B. 0.1

C. 0.110

D. 1.0

1. 9000 – 3782 =
2. 5218
3. 5328
4. 6782
5. 12,782
6. Look at the number sentence below.

67 + 🞏 = 121

Which number will make the number sentence true?

1. 54
2. 56
3. 64
4. 68
5. Which number is 6 more than 1026?
6. 1022
7. 1032
8. 1122
9. 1132
10. The town of Milburg has 5256 grown-ups and 2987 children. How many people live in Milburg?
11. 7133
12. 8133
13. 8243
14. 8343

1. 502 – 273 = 🞏
2. 229
3. 239
4. 371
5. 775
6. There were 3409 pieces of candy in a jar. If 145 pieces were red and the rest were blue, how many were blue?
7. 3244
8. 3264
9. 3344
10. 3364
11. The figure below is a model for the multiplication sentence.

8 x 4 =

Which division sentence is modeled by the same figure?

1. 8 ÷ 4 = 2
2. 12 ÷ 4 = 3
3. 24 ÷ 8 = 3
4. 32 ÷ 8 = 4
5. Lily did this division problem.

375 ÷ 25 = 15

Which problem could she do to check her answer?

1. 25 + 15 =
2. 25 – 15 =
3. 25 x 15 =
4. 25 ÷ 15 =
5. Reese and Jay each correctly used a different number sentence to solve the same problem. Reese used this number sentence:

13 x 4 = 52

Which of the following number sentences could Jay have used?

1. 13 + 4 = 17
2. 52 – 13 = 39
3. 52 ÷ 4 = 13
4. 13 ÷ 52 = 4
5. A company has 6 big trucks. Each truck has 18 wheels. How many wheels is this in all?
6. 24
7. 96
8. 108
9. 116
10. On Friday, 1250 people visited the zoo. Three times as many people visited on Saturday than on Friday. How many people visited the zoo on Saturday?
11. 3615
12. 3650
13. 3750
14. 3753
15. Third-grade students went to a concert in 8 buses. Each bus took 45 students. How many students went to the concert?
16. 320
17. 360
18. 380
19. 3240

1. There are 124 students making 3 stars each for the school wall. How many stars will they make all together?
2. 127
3. 357
4. 362
5. 372
6. How much is nine times four hundred fifty-eight?
7. 4042
8. 4122
9. 4311
10. 4589
11. Six students were sitting at each table in the lunch room. There are 34 tables. How many students were sitting at each table in the lunch room?
12. 208
13. 204
14. 188
15. 1,824
16. 1857 x 5 =
17. 5055
18. 9055
19. 9235
20. 9285
21. During Field Day, 1624 students from Glen Hill School were equally divided into 8 different events. How many students were in each event?
22. 203
23. 206
24. 221
25. 224
26. Jason has 225 rocks in his rock collection. He divides the rock into five equal piles. How many rocks are in each pile?

1. 40
2. 45
3. 50
4. 55
5. What number can be multiplied by 5768 to give the answer 5768?

5768 x 🞏 = 5768

1. 0
2. 1
3. 2
4. 10
5. Which number sentence is true?
6. 275 ÷ 1 = 275 x 0
7. 275 ÷ 1 = 275 x 1
8. 275 ÷ 275 = 275 x 1
9. 275 ÷ 275 = 275 x 275
10. Mr. Brown bought 6 towels. All the towels were the same price. The total cost was $84. How much money did each towel cost?
11. $11
12. $14
13. $78
14. $504
15. Tony had $20. He paid $8 for a ticket to a baseball game. At the game, he bought a hot dog for $3. What amount of money did Tony have then?
16. $5
17. $9
18. $11
19. $15
20. In one week, an airplane pilot flew 1134 miles on Tuesday and 1475 miles on Thursday. If the pilot flies the same number of miles 3 weeks in a row, how many miles does he fly in all?
21. 3402
22. 4425
23. 6818
24. 7827

1. Mr. Guzman bought 48 doughnuts packed equally into 4 boxes. Which number sentence shows how to find the number of doughnuts in each box?
2. 48 – 4 = 🞏
3. 48 ÷ 4 = 🞏
4. 48 + 4 = 🞏
5. 48 x 4 = 🞏
6. The Sumata family took a five-day vacation by car. Each day they drove 250 miles. Which number sentence could be used to find out how many total miles they drove?

