THE IMPACT OF SMART BOARD TECHNOLOGY ON GROWTH IN MATHEMATICS ACHIEVEMENT OF GIFTED LEARNERS

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The Impact of SMART Board Technology On Growth In Mathematics Achievement of Gifted Learners

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Abstract

Patricia Riska. THE IMPACT OF SMART BOARD TECHNOLOGY ON GROWTH IN MATHEMATICS ACHIEVEMENT OF GIFTED LEARNERS. (Under the direction of Dr. Kathie C. Morgan) School of Education, November, 2010.

This study examined whether SMART Board technology increased growth in mathematics performance of fourth grade gifted students. Gifted students in North Carolina were studied to determine if the use of SMART Board technology during mathematics instruction impacted their growth on standardized state tests. The sample consisted of 175 students from six elementary schools with similar populations. Three of the schools used SMART Boards during mathematics instruction, and three schools did not use SMART Board technology. All students were taught the mathematics curriculum according to the North Carolina Standard Course of Study. The instrument for evaluating growth was the state End-of-Grade mathematics test. A formula developed by the state's Accountability Department was used to compare third grade mathematics results to fourth grade mathematics results to determine the degree of growth for each student. The results did not indicate significant growth among gifted students who received instruction using SMART Board technology. This study was limited by the small sample of gifted students who did not receive instruction with a SMART Board. Schools, in this district, matching the specific demographics of the sample are equipped with SMART Boards and utilize them during instruction. Due to this limitation, further research regarding the use of creative technologies to stimulate and challenge the brightest learners is warranted.

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The Lord is my shepherd……….Psalm 23

I would like to thank my Heavenly Father for planting the seed and guiding me through this process. Through every challenge you calmed my spirit and gave me the strength to continue. With you by my side, I was able to face my doubts and fears. You r gentle urging instilled a sense of purpose that I could not deny. I am so blessed that your goodness and love is a constant through each phase of my life.

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Table of Contents

List of Tables

List of Figures

CHAPTER ONE: INTRODUCTION

The focus of this study was to examine the use of interactive SMART Boards as an instructional tool to determine their impact on the mathematics achievement of fourth grade gifted students. Identified gifted students will be studied to determine if higher mathematics achievement is attained with the use of SMART Board technology when it is implemented in a classroom setting.

Background Information

The cry for closing the achievement gap in education can be heard across the nation. Monies are earmarked for programs that support targeted populations including, but not limited to, students living in poverty, mentally or physically disabled students, children without means to attend preschool, and students who do not speak English. For the past 30 years, the federal government has focused on disadvantaged children. From its inception in 1965, Title I of the Elementary and Secondary Education Act (ESEA) became the cornerstone of the national commitment to educate economically deprived children (Jennings, 2002). Stringent controls were implemented, and audits were conducted frequently to assure the funds were directed towards programs developed solely for the disadvantaged. In 1988, Title I was amended to require states to report the academic progress of their disadvantaged students. In order to retain funding, substantial growth was and still is required. Currently, strict guidelines are enforced to ensure the appropriate use of Title I funds and the progress of students targeted by the funding.

In the original draft to the 2001 revised ESEA Act, funds were allocated for vouchers. Students who attended schools with large numbers of underachieving populations were given coupons to attend private institutions. This money was earmarked specifically for low performers, and no consideration was given to high performers who were not meeting their learning potential (Olsen, Olsen, & Robelen, 2001).

A report to the U.S. Supreme Court, *Brown v. Board of Education of Topeka, Kansas* (1954), focused on the necessity of ensuring equal educational opportunities for all students. As federal agencies quickly allocated funds for minorities, females, and students with disabilities, the allocation of funds for gifted students was increased minimally (Baker & McIntire, 2003). According to Ross (1993) the attitude toward funding of gifted education is reflected in the dollars allocated for this special population. A federal study on gifted students, as cited in Ross (1993), reported that states spent a meager two cents out of every one hundred dollars in education programs for gifted students.

Gifted students are not a priority in the majority of schools in the United States (U.S.). Russo (2001) expressed this idea, stating that "despite the progress that has been made in the struggle for educational equality, many exceptional students are not being fully served." Little has been done at the federal or state level to provide monies to establish appropriate curricula or programs to meet the needs of the gifted individual. Attention is concentrated on the disadvantaged, high risk student. Both groups are classified as special populations, yet the low achievers are the recipients of curriculum reform, interventions, and financial resources (Russo, 2001). The focus should be expanded to include all students, not merely select groups. Educators must become advocates for the gifted student.

Public interest and support of programs for gifted students has fluctuated.

This fluctuation not only impacts the students, but it has lasting effects on society. Gallagher (1998) stated that "the problems of unfulfilled potential are often hidden ones that affect not only the individuals involved, but the society we live in and depend on." For any nation to remain competitive in the global market, the brightest students must be given opportunities to excel and learn at their highest potential. Unfortunately, in the U.S., gifted students are generally not the focus or recipient of government funding. Funding fluctuates as the American public expresses ambivalence toward special programs aimed at enhancing the curriculum for accelerated learners.

Many policy makers ignore the statistics that show U.S. economic superiority in the global market is declining rapidly (Friedman, 2005). In order for the U.S. to retain economic advantage, educators need to persuade policy makers to fund programs that will challenge students possessing the greatest potential for success. Remaining competitive with other cultures is a necessity if the goal of the U.S. is to retain its rank as one of the super powers. Friedman (2005) wrote that we must actively pursue collaboration, communication, and specialization if the U.S. is to maintain a dominant economic global position. Educators need to take action regarding new practices and trends in order to retain our current status.

As schools look to improve the performance of low achievers, often the performance of gifted students is ignored. Closing the gap should not come at the expense of providing adequate opportunities for growth among the brightest students. Historically, the federal government has not required the implementation of appropriate programming for gifted and talented children (Russo, 2001). Promising changes were expected in 1988 when the Jacob K. Javits Gifted and Talented Students Education Act (Pub. L. No. 100-297) was passed. This act provided modest funding that could not support the development of widespread programs for the gifted. Additionally, few regulations were established to ensure that funding was properly spent on the targeted population. Unlike federal regulations regarding the use of Title I funds, individual states controlled the money. A variety of funding methods were used and minimal consistency existed among states (Baker & McIntire, 2003). Special interest groups lobbied for their share of allocated funding, creating an aggressive pursuit of financial support.

> A critical problem with litigation-based strategies for achieving equity for special populations is that they ultimately create divisive competition among definite student populations for access to finite educational resources, creating an unhealthy and ultimately nonproductive systematic tension, diverting attention from the central issue – providing suitable (ability-appropriate) educational opportunities to all students. (Baker & Friedman-Nimz, 2004, p. 52)

President Obama's 2011 budget proposes consolidating the only federally funded gifted education program with two other programs. Merging the programs eliminates the designation of specific recipients of the funding. Monies would be made available for several special interest groups instead of solely for gifted students who were the original designees (Fine, 2010).

Policy makers argue that gifted students usually experience success regarding academic achievement; therefore, they do not see the need to provide funds or professional development to further enhance their chance for success (Ross, 1993).

Educators argue that the definition of *success* is determined by performance on standardized tests that have been developed to measure "grade level proficiency" in language arts and mathematics. Proficiency is an indicator of meeting a standard that may be substantially lower than the capabilities of gifted students (Goodkin, 2005).

Legislators must recognize the need to challenge and develop the academic potential of gifted students. Settling for performance beneath their capabilities does not create an opportunity for academic growth.

> The persistent myth that gifted students will achieve high grades and test scores, be accepted into the nation's most selective universities, and go on to great achievements, all without the benefit of strategies tailored to meet their learning needs in K-12 education, is just that -- a myth. (Clarenbach, 2007, p. 16)

The reality is that many gifted students are not exposed to a challenging curriculum. According to the National Center for Research for The Education of Gifted and Talented Children and Youth, gifted elementary students have mastered between 40 and 50 percent of the school year's content in several subject areas before the school year begins (as cited in Clarenbach, 2007). The time they spend in school does not enable them to fulfill their intellectual potential. Lacking academically rigorous curricula, many gifted students fail to develop critical study skills or the perseverance to attain high achievement (Clarenbach, 2007).

In January 2002, President Bush enacted The No Child Left Behind (NCLB) Act (Pub. No. 107-110). This law was established to ensure quality education for all children. The expectation is that every student (100 percent) will be on grade level by the year 2014. The controversy surrounding this legislation is the contradictory nature of the two previous concepts. The first concept, quality education for all children, and the second concept, that every student will be on grade level, have different foci. Quality education for all children should encompass every ability level, ranging from the lowest intellectual capacity to the highest IQ ranking, whereas being on grade level shifts the focus to underachievers. Monies are directed for a variety of initiatives to foster growth in the lowest achievers; however, funds are not earmarked for the students who have mastered the basic curriculum. Therefore, gifted children have been neglected in this process. The NCLB Act states that conditions must be created where all students can perform at the highest level of their capabilities. “Gifted students, parents, and teachers want to experience excellence in their schools. Seeking excellence means giving adequate opportunities and instruction to allow the brightest of our students to search and explore new ideas, to be the best they can be” (Gallagher, 2002, p.121). Opportunities for gifted students to participate and excel in an enriched curriculum have been overlooked in an attempt to raise achievement scores of low performing students. It is important that government officials and policy makers recognize that every student needs a challenging, interesting, and rigorous curriculum. Researchers and educators are consistently seeking ways to enhance instructional strategies that stimulate and engage all students in the learning process.

The purpose of the research is to determine if the use of technology will increase the mathematics achievement of gifted students. Innovative means must be explored to determine the best way to challenge high ability students, expand their learning opportunities, and engage them fully in the learning process. The use of technology, specifically the SMART Board, will be investigated to determine its impact on the academic growth in mathematics of fourth grade gifted students. SMART Technologies Inc. is the world leader in interactive whiteboards, which includes the SMART Board.

Current research identifies a concern that gifted students lacking in access to technology do not perform as well as when they have access (Dixon, Cassidy, Cross, & Williams, 2005). Educators supporting technology argue that computers expedite the mechanical aspects that accompany class work. Writing assignments completed in long-hand versus word processing are time consuming. Any mechanical process that can expedite responses from students would create additional time for the process of thinking. Enhanced think-time lends itself to a higher degree of critical thinking. Increasing the level of critical thinking in gifted students, generally, results in higher levels of achievement. Dixon et al., 2005 found that gifted students produced a greater amount of text and higher critical thinking scores on computer-generated versus hand-written writing samples. The aforementioned results provide empirical support for the use of computers in the classroom.

This research in this study examined the use of the interactive SMART Board. Whereas computers are designed for individual use, the SMART Board is designed for whole-class instruction. The entire premise of this technology is built upon active engagement. Touch-sensitive screens are mounted on the wall of the classroom and a projector shows information that can be manipulated and displayed with unlimited capabilities. The advantage of SMART Board technology is its design for use in a spacious work area with group interaction. The enlarged visuals are easily seen due to the size of the interactive whiteboard. Participants become both visually and physically engaged as they connect with electric content and multimedia in a collaborative learning environment (SMART Technologies, 2004). Using special pens, students and/or teachers write directly on the screens. They can manipulate text and images, view websites, cut and paste research information, view video clips, formulate graphs and charts, and design vivid and creative presentations. Students combine their cognitive and physical abilities to interact with SMART Board technology. The interactive nature of the technology and the state-of-the art software enable students to generate activities that are engaging, useful, and enlightening. Informational text, research, and real-time Internet sites can be easily incorporated and accessed during the lesson (Starkman, 2006). Additional interactive features include the conversion of handwritten text to typewritten text, drag and drop boxes, the opportunity to highlight specific words, and the option of diagramming/scaffolding information. Teachers can download lesson plans; adjust them to the specific needs of the students, and save them for future use.

The SMART Board captures students' attention in a unique way and engages them in interactive learning. Gifted students, who may not have been challenged in the past, are engaged when learning is interactive. Shaunessy (2007) stated that in order to address the distinctive intellectual needs of the gifted thinker, supplemental curriculum must complement the existing curriculum that is provided in the general education classroom. Access to instant information, coupled with the ability to develop creative, engaging presentations with research, stimulates rigorous and critical thinking. Colorful animation, graphing, and illustrations motivate and intrigue gifted students. They become absorbed with the multiple dimensions this technology offers as they utilize their own resourcefulness to discover meaning. As future leaders, the brightest students must be exposed to the use of technological tools because they will most likely be involved in the fields that utilize the latest devices (Shaunessy, 2007).

Policy makers must be made aware of the capabilities that SMART Board technology offers gifted students. Amidst the financial crisis currently enveloping global economies, budget cuts are a necessity. Spending must be deliberate and, therefore, research-based. Difficult decisions must be made as to the tools that are the most effective in enabling students to reach their highest potential.

Theoretical Basis for Study

Three theories that provide the basis for this study are social cognitive theory, socio-cultural theory, and the social constructivist theory of learning. These theories support the belief that gifted students require an accelerated curriculum that is unique in design.

According to Burney (2008), social cognitive theory, within the context of gifted education, emphasizes an interactive process among environment, behavior, and personal motivation to explain the learning process. Academic curricula must be challenging for the gifted learner to maintain his or her advanced position in relation to others. Understanding the factors that impact the learning process of gifted students must influence curricular decisions. The need for content that is consistently challenging is essential if the gifted learner is to continue to develop advanced cognitive abilities. Without challenge, these advanced capabilities are likely to diminish (Burney, 2008).

A Magnetic Resonance Imaging (MRI) of a gifted brain reveals bright red blazes of metabolic activity. The imagery is so intense that it appears the brain is on fire (Eide & Eide, n.d.). Gifted brains are highly receptive and exhibit intense sensory activation. They are characterized by increased memory capacity of sensory perceptions. Visual images, color, sound, and smell are often processed in more depth than in the normal brain. Often educators of gifted students believe that filling the expanded memory with factual information is stimulating; in actuality, the opposite is true (Eide & Eide, n.d.). Students who are already information wealthy benefit from activities that further challenge their analytical abilities. Their time is better spent engaged in behaviors that stimulate their processing skills. Storing details is a passive function, whereas processing, analyzing, and critical thinking initiate metabolic activity (Eide & Eide, n.d.).

Gifted students need additional time to contemplate issues and material. They require a mode of education similar to the approach used by classical humanists. In this model, concepts were studied intensely and reflected on at length. Instead of superficially investigating a topic, students were encouraged to explore information thoroughly. Through exploration, they would become highly engaged and pursue a deeper understanding (Eide & Eide, n.d.). To maximize the gifted learner's potential, diverse visual, spatial, verbal, and sensory areas of the brain must be coordinated. To utilize the brain more effectively, gifted students should be given the opportunity to process information. By using cognitive strategies, students are able to sort, analyze, and apply information. Challenging, high interest material provides the impetus for students to enjoy learning simply based on the process and stimulation (Burney, 2008).

Gifted students need interactive learning experiences that involve inquiry-based, self-selected topics that can be investigated. The gifted mind expands with activities that require problem solving and analysis. The inert activity of acquiring facts, devoid of opportunities to acutely examine solutions, inhibits cognitive growth for students with high intellectual ability (Tomlinson, 2009).

Socio-cultural theory posits that social and cultural forces impact cognitive development. To challenge the gifted individual, educators need to identify the skills that have been mastered, and consistently afford the gifted student the opportunity to increase his or her capabilities (Friedman-Nimz, Obrien, & Frey, 2005). In a school setting, socio-cultural theory implies interaction with others. People come to understand the world based on their personal, social experiences. To challenge and ensure the growth of cognitive skills, instruction must go beyond the current mastery of the curriculum. Teachers must learn to focus on developing potential by looking at the future rather than the past (Vygotsky, 1978). In order to accomplish this, teachers must monitor the progress, as well as social and emotional needs, of gifted children. Often, gifted students do not feel socially adept. Their unique intellectual abilities set them apart from their peers. They may become withdrawn and depressed (Bohnenberger, Renzulli, Cramond, & Sisk, 2008). Frequently, perfectionist behavior is manifested, resulting in an insatiable desire to perform every action flawlessly. Left unaddressed, this unrealistic expectation can stifle creativity and the passion for learning (Renzulli, 2002). Teachers should assume the responsibility of identifying the gifted student's social needs and cultural proclivities prior to planning instructional activities. New academic material must be integrated within the social context in order to maximize the full potential of the gifted learner (Vygotsky, 1978).

Social constructivist theory accounts for the individual and idiosyncratic constructions of learning. Through active participation in the learning process, the learner constructs meaning by building connections in a consequential and sequential fashion in order to solve a problem. Through conversation and negotiation with peers and instructors, the outcome is the acquisition of increased intellectual ability. To deepen understanding, the concepts encountered in school must be connected and developed from the individual's concrete experience (Vygotsky, 1978). The teacher's role is to assist the child in discovering connections through collaboration, experimentation, self-regulation of his or her behavior, and selection of negotiated goals. Advanced technologies, such as the SMART Board, heighten and enrich the gifted individual's idiosyncratic constructions of learning. Accessing information is instantaneous through the use of technology. The technological devices enable gifted students to move at an accelerated pace, generate inquiry-based learning, conduct research, examine resources critically, and receive immediate feedback, along with a host of additional features that are not available in a traditional teacher-centered classroom (Villano, 2006). The use of technology has the potential to reach and engage the “gifted learners who are not by definition advantaged but rather, as a result of their specific characteristics, are as much ‘at risk’ of educational underachievement as other, more readily recognized at-risk groups” (McCoach & Reis, 2000, p.157).

Often, theories are not addressed when developing academic curricula. Little to no differentiation takes place for accelerated educational programs. Gifted students are generally subjected to the same strategies and courses that are presented in a traditional classroom-based learning environment where standardized tests with low ceilings are used to determine student performance. The test results substantiate mastery of the grade level curriculum, but they provide no indication as to the student’s potential performance if the ceiling had been higher (McCoach & Reis, 2000). The special abilities of a gifted student must be recognized and focused upon with the same commitment as other populations identified as exceptional.

Problem Statement

The purpose of this quasi-experimental, quantitative study is to investigate the effect that the use of SMART Board technology has on the mathematics achievement of fourth grade students who are certified as gifted learners. This study will compare certified gifted students who receive mathematics instruction using SMART Board technology to certified gifted students who do not receive mathematics instruction using SMART Board technology. Academic growth will be assessed by comparing the scores from the third grade End-of-Grade (EOG) mathematics assessments to the fourth grade EOG mathematics assessment scores. . This comparison will not measure the number of students from each sample who pass the test; instead, it will measure the growth gains of each student by comparing assessment results from the May 2009 Mathematics EOG test to those of the May 2010 Mathematics EOG test.

Research Questions

The primary research questions guiding this study are:

1. Does the receipt of mathematics instruction with the use of SMART Board technology increase gifted students' growth on the EOG mathematics test at a rate higher than that of gifted students who are instructed without this technology?
2. Does the post-test EOG mathematics score of the gifted students in the study show a significant increase over the pre-test scores?

Statement of the Hypothesis

The following hypothesis was developed from the problem statement and the literature review regarding the learning styles of gifted students and the limited tools available to present them with challenging instruction.

H_1: The use of SMART Board technology during mathematics instruction will result in significantly higher growth in the mathematics achievement of fourth grade gifted students in the experimental group than the growth in mathematics achievement of fourth grade gifted students in the control group as indicated by the EOG mathematics assessment.

H_2: The post-test scores of the gifted students in the study will yield a significant increase in their mathematics achievement as measured by the difference between the pre-test and the post-test scores on the EOG standardized mathematics assessment.

Professional Significance of the Study

The importance of this study lies in the value of identifying methods that will enhance academic achievement of the gifted learner. Recognizing the components necessary for sustaining and further developing the skills of gifted students contributes to the expansion of educational theory. The implementation of 21st century technological tools as a mode to increase performance in gifted students impacts not only academia, but the progress of societal achievement. Students with supreme aptitude must be provided with opportunities to maximize their potential.

Gifted students are legally entitled to a Differentiated Educational Plan (DEP), (Academically or Intellectually Gifted Students, §115C-150.S.) but the fulfillment of this requirement is superficial. Programs that offer one hour per week of specialized instruction have been and are considered acceptable. However, this minimal effort does not provide ample exposure to a differentiated curriculum or consistent methodologies that promote critical thinking and problem solving. Gifted students must receive full-time instruction with a challenging, engaging curriculum that utilizes current, creative technology to further expand their knowledge.

The use of interactive SMART Boards as an instructional tool may lead to further analysis of technological devices for enhancing classroom instruction. To date, a limited number of studies have been conducted that examine the impact of technology on academic growth. However, Van Tassel-Baska's (2003) Integrated Curriculum Model (ICM) provides gifted students with opportunities for advanced content and products to accelerate learning. The use of technology aides in facilitating and perfecting this process. Teachers of gifted students must recognize these capabilities and incorporate technological tools to adjust curricula, methodologies, expected outcomes, and assessment measures suitable for gifted learners (Shaunessy, 2007). With the rapid evolution of devices, educators must make research-based decisions to determine which tools successfully complement learning. As school leaders seek methods to increase student achievement, examining the impact of technology has substantial value.

Operational Definitions

The constructs in this proposal are defined operationally as follows:

- *Ability level* is defined as the intellectual capability of the individual student based on standardized test scores.
- *Active engagement* is defined as interactive student participation in the learning process. Inquiry-based mental and physical activities involve, but are not limited to, discussion, collaborative projects, presentations, and research.
- *Certified gifted student*, hereafter referred to as gifted student, is defined as a student identified as a conceptual thinker, who can solve challenging, open-ended problems. Certification in North Carolina is determined through standardized testing of aptitude and achievement, or the Gifted Rating Scale and testing of aptitude and achievement, or a specific Portfolio Process with the Gifted Rating Scale, or a Cognitive Abilities Test (CogAT6) score of 97 percent or above.
- *Differentiated Educational Plan* (DEP) is defined as a document that outlines the program service option(s) appropriate for a student at specific grade configuration (K-3, 4-5, 6-8. 9-12), and addresses the learning environment, content modifications and special programs available to the student during those grade configurations. The purpose is to ensure that cognitive abilities are challenged through the implementation of a program of study that is different from the standard curriculum.
- *Differentiated instruction* is defined as a lesson concept presented in different formats to address the various ability levels within a classroom setting.

- *End-of-Grade mathematics assessment* is defined as a multiple-choice test containing 82 questions, designed to assess students' academic yearly growth and preparation for the next grade. It is also an indicator of the fidelity with which the state Standard Course of Study is taught. The results are reported in terms of achievement levels: Level IV (advanced), Level III (proficient), Level II (basic), and Level I (below basic).
- *Individual Response System* is defined as a peripheral device associated with SMART Board Technology that monitors student participation and accuracy during instruction with interactive technology.
- *Interactive learning* is defined as a process that actively engages a student both mentally and physically in discovering, constructing, and understanding information. Self-selected topics and inquiry-based methodology, coupled with problem-solving and cooperative tasks, are components of the process.
- *The Jacob J. Javits Gifted and Talented Students Education Act* is defined as legislation enacted to provide funds for programs designed to meet the special instructional needs of gifted and talented students.
- *The No Child Left Behind Act* is defined as legislation enacted to ensure that every child is proficient in language arts and mathematics, as measured by standardized tests, by 2014.
- *SMART Board Technology* is defined as a widescreen, high-definition, high-performance, interactive, touch-sensitive whiteboard. Computer input is projected onto the large screen and can be manipulated with a stylus or the light touch of a finger. Vibrant colors and animation enhance engagement and

interactive learning. SMART Board is a trade name for the interactive whiteboard manufactured by SMART Technologies, Inc.

- *Talent development* is defined as a student identified as a conceptual thinker, who can solve challenging, open-ended problems. The term is interchangeable with gifted student.
- *The 21st Century Skill* is defined as an ability that will enable individuals to understand, contribute, compete, and thrive in the global economy of the 21st century. Skills must match the needs of the time period.

CHAPTER TWO: REVIEW OF THE LITERATURE

An abundance of research exists regarding the special need for a challenging curriculum and innovative methodology when educating gifted children. Although opinions may differ in prioritizing the tools that are most effective, there is total agreement that the curriculum for gifted students must be differentiated from the standard curriculum. Gifted students must be afforded opportunities that challenge their mental capacity in order to realize their full potential (Koshy, Ernest, & Casey, 2009). Mainstreaming of gifted students is an acceptable practice in many school systems; however, subjecting all students to the same curriculum and instructional strategies limits academic success. “Many bright students who are set adrift in a general school population that operates on an academic level lower than their capabilities just merge and become indistinguishable from their less-able classmates as the years go on” (Horwitz, 1974, p.17). Generally, the curriculum is designed for average ability students. High achievers and lower ability students are often frustrated by material that is not challenging or too rigorous, respectively.

Basis for the Current Study

This study addresses the need for and investigates methods for providing a rigorous educational experience for the specific learning requirements of gifted students. The purpose is to determine if the use of innovative technology will specifically enhance the complex thought process of the gifted student.

Gallagher (1985) stated, “The educational fate of gifted children, who learn more rapidly and in greater depth than their age mates, has not always been of great concern in the United States" (p. 107). Public interest and support have been marginal regarding the needs for students who are performing well in the classroom. Instead, funding has been allocated to students who are behind academically. Title I of the ESEA allocates federal funding specifically for disadvantaged children. This legislation, originally passed during President Lyndon Johnson's tenure in 1965, is an indicator that for more than 40 years the federal government has been committed to funding education for economically and educationally underprivileged children (Jennings, 2002).