1. 250 + 5 = 🞏
2. 250 – 5 = 🞏
3. 250 x 5 = 🞏
4. 250 ÷ 5 = 🞏
5. If Mai bought apples for $250 and she paid it with a $10 bill, which expression shows the correct amount of change?

1. $10 + $2.50
2. $10 - $2.50
3. $10 x $2.50
4. $10 ÷ $2.50

## Appendix C:

Informed Consent

April 16, 2012

Dear Parent or Guardian,

I am a graduate student in the education department of Northcentral University. I am conducting a research study to determine the effects of Computer-Assisted Instruction on student achievement in mathematics. I request permission for your child to participate. My Supervising faculty mentor is Dr. Dana Cleghorn and she can be reached via email at

dcleghorn@my.ncu.edu or via telephone at (205) 680-8160.

The study consists of three phases. In Phase I, I will give a pretest to determine your child’s math ability on math concepts, depending on his/her grade level. Phase II will be the implementation of Mad Dog Math or traditional math for 10 weeks. Phase III will consist of a posttest of your child’s math ability after going through the Phase II implementation. The research study will be explained in terms that your child will understand, and your child will participate only if he or she is willing to do so. Only members of the research staff and I will have access to information from and about your child. At the end of the research study, all of the results will be presented to you. Your child’s identity in this research study will be anonymous and all information regarding him/her will be kept confidential.

Participation in this study is voluntary and your decision will not affect the services normally provided to your child by Gardena Valley Christian School. Your child’s participation in this research study will not lead to the loss of any benefits to which your child otherwise is entitled to receive. Even if you give your permission for your child to participate, your child is free to decline participation. If your child agrees to participate, he/she is free to end participation at any time. You and your child are not waiving any legal claims, rights, or remedies because of your child’s participation in this research project.

Should you have any questions or desire further information, please call me at (310) 327-4987, or e-mail me at room108@gvcs.net. Please complete and return page two of this letter to your child’s teacher.

Sincerely,

Miriam Cohen

Graduate Student

Northcentral University

## Appendix D:

Parent/Researcher Commitment Agreement

I, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_agree to allow my child \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to participate in the study of Examination of Technology Integration in a Metropolitan Elementary Education Program by Mrs. Miriam Cohen at Gardena Valley Christian School in Gardena, California. The researcher will provide all necessary materials, supervise the student throughout the procedure, and record the progress.

In addition, consent is granted to allow pre-and-post testing for my child. The parents/guardian agrees not to implement specialized math instruction for the student until the completion of the study.

I have read the above and understand the contents.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print Name

## Appendix E:

Child Assent Form

The Examination of Technology Integration in a

Metropolitan Elementary Mathematics Education Program

I would like to invite you to take part in this study. I am asking you because you are currently a second or a third grade student at Gardena Valley Christian School.

The reason for this study is to compare the math scores of students receiving the regular classroom teaching only versus the regular classroom teaching plus the use of the computer.

The reason I am doing this study is to investigate if this way of studying math may help you and other students improve their overall scores.

Your parents will also be asked to give permission for you to take part in this study. Please talk it over with your parents before you decide to agree to participate. You do not have to be in this study if you do not want to and it will not affect your grade. If you decide to participate in this study, you can stop at any time.

If you have any questions at any time, please ask Mrs. Cohen or your teacher.

IF YOU SIGN THIS FORM, IT MEANS THAT YOU AGREED TO PARTICIPATE AND HAVE READ EVERYTHING THAT IS ON THIS FORM. YOU AND YOUR PARENTS WILL BE GIVEN A COPY OF THIS FORM TO KEEP.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Student Signature Date

PRIMARY INVESTIGATOR

Mrs. Miriam Cohen

(310) 327-4987