In society, the perception exists that these children are more deserving and needing of assistance than children performing satisfactorily. The latter may be more self-sufficient, but this is not an indication that their academic performance is less important than economically disadvantaged students (Koshy et al. 2009). The reality is that both groups of students are deserving of the best possible education. Unfulfilled potential at any level should be a concern. "Too often, students who show great academic promise fail to perform at a level commensurate with their previously documented abilities" (McCoach & Reis, 2000 p.167). Instead underachievement, defined as a discrepancy between ability and achievement, is recognized only if the student is categorized as performing below the norm on standardized assessments. Low achievers qualify for special services and interventions, yet the same opportunities do not exist for students who perform well on standardized assessments, but are performing below their capabilities. The indicators for success are performance, not potential (McCoach & Reis, 2000).

Currently, the United States lags behind other countries in both mathematics and science accomplishments (Jones, 1989). Economic superiority over other nations is declining (Coleman & Selby, 1983). According to the Fourth International Mathematics and Science Study (2007) the United States was not among the top 10 countries in eighth or twelfth grade mathematics proficiency. Sixteen countries participated in the 1995 and 2007 assessments. Average mathematics scores from 1995 were compared to average mathematics scores in 2007 to determine each country's growth in scale scores. England had the highest gain with 57 points, Hong Kong Special Administrative Region of the People's Republic of China had 50 points, Slovenia had 40 points, Lativia had 38 points, New Zealand had 23 points, Australia had 22 points, Iran had 15 points, and the United States had 11 points. In fourth grade mathematics, the United States was ranked eighth in improvement, however; in eighth grade they were ranked 14th and in twelfth grade they were ranked 19th. Policy makers need to realize that gifted students are the potential strength in the areas of commerce, engineering, medicine, and the arts (Gallagher, 1985). Failure to advocate on their behalf places the U.S. in jeopardy.

The NCLB Act of 2001 established a law designed to ensure quality education for all students. An extensive testing program measures the progress of every sub-group within a school, but particular importance is placed on students who are at-risk for academic problems or failure. Emphasis is placed on closing the gap between high achieving and low achieving students. The focus is to ensure by 2014 that all non-readers become readers by third grade and perform on grade level. The need to challenge students who are fluent readers in kindergarten is ignored (Davidson Institute, 2006). In essence, NCLB places the performance of the low achieving learner before the accelerated learner by addressing the achievement gap instead of addressing the task of maximizing the full potential of every child. Gifted students, their parents, and teachers express concern that resources are allocated to low performers at the expense of the high achievers.

Gifted Curriculum

Recognizing that every student needs a challenging, enriched, and interesting curriculum is important. Researchers are consistently seeking ways to enhance instructional strategies that stimulate and engage students in the learning process (Edwards, Carr, & Siegel, 2006). Educators should note that for gifted and talented students, lateral extensions are not enough (Kay, 2002). If a middle school student has proven capabilities in high school mathematics, the extension of middle school concepts will not enrich the student's capabilities. "The intellectual rigor of the material designed for academically able or gifted students must be dictated by their level of ability" (Kay, 2002, p. 241). In order to truly challenge the innate abilities of gifted students, educators should provide programs and opportunities that develop the cognitive abilities of gifted students. SMART Board technology provides instant access to a myriad of information. The act of processing, analyzing, and evaluating a vast range of material is mentally stimulating and lends itself to further development of the gifted student's unique cognitive abilities.

Learning Needs of Gifted Students

According to research from the Davidson Institute (2003) there are a variety of characteristics that are unique to intellectually gifted students. They possess a strong ability to think in an abstract manner and rapidly solve complex problems. They process information quickly and have a passionate desire to move ahead with additional challenges because of their desire for constant mental stimulation. They easily become frustrated if they are consistently exposed to information that does not challenge their mental capacity. Students who demonstrate these tendencies have specific academic needs that must be addressed in order to assist them in meeting their full learning potential.

Winebrenner (2000) states that the needs of gifted learners are often overlooked because of their high performance on standardized assessments which are used to hold schools accountable for academic proficiency. These tests merely determine if students meet, not exceed, basic grade level requirements. They do not measure a student's performance that exceeds the basic standard. The tendency is to focus on instructional strategies that target students who are at risk of failing to meet the benchmark.

> Teachers are expected to create numerous differentiation adjustments for low-achieving students in modifying the amount of work, depth, complexity, and content of the curriculum by linking students' learning styles and interests to the prescribed learning tasks. These same strategies should be applied to challenge those students who have already mastered the content area so that they can go beyond where they presently are (Winebrenner, 2000, p. 52).

According to Wienbrenner (2000) there are five ways that gifted students learn differently from the students who are not considered gifted: a) they learn material very quickly, b) their capacity for recall is acute, which makes review frustrating and painful, c) their perceptions are abstract and complex which results in more in-depth learning, d) they possess a strong desire to fully investigate topics that interest them, e) they have the ability to multi-task which enables them to simultaneously listen and work collaborative or independently.

Winebrenner (2000) offers specific recommendations to assist teachers in planning instruction for gifted learners. Pre-assessment must be conducted prior to instruction. Students should be given instruction that matches their level of understanding on the topic. Curriculum compacting is a strategy that enables students to omit areas of mastery and commence learning new information. Teachers assess the degree of knowledge that a student has regarding a topic and eliminate those portions of the curriculum in which the student is proficient. The material is condensed by excluding items that were previously learned. Differentiated pacing, alternative learning experiences, opportunities for in-depth research, and self-selected topics are beneficial in challenging the gifted learner. "It is essential that gifted students realize that they must demonstrate competencies that exceed those designated as basic (Winebrenner, 2000, p. 54). Teachers must set high expectations in the classroom and present opportunities for gifted learners to further develop their capabilities. In this process, it is important for gifted students to experience interaction with their instructors to prevent a feeling of isolation during their search for knowledge. Gifted students have the same need for support and guidance as their classmates. Even the most prolific, gifted learner needs assistance in sustaining motivation (National Association for Gifted Children, 2006).

Gifted learners need objectives for learning and a measure for identifying the progress of their task. "Without a clear understanding of what is to be learned and how that learning is taking place, the learner loses interest, motivation, and comes to see learning as a process devised by others that is trivial, irrelevant, and a waste of time (VanTassle-Baska, 2000, p.1).

Educators need to recognize that the learner outcomes for gifted students should be different from generic outcomes. VanTassel-Baska (2000) compares generic outcomes to gifted outcomes within the context of American Literature. Generic outcomes involve comprehending a variety of materials, demonstrating a familiarity with the structural elements of literature, and developing an understanding of the chronology of American Literature. To the contrary, gifted outcomes involve evaluating diverse materials according to a set of criteria or standards, creating a literary work in a self-selected form using appropriate structural elements, and analyzing and interpreting key social, cultural, and economic ideas expressed in the literature, art, and music of America at 40-year intervals.

The goal for instruction of gifted students is to make the objectives more challenging and comprehensive. Educators must recognize that requiring students to do additional work in an area that has already been mastered does not challenge the analytical skills of the gifted learner. "When tasks are not sufficiently challenging, the brain does not release enough of the chemicals needed for learning: dopamine, noradrenalin, serotonin (Schultz, Dayan, & Montague, 1997, p. 9).

Johnson and Ryser (1996) offered six instructional strategies that have been linked to increasing the problem-solving and critical thinking abilities of the gifted learner. Teachers should: a) pose open-ended questions that require higher-level thinking, b) model thinking strategies, such as decision-making and evaluation, c) accept ideas and suggestions from students and expand upon them, d) facilitate original and independent problems and solutions, e) help students identify rules, principals, and relationships, f) take time to explain the nature of the errors.

Teachers who recognize the needs of the gifted learner and implement research-based strategies to support their unique characteristics could impact college graduation rates. Rimm (2003) states that only 40% of the top 5% of high school graduates complete college. Failure to challenge these students prevents our brightest students from meeting their potential and contributing to the progress of our country.

To sustain advanced development, gifted students must make use of their high abilities "Without an appropriate learning environment, the brightness dims and the excitement for learning is suppressed. Mediocrity in academic performance becomes the standard, excitement for learning fades, and behavior problems commonly surface" (Hanninen, 2005, p. 18). When gifted students are presented with opportunities that are challenging and fulfilling, they further develop their abilities. Conversely, when they are not exposed to experiences that are appropriate for their abilities, they lose motivation. They may be at-risk for educational failure. When educational methodologies do not meet the needs or expectations of the gifted student, these students may become disengaged (Prensky, 2003).

Research substantiates the theory that the brain will not maintain its level of development if stimuli are unchallenging. Gifted students are identified as developmentally advanced. "In order to sustain the description of having advanced development, a student will have to make use of her high abilities to continue to develop, so as to maintain the same advanced position in relation to others" (Cross & Coleman, 2005, p.55). Challenge is a very important component of effective curriculum and instruction (McAllister & Poiurde, 2008). Lack of challenge often results in boredom and frustration, which, in turn, results in loss of interest in learning. If our most able students are denied a challenging curriculum, it greatly impacts America's ability to compete in the global economy (Renzulli, 2005).

Since resistance is often expressed toward funding for gifted education, Donald Treffinger (1998) proposed a shift in programming from traditional gifted education to a Talent Development (TD) program. By changing the focus from a select group to a more comprehensive group, wider service would be given if talents in areas other than academic achievement were recognized. Many viewed this proposal as too broad and deemed it unable to meet the needs of the truly gifted. Nevertheless, agreement was voiced that reinforced the notion that, “Every effort possible must be made to discern students’ special needs, interests, and potentials and to provide educational opportunities that nurture their talents” (Treffinger, 1998, p.752).

Methodology

Having established the necessity for a challenging, stimulating curriculum specifically for gifted students, the focus shifts to the best method(s) of delivery. Brain research supports the value of interactive engagement in the learning process. Active engagement in solving real-world problems is highly stimulating for the gifted learner (Wolfe, 2001). Students must have some flexibility in pursuing areas of interest and areas in which they excel, and they must have opportunities to work collaboratively, as well as independently (Wolfe, 2001). A study conducted by Edwards et al. (2006) examined teachers’ instructional practices. Emphasis was placed on differentiated instruction: Was it implemented? If so, was it implemented correctly? What was the attitude of the teacher regarding differentiated instruction? Did it have a positive effect on student achievement at all ability levels? To answer these questions, research was conducted to explore teachers’ current practices. The study indicated that teachers teach the way they were taught. It is important to note that in order to transform teacher practice, teacher education programs must be designed to address the complexities and challenges that face educators of the 21st century. “Today’s students are demanding a change in the classroom because of their ability to gather information faster than any previous generation” (Jacobs, 2010). Pre-service programs must be designed using research-based methods despite resistance from cooperating teachers and mentors. A paradigm shift must accompany the identification of “best practices” that will be standard in classrooms of the future (Edwards et al., 2006).

Professional Development

In a study conducted by Howland and Wedman (2004) at a mid-western university, 135 teachers voluntarily participated in a two-year professional development program designed to enhance their awareness of technology. The process was intended to improve their knowledge and skills regarding technology so they would be able to successfully integrate the tools in their teaching. The project embraced a research-based vision consisting of seven principles for adapting technology applications and incorporating them into the existing curriculum.

Baseline data was collected to determine the extent to which technology was already being integrated into courses. A questionnaire was utilized to determine the technology proficiency level of each participant. This information was the basis for creating individualized professional development. Participants were paired with a coach from the university, who designed weekly sessions to train the individuals to meet their specific learning goals. Through the use of one-on-one teaching sessions, the participants were provided with hands-on opportunities to use technology software and hardware.

Data were analyzed comparing the teaching practices from pre- and post-measures. By subtracting the end measures from the baseline data, change variables for good instructional practices and technology skill efficacy were identified.

The greatest increase in technology integration was the implementation of internet-based research projects. Prior to the professional development process, 40 percent of the teachers utilized this concept as compared to 75 percent after the training. Additional findings indicated that teachers greatly reduced the frequency with which they implemented a lecture or teacher-centered instruction to their students, which resulted in an increase of student collaboration and engagement. Based on the teachers' post-training data, the professional development process utilized in this study led to the implementation of effective and successful use of instructional technology in their classrooms. The importance of adequately preparing teachers to understand the power of technology and utilize it as a learning tool is undeniable. Training is the key ingredient if the use of technology is to become standard in classrooms of the future.

Shaunessy (2007) states that for gifted students to be tomorrow's leaders in technology they must be presented opportunities to effectively utilize technology in their learning. The implementation of technology in the gifted students' classroom should be designed to address higher levels of analyzing, synthesizing, and evaluating issues and tasks. In a study conducted to investigate teachers' rationale regarding implementation of technology in their classroom Shaunessy (2007) found a link between teacher's attitudes and their impact on gifted learners.

A demographic survey and a Teachers' Attitudes Toward Information Technology Questionnaire (TAT) was sent to 551 public school teachers who taught gifted students in grades 2 through 6. The response rate for the data collection was 76% (N = 418 responses). The TAT consists of 100 questions with sub-scales that require self-reporting of teacher attitudes toward information technology. Using a semantic differential scale, seven possible answers ranging from 1 (negative) to 7 (positive) were used to compile data. Surveys with less than 8 answers on each sub-scale were not included in the results.

The study revealed that the age of the teachers greatly influenced their attitude toward the use of technology in the classroom. Negative responses were more prevalent as the age of the teachers increased. Their responses indicated a lack of confidence in using unfamiliar technology. Additional findings indicate a significant correlation with deficient teacher training and negative feedback. The findings support that teacher training impacts the attitude of teachers toward implementing technology in the classroom. Training is vital if technology is expected to become part of the gifted curriculum. Based on the results of the survey and questionnaire, professional development is a necessary component for preparing teachers to effectively use technology in the classroom. Teachers should be exposed to the benefits of curriculum modification which enable their students to interact with informational technology. In order to shift the paradigm, educators must be given extensive opportunities to engage with technology resources prior to implementing them in the gifted classroom.

To prepare students for the future and to bolster their competitive status, educational practices should focus significantly more on the gifted learner. The role of the classroom teacher in identifying the learning styles and educational needs of gifted students has become increasingly paramount (Tomlinson, 2009). The teacher must provide opportunities for interactive techniques that stimulate the gifted thinker in progressive degrees. Academic performance is increased when gifted children are provided with rigorous tasks that increase in difficulty (Dettmer, 2006). “Consistent practice at progressively more difficult levels in skill, coupled with the talented learner’s natural ability to link new knowledge to prior knowledge and skill, accounts for what ultimately is perceived as expert performance” (Rogers, 2007, p. 382). Instructional practices should capitalize on higher order thinking skills, creativity, originality, and progressively, challenging activities that require student reflection. In doing so, the teacher provides the gifted learner opportunities to evaluate, synthesize, and utilize information. Interactive whiteboards enable teachers to develop and present highly engaging, interactive lessons. Students are able to access current information from the internet and display their findings in creative, colorful displays. The effective use of this technology lends itself to meeting the higher level needs of the advanced learner.

It is important to evaluate the correlation between methods of instruction and the achievement of gifted students (McCoach & Reis, 2000). Challenging programs must be developed that will stimulate and meet the needs of the gifted student. Educators should be required to develop an approach to teaching that recognizes and adjusts to learning style preferences, abilities, and backgrounds of their students. According to a study with high and average ability students regarding their language learning, Nikolova and Taylor (2003), found that when students, especially gifted students, are permitted to exert some control over their learning in a creative environment, learning can be enhanced. The purpose of this study was to explore the educational outcomes of a foreign language learning task when presented to gifted students and average ability students. This task was utilized because of the evidence of its positive impact on vocabulary acquisition, reading comprehension, and student motivation.

The study involved 181 students enrolled in a 1st year Spanish course at a large university. Ninety-seven students were of average ability and 84 were identified as gifted. Both samples were randomly divided across control and experimental groups. On two consecutive days, the students were given a language task where they were scored on their ability to recall unfamiliar Spanish vocabulary to interpret a passage. The students read the same passage, and both groups used computers during the task, but the experimental group annotated the vocabulary using a dictionary and graphics to define the vocabulary words. The control group was given a test that had been annotated by the experimenters. Analyses were conducted to determine whether there was a difference in scores between the two methods at each of the two ability levels.

The results indicated a statistically significant interaction between the two methods and achievement for the gifted students, whereas there was no statistically significant difference between the two methods and achievement for the average ability students. The results indicate that the high ability experimental group's task of looking up the words, and adding graphics had an impact on gifted students' immediate and delayed vocabulary recall. Whether the students had annotated vocabulary supplied, versus looking up the words and supplying graphics, did not significantly impact the average-ability students' achievement. The gifted students scored considerably higher on the more challenging task. Nikolova and Taylor's (2003) study substantiates the theory that when gifted students are challenged and have control over their learning in a creative environment, their performance can be enhanced. "In order to help gifted students maintain their motivation and reach their highest level of achievement, they must be stimulated with creative and compelling activities in which they are responsible for their learning" (Nikolova & Taylor, 2003, p. 213). If the environment is not conducive to the identified needs of gifted students for a challenging, stimulating, increasingly complex classroom setting, then research should continue to determine the best practices that will stimulate their interests and needs.

Rizza and Gentry (2001) conducted interviews with six American leaders, Gallagher, Kaplan, Reis, Renzulli, Tomlinson, and VanTassel-Baska, in the field of gifted education. Three open-ended questions were posed to gain their perspectives on the accomplishments of gifted education in the 20th century, the challenges facing gifted education in the 21st century, and the essential qualities necessary for teachers of the gifted. Their responses were analyzed qualitatively through a review process which categorically determined common themes for organization of the data. Reliability was handled through member checks for all raw data reported. Triangulation was achieved through the use of outside auditors familiar with the complex issues related to gifted education. The perspectives of this group of researchers on the first two questions differed slightly, but their views on the skills necessary for educators of gifted students were comparable. Each participant agreed that teachers must be aware that gifted students require different strategies from what is offered in a standard classroom. Educators must provide rich learning experiences that go beyond straightforward knowledge acquisition and address deeper understanding and processing skills. They must establish a classroom environment where individual abilities can flourish through creative expression, collaboration, independent projects, and self-reflection. To meet the full potential of gifted students, teachers must provide access to the latest intellectual resources and methodologies. The ability of gifted students to process information quickly must be met through cutting-edge strategies.

The results of a study conducted by McCoach and Siegel (2003) indicate that gifted students need reassurance from their teachers about their academic potential in order to further develop confidence in their abilities. This study examined the relationship between academic self-concept and academic achievement in both gifted and non-gifted students.

The sample consisted of two sub-samples. One sub-sample consisted of 160 non-gifted, 9th grade students, and the other sub-sample consisted of 210 high school 10th -12th grade gifted students. The School Attitude Assessment Survey-Revised (SAAS-R) was used to determine academic self-perceptions (ASP). The survey utilized a 7-point Likert-type agreement scale and the results were measured in comparison to a Grade Point Average (GPA) 10-point scale where 10 = all A's, 9 = mostly A's and 1 = mostly D's and

F's. The sample of gifted students scored significantly higher than the non-gifted students on the ASP factor of the SAAS-R. Based on this study, gifted students appear to be much more confident in their abilities. The gifted sample also reported higher GPA's than the non-gifted sample. These results indicate that a significant relationship existed between the ASP and GPA of the gifted students. Conversely, the non-gifted students' ASP did not correlate with their GPA.

The distinct correlation between the ASP and GPA of the gifted sample is an indicator that academic self-perceptions impact gifted students' academic performance. Teachers who recognize this correlation, and provide a classroom environment that supports high self-concept, assist gifted students in meeting their full potential. Gifted students who are confident about their abilities are more likely to participate in challenging, rigorous tasks and persevere in completing arduous assignments.

Although the previous study investigated student achievement in a high school sample, identified practices that support gifted learners should be implemented during the elementary years when crucial learning patterns and effort levels are established. "A review of the literature on underachievement by these potentially capable students reveals little success in reversing their apathy toward learning"(Rayneri, Gerber, & Wiley, 2006, p.104). Elementary school teachers must become adept in identifying the needs of the gifted learner. They must assume responsibility for presenting the curriculum through methodologies that stimulate the cognitive abilities of gifted students. Failure to address their needs will perpetuate underachievement and unfulfilled potential in classrooms throughout the nation (Rayneri et al., 2006). The importance of finding appropriate methods is critical, because the classroom can be uninspiring for gifted children (Taylor & Oakley, 2007).

Rayneri et al. (2006) conducted a study to investigate the impact of gifted students' learning styles and their classroom environment on their academic performance. The participants in this research study were 80 gifted students enrolled in grades 6 to 8. They were identified as gifted according to the state requirements set for performance on standardized tests and performance data based on mental ability, achievement, creativity, and motivation. Data from the Learning Style Inventory (LSI) was analyzed for each participant to determine individual preferences for environment, emotionality, sociological and physical needs. A second category of data was analyzed using the Student Perception Inventory (SPI), which provided the student's perspective of his or her learning environment. To determine compatibility of the students' learning preferences and their perception of their environment, a compatibility index was calculated for each learning style element.

A descriptive statistical analysis was conducted on the t-scores for the LSI and SPI to determine the degree of compatibility for each element of student learning styles and their personal perceptions of the learning environment. A significant correlation was evident when the students perceived the classroom atmosphere to be conducive to their learning style and their teacher as supportive and motivational. Inspirational teachers impacted student productivity significantly. The majority of the students in this study had teachers who were trained in gifted education and understood the importance of intrinsic and extrinsic motivation on student achievement. This study demonstrated that until teachers fully understand the specific needs and learning styles of gifted students, underachievement and unfulfilled potential will continue to be a problem in classrooms across America.

It is important to tap the potential of gifted students before they become disengaged with the existing formal learning process. Gifted students who are subjected to instructional material that lacks challenge often perform poorly. McCoach & Reis (2000) studied the underachievement of gifted students to determine the complex causes of their unfulfilled potential. Giftedness was defined by an IQ test, whereas underachievement was defined in relationship to three general themes: a) a discrepancy between ability and achievement, b) a discrepancy between predicted achievement and actual achievement, and c) a discrepancy between utilization of latent potential without reference to other external criteria (e.g., failure to self-actualize). The researchers surmised that the estimated correlation between IQ and estimated GPA was approximately .5, indicating that IQ scores account for 25 percent of the variance between school grades and predicted ability. The remaining 75 percent of the variance could be attributed to motivation, personality characteristics, and both home and school environments.

Student Underachievement

Investigating the school environment as a cause for underachievement, McCoach & Reis (2000) identified the disparity between the student and the curriculum as a factor that impacts performance. They suggested that academically gifted students who are confronted with work below their intellectual level often fail to complete required work. Although they may be categorized as underachievers, their performance is the result of boredom rather than a lack of ability.

Several causes have been identified in the underachievement of gifted students, but McCoach & Reis (2000) supported the specific educational intervention of establishing a special classroom for gifted underachievers. Unlike traditional classroom organization, students are given choice and freedom over their learning environment and their selection of topics of interest. The classroom is student-centered, and the teacher's role becomes one of a facilitator. The researchers used Type III enrichment projects as a methodical intervention to improve academic performance. This approach specifically targets the student-teacher relationship, students' preferred learning styles and self-regulation strategies, and student-selected, inquiry-based learning. Almost all of the students who completed Type III projects showed positive growth during the study. Of the 17 participants, 11 exhibited improved academic performance and 13 of 17 exhibited increased efforts regarding their school work. The results of this research indicate that an adaptable, student-centered classroom environment can impact the performance of underachieving gifted students.

A study of instructional methods by Lee and Olszewski-Kubilius (2006) indicated that fundamental changes in the curriculum and method of delivery are factors in ameliorating the low performance of gifted students. These researchers posit that the norm for gifted students is to spend a substantial segment of time in school studying repetitious curricula in which they are proficient. The gifted students perceive the curricula as monotonous and dull, and they view their educational opportunities as limited. Lee and Olszewski-Kubilius (2006) pointed to a need for implementing a curriculum for gifted students that is accelerated in order to accommodate their specific needs.

The purpose of their study was to determine the instructional methods, class assignments, mode of delivery, and activities that best motivate the gifted learner. The participants were 15 teachers selected on the basis of their ability to develop creative, exciting lessons, knowledge of the curriculum, and their ability to interpret the various academic needs of their gifted students. The data from a one-page survey and an hour long taped interview were collected and analyzed to determine the type of instructional methods that were implemented during an eight-week summer session for gifted students. The same method was used to compare instructional methods from a nine-month period presented to students who were not classified as academically gifted.

The survey results indicated substantial mean differences between the gifted classes and the non-gifted classes. The methods utilized in the gifted classes were independent research activities, enrichment material, advanced level reading, and higher level questioning strategies. The expectation for performance was higher for the gifted students versus the non-gifted students. A traditional lecture method of delivery and a slower pace were prevalent in the non-gifted classes.

In comparing the performance of the gifted students to the non-gifted students, the teachers attributed the superior achievement of the gifted students to the classroom environment. The higher expectations set by the teachers, students' freedom and flexibility regarding self-selected study, the creative methods of delivery, and a challenging curriculum contributed to the gains in performance of the gifted students. This study validated the importance that an exciting classroom environment, complemented by a challenging curriculum, fully engage and increase the achievement of gifted students.

Technology in the Classroom

One possible solution for providing an engaging, interactive, and challenging classroom environment for gifted students is the use of technology as an instructional tool. Many schools are attempting to motivate students by providing inquiry-based technology classrooms (Lacina, 2009). The use of interactive technology was designed initially to improve communication in the corporate sector, but it is now being utilized in the classroom (Smith, Higgins, Wall, & Miller, 2005). The benefit of incorporating this technology is the complement of visual representations to the teacher's verbal purveying of information (Johnson, 2000). It increases interactive teaching and student engagement. Mathematics and science classrooms, areas in which gifted students traditionally have high ability, strongly benefit from the interactive nature of technology (Knight, Pennant, & Piggott, 2004).

A study conducted by Dixon et al. (2005) investigated the impact that technology has on the writing ability and critical thinking of gifted students. They examined the premise that gifted students lacking in access to technology do not perform as well as when they have access to technology. Two writing samples were requested from each student in the study and the content was compared. One sample was handwritten by the student and one sample was composed on the computer. This study compared the critical thinking process that was utilized in the two samples. Educators who support technology believe that computers expedite the writing process and, consequently, enhance the thinking process by providing more time for critical thinking. Five areas were addressed on the assessment of critical thinking: Inference, Recognition of Assumptions, Deduction, Interpretation, and Evaluation of Arguments. The data analysis showed an increase in the amount of text on the samples where technology was used to create the sample. The same rubric was used to evaluate both the handwritten and computer-generated samples. The difference was significant and in favor of the word processing group. The average critical thinking score for the computer-generated sample was 4.1 compared to the average of 3.1 for the handwritten essay. The results of this study indicate a positive effect when gifted students are presented with tools that streamline performance. Academically gifted students benefit from the use of techniques that enable them to focus more on thinking.

Tomlinson (2009) supports these findings with research regarding effective methodologies that benefit the gifted learner. This research indicates that when gifted students have an opportunity to reflect on their learning, the results show evidence of an increase in retaining and synthesizing information. This reflection affords them the opportunity to delve deeply into the breadth of understanding, an act that is vital to the gifted student. Incorporating the use of interactive technology enables the gifted student to acquire information instantaneously (Tomlinson, 2009). The time consuming task of manual research is lessened, resulting in increased time for analyzing and processing information.

Educators see the benefit of using technology as a means of providing increased think-time for gifted students. School districts across the country are investing in technology in order to modernize classroom instruction (SMART Technologies, 2009). SMART Boards are replacing chalk boards because they enable students to be actively engaged in the learning process. The interactive process is a natural phenomenon for students accustomed to technological devices. A 2006 report from the National Academy of Sciences reported that 26 percent of U.S. teenagers spend between one and two hours a day on-line (as cited in Sohn, 2006). This statistic supports students’ familiarity with technology. It also supports both their desire to learn visually and to have quick access to information (Villano, 2006).

The purchase of interactive whiteboards for classroom use has increased substantially over the past several years. This technology is not considered new since it was introduced in 1991, but it is still considered cutting-edge, because it replaces the chalkboard with a whiteboard that is powered by a computer. In less than 20 years since its inception, more than 1.6 million SMART Board interactive whiteboards have been installed in business and education settings. Over 30 million students in more than 1.3 million classrooms currently use SMART products. Globally, in 2009 SMART Technology sold over 360,000 SMART Board interactive whiteboards (SMART Technologies, 2009). The technology supports instructional strategies by engaging students in critical thinking, goal setting, problem solving, and collaboration. These skills are necessary if students are to be productive in the 21st century (Page, 2006).

Education is changing due to the evolution of technology which affords immediate access to information. With the click of a mouse, search engines provide instant perspectives on any topic. According to Google CEO, Eric Schmidt:

> Search is so highly personal that searching is empowering for humans like nothing else. It is the antithesis of being told or taught. It is about self-empowerment; it is empowering individuals to do what they think best with the information they want. It is very different from anything else that preceded it. Radio was one-to-many. TV was one-to-many. The telephone was one-to-one. Search is the ultimate expression of the power of the individual, using a computer, looking at the world, and finding exactly what they want – and everyone is different when it comes to that. (Friedman, 2005, p. 156)

Along with the simplification of gathering information comes the ability to rapidly collaborate and problem solve which supports the needs of the gifted learner. The use of technology streamlines the process of acquiring factual data which enables the student to spend time on analytical thinking and reflection. The same holds true for teachers who can devote the additional time to focus on higher level questioning strategies that assist students in developing problem-solving skills. With increased accountability for schools based on standardized testing, students are taught to respond with memorized answers instead of critically thinking about a solution. The use of technology to quickly acquire information, synthesize the material, and effectively apply the concept supports a new way of looking at instruction which is more compatible with 21st century learning skills (Jacobs, 2010).

Students in this day and age, who are accustomed to immediate gratification, find the quick access to information appealing. Teachers find that this innovative technology is responsible for an increase in lesson pace, because there are fewer transitions (Howland & Wedman, 2004). Instead of subjects being taught in isolation, the curriculum is easily integrated with lessons plans that generate research and sharing of information. Students need learning that is connected, contextual, relevant, and authentic (Warlick, 2007). "Educators of the gifted strive to provide curricula with complexity and depth. This includes organizing, analyzing, synthesizing, and communicating large amounts of information. Technology can be used effectively in this process" (Siegel, 2004, p.33).

Hinostroza and Mellor (2000) concluded that technology should be used to supplement existing teaching strategies. In a case study designed to investigate teachers' perspectives regarding the use of computers in the classroom, the results support the use of computers as a complement to instruction. Teachers who understand the complex needs of gifted learners should recognize the value of implementing a tool that will enhance their learning. The interactive whiteboard is not intended to replace strong teaching. It is a tool that can augment instruction and increase student achievement. It allows teachers to be more spontaneous in response to inquiry-based learning (Hinostroza and Mellor, 2000). The teacher can instantaneously substantiate information and provide an interactive learning environment. Both students and teachers can manipulate visual images. By touching the screen, colorful diagrams, pictures, charts and symbols can be displayed to reinforce virtually any concept (Solvie, 2004). Retention of information is increased, because students remain focused and involved in their learning and this can translate to higher academic achievement.

Limited research has been conducted on the use of SMART Board technology with gifted students. However, numerous studies have been conducted regarding their use in the regular classroom. Their implementation has been associated with increased academic performance. Since the use of interactive technology specifically supports the instructional methodologies that best suit gifted students, research targeting the use of this technology with this population is warranted. When SMART Board technology is utilized with gifted students, the possibility exists that gains in academic achievement could be more substantial than the gains reported in the regular classroom without this technology.

Beeland (2001) conducted an action research study to determine the impact of the use of SMART Board technology on student engagement. The goal was to determine if the technology led to an improved learning environment. Beeland identified student engagement as a critical component in successful teaching and learning. He hypothesized that the use of an interactive whiteboard as an instructional approach would increase the level of student engagement during instruction. The participants were 10 teachers and 217 students. Student engagement and motivation to learn were measured through the use of a questionnaire and a survey. The data were analyzed to determine if a connection existed between student motivation and the use of the SMART Board to deliver instruction.

The results of the study indicated that the use of interactive technology led to increased student engagement. All three modalities of learning, visual, auditory, and tactile, were positively impacted by the use of the SMART Board. Visual learning was impacted by the use of animated pictures and colorful text. Auditory learning was impacted by incorporating music and sounds during student and staff oral presentations. Tactile learning was impacted by physical interaction with the whiteboard. The degree to which the three modalities were incorporated into the instructional presentation was directly related to the degree of student engagement in the lesson. The findings support the premise that interactive instruction improves student achievement.

Marzano (2009) conducted a study to determine the impact that interactive whiteboards have on student achievement. The participants were from 170 classrooms that were instructed by 85 teachers. The sample was divided into two groups: one group was instructed using interactive technology and the other group was taught without using this technology. Both groups were taught the same information. The results indicated a substantial increase in the scores of the students who were instructed with interactive technology. In general, a 16-percentile point gain in student achievement was noted. Additional findings in this study indicated further growth was exhibited when various peripheral devices were utilized to enhance the whiteboard technology. The use of voting devices, visuals, and reinforcers resulted in a 26 to 31 percentile point gain in student achievement. The additional apparatuses enhanced the technological features and further improved the academic performance of the students.

A study was conducted by Glover and Miller (2001) to determine whether the use of SMART Board technology had an impact on teaching and student achievement. The research was conducted in a United Kingdom middle school with an enrollment of 750 students ranging in age from 11-16 years. Forty-six staff members were part of the study. They responded to a 19-item questionnaire and participated in a formal, structured interview to determine the use of technology in their classrooms and the response from their students regarding the use of interactive technology.

The response from the teachers indicated that the interactive whiteboard enabled instructors to address the learning needs and diverse learning styles of their students. When using interactive technology, instructors were better able to meet individual needs, address sub-group interests, and increase involvement of students during whole-group instruction within a classroom setting. Interactive whiteboard technology converts traditional methods of instruction into engaging, participatory activities that enhance learning. Teachers indicated they were able to address multiple intelligences and alternative learning styles in any one lesson. They perceived that their instructional presentations were improved as a result of the use of this technology. The study also raised staff awareness regarding multiple intelligences and diverse learning preferences that can be addressed more effectively through the use of interactive whiteboard technology.

Fifth-grade elementary students were studied by Amolo and Dees (2007) for the purpose of evaluating the impact of interactive whiteboards on student learning experiences. Twenty-six participants were fifth grade students from a suburban community in central Georgia, nine of whom were identified as gifted. This class was selected because of the teacher's willingness to integrate whiteboard technology into her lessons during the designated timeframe of the research.

During a 4-week period, the students received instruction with a SMART Board in the media center. Technology was used as an impetus to enable interactive engagement during social studies instruction. The SMART Board was used in all facets of the lesson in order to display and manipulate objects on the projected surface. A peripheral device known as an Individual Response System was used to determine student accountability pertaining to participation and understanding of the concepts.

Prior to instruction with the SMART Board, the students were given a pre-test to determine a baseline of student learning without the use of this specific technology. Upon conclusion of the intervention, the students were given a post-test to determine the mean and standard deviation of the responses when compared to the pre-test. Additionally, a post-intervention survey was given to the students to identify their perception of the use of the technology on instruction. Multiple data were collected from field notes, student journals, pre- and post- tests, and interviews to strengthen the reliability and validity of the study. The results indicate that all students demonstrated an increase in learning. The grades for the students based on instruction without the use of technology were compared to the grades after the technology was implemented. The grades indicated an increase in learning when the students were instructed with the interactive whiteboard technology.

The results of this study indicate that interactive whiteboards positively impact student learning. Students pay more attention and are active participants when technology is implemented. The implication for educators is that technology enhances learning. When teachers effectively utilize this educational tool, student progress is impacted positively.

A study was conducted by Lim and Tay (2003) to analyze the impact of Information and Communication Technologies (ICT) on engaging students in higher-order thinking. Their findings are based on a case study of an elementary school in Singapore where different types of technology were used to engage students in critical thinking. The study was conducted from July 3, 2002 to August 22, 2002 in a government school with an enrollment of 1,800 students. The age range of the students was 7 to 12, and the average class size was 36. The staff consisted of 70 teachers and eight support positions. The school had three computer laboratories which were equipped with 21, 21, and 15 computers respectively. Technology was to be utilized by the students to find, frame, and resolve open-ended problems. Classroom observations were used to determine the degree of organization, synthesis, and reasoning skills utilized to support higher order thinking. Students were trained in the use of tool-enhanced problem solving. The training enabled students to further develop their skills in understanding, addressing, and resolving complex, open-ended problems with the use of ICT. The study rejects the notion that ICT can be used effectively in isolation, but it can complement a strongly designed lesson and a skilled teacher.

The qualitative study included the use of observations, focus group discussions, and interviews. The use of classroom observations enabled the researchers to collect data in an authentic setting. An observation checklist was created to ensure consistency of data collection. Fifteen ICT lessons were observed in a variety of subject areas. Eight were observed in the computer lab and seven in the regular classroom.

Forty-five minute interviews were conducted on three occasions with the teachers. This provided insight as to the actions of the teachers and enabled the researchers to reconcile discrepancies in teacher’s perceptions of their actions from the observer’s perception.

Focus Group Discussions were utilized with students instead of individual meetings in order to save time and to encourage students to build upon responses by other group members. The discussions focused on teacher directed learning expectations and their purpose, experience with using ICT for learning, and student perceptions of the activities used during the ICT-based lessons.

The results of the study indicated ICT based lessons improve critical thinking when supported by a strong lesson objective. The impact of ICT based lessons is neutral when used without adequate student training and skillful instructional practices. The type of tool is not nearly as important as the method in which it is used. If used correctly, and based on solid pedagogy, ICT enhances the problem-solving abilities of students.

In 2003 Waxman, Lin, and Michko conducted a study to synthesize research on the effects of teaching and learning with technology on student outcomes. These meta-analyses have substantiated the positive impact the use of technology has on student achievement (Wenglinsky, 1998) and in some cases, influenced change in the methodology implemented by the classroom teacher (Sandholtz, Ringstaff, & Dwyer, 1992). Moderate use of technology changed the classroom environment from whole-group traditional instruction that was provided by the teacher, to independent work with the teacher as a facilitator (Waxman & Hung, 1996). This study quantitatively synthesized experimental and quasi-experimental published research to determine the impact of technology on student learning and teacher practices in relation to student outcomes in authentic settings. The meta-analysis addressed the following questions:

- How extensive is the empirical evidence on the relationship between teaching and learning with technology and student outcomes?
- What is the magnitude and direction of the relationship between teaching and learning with technology and student outcomes?
- Is the relationship affected by social contexts or student characteristics, methodological characteristics, characteristics of the technology, or

characteristics of instructional features? Using ERIC and examining the reference lists or relevant literature reviews, reports, and websites to find applicable research, statistical data from 42 studies with a combined sample of approximately 7,000 students were examined.

The results of this study were based on data synthesized by three researchers who recorded 69 coded characteristics and other data for each of the 282 effect sizes from the 42 studies. An ANOVA was used to determine the impact of the 69 variables on the outcome. Each researcher coded three studies from each of the two researchers, and the inter-coder agreement for each study reviewed exceeded the 85 percent criterion. The results of the quantitative synthesis indicate a modest, positive effect on student achievement cognitive outcomes when technology is used for instruction. The results of this meta-analysis indicated that the use of technology has a substantially greater impact over the findings from other recent meta-analyses conducted (Lou, Abrami, & d'Apollonia, 2001; Blok, Oostdam, Otter, & Overmaat, 2002, as cited in Waxman et al., 2003). This suggests that the use of technology in an educational setting may have a more positive impact on instruction than was previously recognized.

In a review of classroom case studies presented by SMART Technologies Incorporated (2004), it was concluded that interactive whiteboards impact learning in various ways. Their findings indicate that the level of student engagement is increased, along with students' motivation and enthusiasm for learning. In one case study, the positive results included an increase in student attendance. An additional finding indicated that SMART Board technology positively supported students in hearing-and visually-impaired classrooms. The data also indicate that the benefits are not limited to students. Teachers found that the time devoted to lesson preparation was lessened and the increasingly efficient process culminated in creative, informative instructional presentations. Teachers felt better prepared, which translated into a more confident and engaging instructional presentation. They found the visual nature and touch sensitive activation of the whiteboard to be effective for engaging students in participatory lessons. Once engaged, students remained attentive for longer periods than they did prior to the use of the SMART Board.

Review of the Literature Summary

This review has highlighted the need for resources to enrich and challenge the curriculum for gifted students. Funding is not readily available for or directed toward the high ability learner. At-risk students are the recipients of substantial financial backing, whereas gifted students receive minimal financial support. This is an indication that the needs of high achievers seem less important than the needs of lower-achieving students. This view is prevalent in school systems throughout the nation. The results are far-reaching. Opportunities for students, who are most able to excel in fields that will allow the U.S. to prosper, are not readily available. Research is scarce or limited, at best. These students are not rigorously challenged and, consequently, are at-risk of falling behind their peers from other countries. If U.S. students lag behind, specifically in mathematics and science, our nation is at-risk of losing the edge in global competition.

Gifted students must be afforded every opportunity to maximize their full potential. To ensure academic success, teachers of gifted students must be trained to utilize innovative methods to meet the learning needs of this group. Howland and Wedman (2004) found that when teachers were provided professional development in the use of instructional technology, their implementation of the tools nearly doubled. Teacher-centered instruction was greatly reduced, whereas student-centered, interactive instruction increased. Training is a critical component if technology is to become the norm in today's classroom. Shaunessy (2007) supported this finding in a study designed to analyze the impact of teacher attitude toward the use of informational technology in the gifted classroom. The results indicated a strong correlation between teacher training and teacher attitude. Teachers who felt ill-prepared to use technology during instruction expressed negative attitudes toward implementing unfamiliar tools.

Studies show that gifted students, who are not exposed to a challenging educational experience, often regress in their ability to think critically and analytically (Renzulli, 2005). Allowing this to occur is in direct opposition to the current legislation of NCLB. This legislation mandates an equally valuable, quality education for all students. To accomplish this ruling, the needs of gifted students must be addressed with the same urgency that is afforded at-risk students. The results of a study by Nikolova and Taylor (2003) confirm that when gifted students are challenged they exhibit gains in their academic performance. When given opportunities to problem-solve and think critically, their educational experiences are enriched. Gifted students who are permitted latitude in topic selection and in their learning environment showed academic improvement.

Sandergeld, Schultz, and Glover (2007) found that, characteristically, gifted students are creative, analytical, and competitive. They enjoy learning, especially when it is challenging and requires critical thinking. Teachers who provide gifted students with demanding, rigorous instruction, and affirm their potential for success, see an increase in achievement. A study conducted by McCoach and Siegel (2003) confirmed a distinct relationship between academic self-concept and academic achievement. Gifted students whose teachers reassured them of their academic potential readily participated and persevered in arduous assignments.

Rayneri, et al. (2006) studied the impact of learning styles and classroom environment on the academic performance of gifted students. The results indicated a significant correlation between the achievement level of gifted students and their perception of the classroom environment. Gifted students, who believed the classroom environment to be compatible with their learning style, performed at a higher level than gifted students who did not connect with the environment. The study emphasized the importance of early identification of the special needs of gifted learners. By recognizing and addressing that gifted learners can rapidly process information, require complex problems to stretch their ability to think critically, are stimulated by in-depth study, and thrive in a creative environment, teachers can effectively plan lessons that meet these unique processing skills. Teachers must recognize these needs and address them before the classroom becomes a tedious, uninspiring experience. Rayneri et al. (2006) indicated that crucial learning patterns are developed early. Elementary school teachers bear the responsibility of providing a classroom environment that supports gifted students in meeting their full potential.

The results of a study by McCoach & Reis (2000) substantiate that classroom environment can impact the performance of gifted students. They confirm the importance of motivating gifted students before they lose interest in an unchallenging classroom experience. They found that gifted students presented with work below their ability level often become disengaged and fail to complete their assignments. Gifted students who perceived the environment as student-centered, fast-paced, inquiry-based, and self-regulatory fulfilled their academic potential. An accelerated curriculum is needed to stimulate the gifted student. In a study to determine effective methods of motivating gifted learners, Lee and Olszewski-Kubilius (2006) found that when gifted students were presented with creative methods of delivery in an exciting classroom environment, significant gains were noted in their academic achievement.

When used effectively, technology can enhance instructional presentations. Specifically, with SMART Board technology, information can be retrieved instantaneously, presented creatively, and stimulate interactive engagement. The applications support the needs of gifted learners. Gifted students who have access to technology out-perform students who do not have access to technological tools. Dixon et al. (2005) conducted a study to determine the impact that technology has on the manual tasks of gifted students. The results indicated that when the time frame for manual tasks was decreased, the time for analysis and problem solving was increased. When gifted students used technology to streamline manual tasks, and focused their additional time on problem solving, their academic performance improved. Technological tools, such as calculators, computers, document cameras, and SMART Boards, enable high achievers to expedite manual tasks. This increases the time allotted for students to focus on strategies and solutions for problems. Instructional methods that promote, complement, and cultivate this style of learning address the specific needs of gifted learners.

The results of a study by Lim and Tay (2003) support the use of technology as an effective instructional tool, but emphasizes that devices alone cannot make a difference. Skilled teachers who are competent in designing quality lessons with strong measurable objectives must facilitate the learning process. Although innovative and engaging, the use of technology in the classroom must be supported by educators who adeptly identify the specific needs of their students. Teachers should design lessons with differentiated activities that target diverse abilities, and use technology to complement their instruction.

Beeland (2001) conducted a study to determine the impact of SMART Board technology on student engagement. He surmised that for learning to occur, students had to be engaged in the process. The results of the study indicated that the use of the SMART Board increased engagement, which positively impacted visual, auditory, and tactile learning. These findings support the premise that technology led to an improved learning environment.

In a study conducted by Marzano (2009), students who were instructed using SMART Board technology showed a substantial increase in their scores over students who received the same instruction without the use of interactive technology. Adding various peripheral devices such as the interactive technology further increased the performance of students instructed with SMART Board technology.

To determine whether the use of SMART Board technology had an impact on teaching and student achievement, a study was conducted by Glover and Miller (2001). Data from teachers and students were compiled to determine their use of interactive technology. Student participation increased when the lessons incorporated “modern” devices. They responded positively to a new mode of instruction instead of a traditional-based approach. Students’ familiarity with technology enabled them to quickly become active participants in the lesson. Increased engagement and participation positively impacted student achievement. Also, teachers believed the implementation enabled them to meet the diverse learning styles and needs of their students. They felt equipped to address multiple intelligences and learning styles within a single lesson.

As the above review indicates, there is an abundance of research that supports the use of technology as an instructional tool. However, research is limited regarding the impact that SMART Board technology has on the learning process of high-ability students. Currently, many gifted students are subjected to a standardized curriculum that does not challenge them to meet their full potential. Few resources target the needs of high ability learners. Accepting the premise that gifted students require rigorous, engaging, self-paced, highly participatory lessons to stimulate their learning, this study investigated the impact of the interactive SMART Board on the academic growth in mathematics of gifted fourth grade students. The research was warranted in order to identify additional strategies that target the needs of this special population. As educators strive to create optimum learning conditions, where students are given opportunities to reach their full potential, gifted students must not be excluded from the process. Research was conducted to determine strategies that further engage and develop the potential of gifted students.

CHAPTER THREE: METHODOLOGY

Introduction

The focus of this study was to examine the use of SMART Board technology as an instructional tool to determine its impact on the academic achievement of gifted students. Identified gifted students were studied to determine if the SMART Board impacts their growth at a significantly higher rate than gifted students who are instructed without the technology. The purpose of this study was to determine whether SMART Board technology is an effective tool in promoting increased academic achievement for gifted students. This chapter will explicate the methods, research perspective, subjects, and procedures for data collection and data analysis.

Research Design

A quantitative approach was the primary research method used in this study. Waetjen (1992) in his call for good research in technology education, states that "the plea is to use experimental type research as much as possible" (p.30 as cited in Hoepfl, 1997). Quantitative research was used to generate numeric data to determine if greater growth in gifted students' mathematics scores occurred with the use of interactive whiteboard technology. Quantitative research is limited, at best, on the effects that interactive technology has in the educational setting, therefore; using a primarily quantifiable method to measure growth calculations was warranted. Using a statistical method, the researcher was able to ascertain if there was significant difference between the growth scores of the two samples by testing theoretical assumptions to gain empirical data.

In this study the independent variable was the use of SMART Board technology, or lack thereof, during mathematics instruction of fourth grade gifted students. The dependent variable was the change or growth scores in mathematics of the participants. The design incorporated the use of pre-test and post-test scores. The pre-test score was the third grade EOG mathematics score and the post-test score was the fourth grade EOG mathematics score. Utilizing a formula devised by the state, a numerical result was calculated to determine the degree of growth for each student.

The study was quasi-experimental due to the specific qualifications required of the participants. Students who were assessed and deemed gifted, according to state standards for gifted certification, were included in the sample. Therefore, the sample was non-randomized.

The researcher also minimized the potential effect of school of attendance by including only schools that were located in the same geographic vicinity of the city with similar socio-economic status, ethnicity, parental support, comparable teaching experience among teachers, and identical training of teachers from SMART Technologies Inc.

This research objectively sought to determine if SMART Board technology had an effect on the mathematics achievement of the subjects in the study. The impetus behind this research was to determine if technology is an effective tool for meeting the unique learning styles of the gifted learner. Often gifted students are not challenged in the general education classroom. Educators must seek instructional strategies that stimulate, motivate, engage, and challenge the gifted mind (Prensky, 2003). Failure to pursue this quest can be a disservice to highly capable students who possess the greatest potential for academic achievement.

The reliability of this quantitative study is validated by the use of the North Carolina standardized EOG assessment. The high reliability coefficients extend across a variety of variables (Bazemore, Kramer, Gallagher, Engelhart, & Brown, 2008). The growth factor for every test result is calculated with a formula that was developed by the state. To eliminate bias, all state standardized test scores are analyzed by the North Carolina Department of Accountability in Raleigh instead of at the local level. The identity of the students is not revealed during the calculation of the growth score. Upon receipt of the raw scores from the mathematics assessment of gifted students in the fourth grade at the participating schools, the results were analyzed using the SAS System. The scores for students who received mathematics instruction with the use of SMART Board technology were compared to the scores of the students who did not receive instruction using the technology.

To minimize the variables associated with different school environments, the schools that were selected for this study were chosen on the basis of comparable student populations. The schools are located in close proximity and their resources, enrollment, and socio-economic status have little variance. By minimizing these variables, the sample was limited to six schools.

Procedures

One-hundred seven students received mathematics instruction according to the North Carolina Standard Course of Study through the use of SMART Board instruction, whereas 66 students did not receive mathematics instruction using SMART Board technology. Mathematics instruction for both samples commenced Tuesday, August 25, 2009 and ended Friday, May 10, 2010. In addition, building principals verified that the designated teachers were effectively utilizing the SMART Board and were following the

Standard Course of Study for fourth grade mathematics. The EOG mathematics assessment took place on Tuesday, May 11, 2010 and Wednesday, May 12, 2010.

The EOG assessment measures performance in relation to the state Standard Course of Study. The comparison of the test scores measures how much growth occurred between the end of the third grade and the end of the fourth grade in relation to specific goals and objectives. The EOG is administered to all students on the same dates and in the same form. The mathematics test is timed.

The state establishes academic achievement guidelines for all students and sets the achievement standards and achievement scales based on the Department of Public Instruction's recommendations. The mathematics test allows for four achievement levels.

I Insufficient mastery

II Inconsistent mastery

III Consistent demonstrated mastery

IV Consistent superior performance

EOG scores are used in computing state-mandated composites for the ABC Accountability Program and AYP under Title 1 of NCLB.

The EOG test results are reported as follows:

1) The Raw Score is the number of questions answered correctly.
2) The Raw Score is converted to a Scale Score**.** The Scale Score depicts growth in achievement from the score of the previous year, as described earlier. The Scale Score also compares the individual EOG score to the average scores for the particular school, the school system, and the state.
3) Achievement Level is the pre-determined performance standard set by North Carolina.

4) Percentile Rank ranks an individual's performance in comparison to all North Carolina students who took the test in the same year.
5) Gateways are a simple yes or no as to whether the student has met the minimum expectations for the third and fifth grade levels in order to be promoted to the fourth and sixth grades, respectively.
6) Subscale Performance reflects goals and units mastered in the mathematics exam by calculator-active questions and calculator-inactive portions of the exam.

Individual Student Reports are supplied through numbers and through graphs. Included in the report is the Standard Error of Measurement (SEM)**.** The SEM indicates how much an individual score is expected to vary if the individual is tested repeatedly with the same exam without additional instruction. The reporting system of the state removes any researcher bias and strictly quantifies student performance from the third grade test to the fourth grade test.

The results of the EOG mathematics test were tabulated by the North Carolina Accountability Division of the Department of Education. The results compared each participant's third grade EOG mathematics score to their fourth grade EOG mathematics score. The results were collected and analyzed to determine if greater student growth occurred with the use of SMART Board technology, and if the technology resulted in a difference between the two groups of students.

Setting

There are 167 schools in this school system with an enrollment of 132,281 students. The racial percentages within the system are African-American, 42%, White 35%, Hispanic 15%, Asian 4%, and multi-racial 4%. Approximately 47.2% of the students participate in the Free and Reduced Lunch Program. At the end of each year, schools are rated based on their results from the End-of-Grade (EOG) or End-of-Course (EOC) composite score.

- A composite score of 90 to 100% and achieving Adequate Yearly Progress (AYP) designates a school as “An Honor School of Excellence.”
- A composite score of 90 to 100% without achieving AYP designates a school as “A School of Excellence.”
- A composite score of 80 to 90% designates a school as “A School of Distinction.”
- A composite score of 70 to 80% designates a school as “A School of Progress.”
- A composite score of 60 to 70% designates a school as “No Recognition.”
- A composite score of 50 to 60% designates a school as “A Priority School.”
- A composite score below 50% designates a school as “Low Performing.”

The six elementary schools participating in this study are located within a seven mile radius. Their demographics are similar to each other with a racial breakdown of approximately 70% white, 14.5% Asian, 7% African-American, 4% Hispanic, and 2.5% multi-racial. Approximately 5% of the students are enrolled in the free and reduced lunch program. Although the area within the boundaries of the schools is expanding in population, the existing population is extremely stable. Not being a transient population, the overwhelming majority of subjects will be participants from the beginning to the final stages of the study.

Participants

One-hundred-seventy-three fourth grade elementary school students were involved in the study. Eighty-nine of the participants are female (51%) and 84 are male (49%); therefore, the gender distribution in the study sample is relatively balanced. The racial statistics for the group were 80% white, 13% Asian, 4% multi-racial, 2% Hispanic, and 1% African American. The sample was obtained from six public elementary schools that have similar populations. The schools are located in an affluent suburb of a major metropolis and are part of the second largest school system in North Carolina.

All subjects in the study had been previously identified as gifted by the school system using a system-wide evaluation process conducted for high performing students during their second grade year. Every Talent Development (TD) teacher in the school system participates in the evaluation process. Teams of TD teachers are sent annually to conduct standardized tests on students who have been recommended for the process. The selection of qualified students is based on multiple factors that include academic achievement, teacher recommendation, and a battery of standardized tests. Students who enter the school system after second grade are eligible for testing during an annual evaluation process that takes place during the second semester of subsequent years. The evaluation is conducted by the TD teacher who is assigned to the school that the student attends. Students may also be identified as gifted through private testing if the methods and standardized tests are equivalent to state and local standards.

During this research the identity of the student participants was not revealed. Data were classified and sorted by certification status, rather than individual identity. The nature of the study was not revealed to the student participants or the teachers. The basis for school selection for the study was determined by their geographic, economic, ethnic, and cultural similarities. By choosing schools with similar demographic characteristics, the homogeneity of the sample was increased and the number of variables was reduced in the study. The classes from which the students were selected ranged in size from 24 to 29 students. The teachers' experience ranged from 2 to 18 years. Teachers utilizing SMART Board instruction had previous experience with the interactive SMART Board and had participated in the school system's and technology provider training. The six schools in the study are identified as School A, School B, School C, School D, School E, and School F.

School A has an enrollment of 680 students in grades K-5. There are 40 classroom teachers and 24 support staff. Student demographics are 11.0% African American, 14.4% Asian, 6.3% Hispanic, 61.8% white, and 6.5% other. The number of students who qualify for free and reduced lunch is 11.8%. The staff deemed "Highly Qualified" is 100 percent with 10 teachers earning National Board Certification and 32% completing advanced degrees. The average number of students who attend school daily is 97%. One hundred twenty-two students are enrolled in fourth grade and 17 students from this grade level are gifted. The average fourth grade class size is 24. The number of students per instructional computer is 4.71. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 90.2%. Sixty-three percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 13 out of 13 sub-group goals. School A is designated as an "Honor School of Excellence."

School B has an enrollment of 806 students in grades K-5. There are 44 classroom teachers and 30 support staff. Student demographics are 8.8% African American, 16.6% Asian, 6.3% Hispanic, 64.1% white, and 5.1% other. The number of students who qualify for free and reduced lunch is 8.2%. The staff deemed "Highly Qualified" is 100 percent with eight teachers earning National Board Certification and 46% completing advanced degrees. The average number of students who attend school daily is 97%. One hundred thirty-four students are enrolled in fourth grade and 29 students from this grade level are gifted. The average 4^{th} grade class size is 27. The number of students per instructional computer is 5.01. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 94.4%. Sixty-six percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 13 out of 13 sub-group goals. School B is designated as an "Honor School of Excellence."

School C has an enrollment of 711 students in grades K-5. There are 41 classroom teachers and 29 support staff. Student demographics are 12.0% African American, 10.1% Asian, 12.4% Hispanic, 58.5% white, and 7.0% other. The number of students who qualify for free and reduced lunch is 19.5%. The staff deemed "Highly Qualified" is 99% with 11 teachers earning National Board Certification and 39% completing advanced degrees. The average number of students who attend school daily is 96%. One hundred three students are enrolled in fourth grade and 19 students from this grade level are gifted. The average fourth grade class size is 22. The number of students per instructional computer is 2.96. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 87.3%. Sixty-four percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 17 out of 17 sub-group goals. School C is designated as a "School of Distinction."

School D has an enrollment of 545 students in grades K-5. There are 37 classroom teachers and 31 support staff. Student demographics are 7.2% African American, 9.4% Asian, 5.3% Hispanic, 72.7% white, and 5.5% other. The number of students who qualify for free and reduced lunch is 11.0%. The staff deemed "Highly Qualified" is 100 percent with eight teachers earning National Board Certification and 32% completing advanced degrees. The average number of students who attend school daily is 97%. Eight-four students are enrolled in fourth grade and 20 students from this grade level are gifted. The average fourth grade class size is 26. The number of students per instructional computer is 2.22. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 89.8%. Fifty-eight percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 13 out of 13 sub-group goals. School D is designated as a "School of Distinction."

School E has an enrollment of 869 students in grades K-5. There are 47 classroom teachers and 33 support staff. Student demographics are 4.0% African American, 8.1% Asian, 3.0% Hispanic, 82.5% white, and 2.4% other. The number of students who qualify for free and reduced lunch is 1.8%. The staff deemed "Highly Qualified" is 100 percent with 12 teachers earning National Board Certification and 28% completing advanced degrees. The average number of students who attend school daily is 97%. One hundred forty students are enrolled in fourth grade and 59 students from this grade level are gifted. The average fourth grade class size is 24. The number of students per instructional computer is 3.93. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 99.4%. Seventy-two percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 9 out of 9 sub-group goals. School E is designated as an "Honor School of Excellence."

School F has an enrollment of 785 students in grades K-5. There are 43 classroom teachers and 28 support staff. Student demographics are 7.0% African American, 15.2% Asian, 3.8% Hispanic, 70.7% white, and 3.3% other. The number of students who qualify for free and reduced lunch is 6.8%. The staff deemed "Highly

Qualified" is 100 percent with three teachers earning National Board Certification and 35% completing advanced degrees. The average number of students who attend school daily is 97%. One hundred sixty-three students are enrolled in fourth grade and 35 students from this grade level are gifted. The average fourth grade class size is 25. The number of students per instructional computer is 5.51. The composite testing score for 2008-2009, which indicates the number of students who performed at or above grade level, is 93.7%. Seventy-one percent of the students achieved High Growth. This school met the Federal NCLB criterion for AYP by attaining 13 out of 13 sub-group goals. School F is designated as an "Honor School of Excellence."

Instrument

The instrument used to evaluate the fourth grade students is the North Carolina End-of-Grade mathematics test for grade 3 as compared to the End-of-Grade mathematics test for grade 4. This test is mandated by the state and used to measure student progress. It is a tool that is used to assess individual development of skills and specific school effectiveness. Although the test was developed in 1995 and has been used since the 1996-1997 school year, it is considered a reliable accountability measure that is compatible with the accountability measures of the 2001 legislation of NCLB. From 1995 to the present, the test has undergone many revisions. It is the cornerstone of the State Accountability Division of the Department of Education. The test is designed to measure the knowledge acquired to meet the specific goals and objectives of the Standard Course of Study, most recently re-adopted in 2003. As the state's first school-level accountability system, it is the primary tool used to evaluate the effectiveness of school improvement strategies. In 2006, considerable modifications were made with the implementation of new growth formulas that measure change in student performance between consecutive years. Individual students are expected to maintain or improve their performance in relation to their achievement from the previous year. Although the percentage of students passing the test make up each school's performance composite, it is the growth score that determines if staff members receive monetary stipends.

In order to determine if there was a significant increase between the pre-test scores and the post-test scores, the raw scores were analyzed. The mean scores will indicate if a significant difference is evident.

During the 2009-2010 school year, students who scored a Level II were required to take a retest. The higher score was used in the calculations of Adequate Yearly Progress and school performance composites. Unlike the initial test which is administered on a specified date, retests can be given at any time during a 5 day period. To ensure reliability, only original scores were used in this study.

The EOG mathematics test consists of 82 multiple-choice questions. The five key areas of assessment are Number and Operations, Measurement, Geometry, Data Analysis and Probability, and Algebra. The test is administered in two parts: Calculator Active (54 questions) and Calculator Inactive (28 questions). The test is timed. No rulers or protractors are permitted. Graph paper and calculators are provided by the school system. The calculators have at least four functions and memory.

Students receive scale scores, percentile scores, and achievement level results. The scores are reported on a developmental scale, which allows for the measurement of growth in achievement. A student's developmental scale score is converted to a *c-scale* or change scale score. The current accountability model in North Carolina defines growth, operationally, as academic change. Academic change is expressed as the difference between a student's *c-scale* score for the current year and the average of a student's scores on two previous EOG tests. For students with only one previous year's EOG test results available, as is the case with fourth grade students, academic change is based on one previous EOG assessment. Factored into the change formula is an adjustment for regression to the mean. That is, a student who performs above or below the mean score on one EOG assessment is likely to score closer to the mean on an ensuing assessment. On the *c-scale*, if a student performs equally well in two successive years, the academic change would be "0" on the *c-scale*. Otherwise, a positive academic change indicates a gain or growth in academic achievement, whereas a negative academic change indicates a loss or lack of growth in academic achievement from the previous year. The formula for determining academic change, whereby only one previous year's EOG score is available, is as follows: $AC = CS_{c\text{-}scale} - (0.82 x PA_{c\text{-}scale})$, AC = academic change, CS = current score, and PA = previous assessment score (North Carolina Department of Public Instruction, 2009).

Reliability and Validity of the State's 4th grade EOG Mathematics Test

The reliability and validity of the state's fourth grade EOG Mathematics test is well established, as described extensively in (Bazemore et al., 2008), The internal consistency reliability of the state mathematics test for grade 4 is an average coefficient alpha of 0.915. The range of coefficients alpha is 0.911 to 0.919. The coefficient alpha is the metric generally used to establish reliability for the state's EOG Test of Mathematics. Of note is the fact that these high reliability coefficients extend across gender, ethnicity, limited English proficiency status, migrant status, Title I status, and disability.

The validity of the state's EOG Test of mathematics is evidenced by relatively strong content, instructional, criterion related, concurrent, and predictive forms of validity. The content assessed by the test is categorized by the five construct areas noted previously. Each test item measures one of those five constructs. Almost all of the items are developed by teachers and other educators in the state. Several of the items are written by a reputable testing company contracted by the state. All item writers attend a day-long training where they are presented with certain guidelines for item construction. Included in this training is information relevant to special populations such as students with disabilities and English language learners. All created items are reviewed by at least two content-area teachers from North Carolina. These teachers deliver the Standard Course of Study, and they are the most familiar with the manner in which students learn and comprehend the material. Items are also reviewed by a specialist in Exceptional Children and a specialist in English as a Second Language.

Instructional validity involves administering questionnaires to teachers to evaluate, in general, the appropriateness of the mathematics test items for 4th graders. Teachers are asked to use a five-point scale to evaluate items, with the highest score being “to a superior degree,” and the lowest score being “not at all.” In recent administrations, teachers rated the appropriateness of questions generally to a superior or high degree.

Criterion-related validity for the 4th grade EOG Test of mathematics, using teacher judgment of: a) achievement level by assigned achievement level, b) achievement level by expected grade, c) achievement level by mathematics scale score, d) achievement level by expected grade, and e) expected grade by mathematics scale score, yielded moderate to strong correlation coefficients ranging from .58 to .77.

Concurrent validity has been shown by positive correlations between students’ progress on the National Assessment of Education Progress (NAPE) Test, which is administered in grades 4 and 8, and students' progress on EOG scores. Trends show corresponding increases in both NAEP mathematics scores and scores on the state's EOG Test of mathematics in previous editions.

The predictive validity of the state's EOG Test of mathematics has been shown by the high correlation (i.e., .82) between EOG mathematics scores for grade 8 and mathematics Scholastic Aptitude Test (SAT) scores.

Analysis of Data

The data for this quasi-experimental study was organized into tables and charts. The data for the control group and the experimental group were presented in both formats. The assessment data were de-identified and analyzed using the SAS 9.2 program (SAS Institute, Inc., Cary, NC). Standard statistical methods, as described by Glass and Hopkins (2008), were applied to the analyses performed. Upon collection, the numerical data were analyzed according to the research questions stated in the introductory chapter. The raw scores were analyzed by the researcher to determine if a significant increase was yielded in the post-test scores from the pre-test scores.

An analysis of covariance (ANCOVA) was conducted using SAS 9.2 to determine if there was a significant difference in the scores of the gifted students in the experimental group when compared to the scores of the gifted students in the control group. The results from the ANCOVA controlled for the differences in student ability coming into the class, thus making it possible to formulate an appropriate comparison of the pre-test scores to the post-test scores. The results were utilized to answer the first research question that was stated previously in Chapter One. A paired-samples t-test was used to calculate the raw pre-test score in comparison to the raw post-test score to determine if there was a significant difference in the math achievement of the gifted students in the study. The independent variable of the use of SMART Board technology during mathematics instruction was not a factor in this calculation. The results were utilized to answer the second research question that was stated previously in Chapter One.

In order to confirm the first hypothesis the experimental group needed to perform significantly higher on the post-test scores than the control group. This would indicate that the independent variable, specifically the use of SMART Board technology during mathematics instruction, was the cause of the increase in the post-test scores on the EOG mathematics assessment for the fourth grade students. The results of this study are presented in the following chapter.

CHAPTER FOUR: RESULTS

As stated in Chapter 1, this research was conducted to discern if SMART Board technology, when used during mathematics instruction of fourth grade gifted students, would result in greater growth scores than the scores of gifted students who did not receive this type of instruction. The findings from this study are reported in this chapter and address two specific research questions as presented in Chapter One. The numerical data collected from this quasi-experimental, quantitative study were analyzed to determine if the use of SMART Board technology significantly increased the growth in mathematics performance of fourth grade gifted students. The results of the pre-test and post-test scores of the participants were examined to see if there was a difference in the academic achievement between the two groups.

Research Questions

1. Does the receipt of mathematics instruction with the use of SMART Board technology increase gifted students' growth on the EOG mathematics test at a rate higher than that of gifted students who are instructed without this technology?
2. Does the post-test EOG mathematics score of the gifted students in the study show a significant increase over the pre-test scores?

Hypotheses

H_1: The use of SMART Board technology during mathematics instruction will result in significantly higher growth in the mathematics achievement of fourth grade gifted students in the experimental group than the growth in mathematics achievement of fourth grade gifted students in the control group as indicated by the EOG mathematics assessment.

H_2: The post-test scores of the gifted students in the study will yield a significant increase in the mathematics achievement as measured by the difference between the pre-test and the post-test scores on the EOG standardized mathematics assessment.

This study utilized a non-randomized control group, pre-test post-test design. This design was selected because the participants were chosen due to their gifted certification; therefore random selection was not possible. The design did not allow for random assignment of the subjects to the control and experimental groups. The groups were determined based on the availability of SMART Boards at three of the six schools in the study and its utilization as an instructional tool during fourth grade mathematics instruction. The fourth grade students who participated in the experimental group attended schools B, D, and E. The fourth grade students in the control group attended schools A, C, and F. The sample consisted of 173 students comprised of 89 females and 84 males. The control and experimental groups were similar in their statistical make-up due to the purposeful selection of schools with comparable enrollment, ethnicity, socio-economic status, geographical location, parental support, resources, and previous EOG performance composites.

The teachers of the experimental and control groups utilized the "Math Investigations" mathematics curriculum for instruction during this study. The school system adopted the curriculum for the 2009-2010 school year, thus the study was conducted during the initial year of implementation. The teachers attended 40 hours of training provided by central office math facilitators whom are employed within the school system. To ensure the uniform pacing of instruction, specific guides were distributed for the teachers to follow. The teachers were required to submit weekly lesson plans that were monitored by the building principals to verify the appropriate concepts were being addressed by all schools in the study at the same time. This increased the uniformity and accountability regarding the time frame devoted to the various concepts of the curriculum. The principals conducted random observations using the state adopted Teacher Performance Appraisal Instrument – Revised (TPAI-R) to monitor instruction. The teachers in the experimental group utilized SMART Board technology during mathematics instruction. The teachers in the control group did not utilize SMART Boards during mathematics instruction.

The Data

Table 4.1

Between Subjects Factors

Group	N
Control	66
Experimental	107

This table provides the number of participants in the control group that did not receive instruction with SMART Board technology and the number of participants in the experimental group that received instruction with the use of SMART Board technology.

Table 4.2

Descriptive Statistics – Pre-Test

Group	Mean	Standard Deviation	N
Control	360.0455	5.021283	66
Experimental	359.1776	4.567756	107
Total	359.6115	4.794519	173

This table provides the mean score and the standard deviation of the pre-test for the participants in the control and experimental groups.

Table 4.3

Descriptive Statistics – Dependent Variable: Post-Test

Group	Mean	Standard Deviation	N
Control	366.0303	5.021283	66
Experimental	366.0280	4.040965	107
Total	366.02915	4.391736	173

This table provides the mean score and the standard deviation of the post-test for the participants in the control and experimental groups.

Table 4.4

Descriptive Statistics – Pre-Test and Post-Test

Group	N	Raw Score Range	Percent with Growth
Control	66	-7 to + 14	95.45
Experimental	107	-2 to + 11	94.39

This table displays data on the raw score range and the percentage of participants who exhibited growth in mathematics achievement.

Figure 4.1

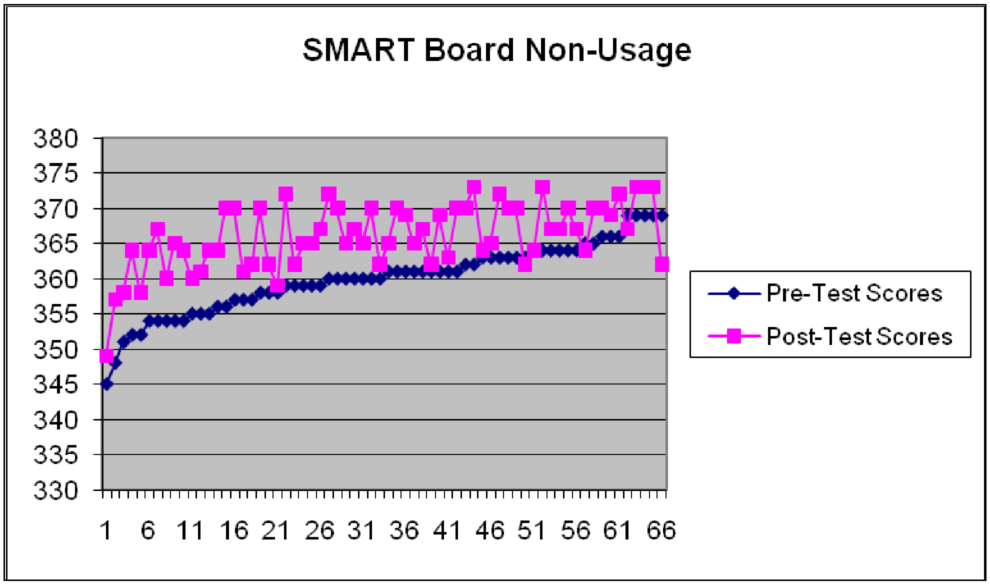

Figure 4.1 shows the difference between the pre-test and post-test scores of the students in the control group.

Figure 4.2

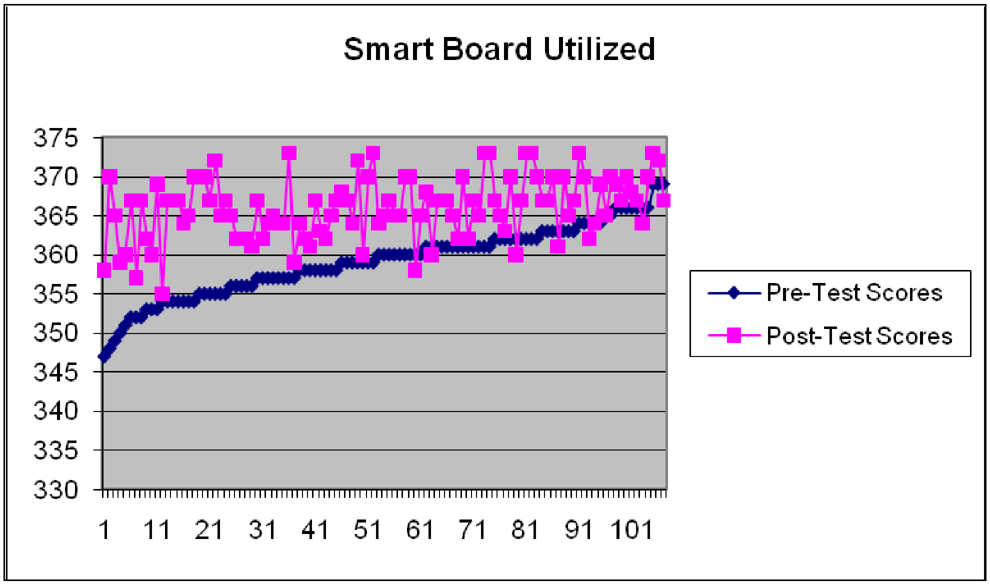

Figure 4.2 shows the difference between the pre-test and post-test scores of the students in the experimental group.

Table 4.5

ANCOVA - Pre-Test Impact on Post-Test

SMART Board Impact on Post-Test

Source	Type III SS	df	Mean Square	F Value	Sig.
Score	749.1208850	1	749.1208850	52.11	< .0001
SMART	5.8645021	1	5.8645021	.41	0.5239

The results indicated that the pre-test score significantly impacted the post score, but the use of the SMART Board did not show a significant difference on the post-score. By using the results of the ANCOVA, it was possible to utilize the scores on the pre-test to equate differences in ability of the control group and the experimental group to allow for an appropriate comparison of the post-test scores.

Table 4.6

Paired-Samples t-Test

Group	n	M	SD	t-value	p
Control	66	-5.9848	4.0894	-11.89	<.0001
Experimental	107	-6.8505	4.9140	-14.42	<.0001

The results of the t-test show a significant difference in the fourth grade EOG post-test scores from the third grade EOG pre-test scores. This result supports the second hypothesis that gifted students will increase their performance on EOG standardized mathematics assessments.

Summary

The purpose of this study was to determine if the use of Smart Board technology increased gifted student's growth on the EOG test over those gifted students who do not have access to that particular technology, and to learn if gifted students increase their scores in the post-test mathematics versus the pre-test of mathematics in EOG testing.

In response to the first research question it was determined that the use of Smart Board technology does not provide a significant increase in the performance of gifted students over the gifted students in the study who do not have access to the same technology. The result from the ANCOVA made possible the use of the pre-test and post-test scores to equate differences in the ability of the control group and the experimental group, thus allowing for an appropriate comparison of the post-test scores. The data revealed no significant difference in the post-test score, thus rejecting the primary hypothesis that the use of SMART Board technology during mathematics instruction would have a significant impact on the fourth grade EOG mathematics assessment.

In addressing the second research question a paired-samples t-test was conducted to determine if significant growth is evident in the post-test scores when compared to the pre-test scores. The results indicated that the fourth grade gifted students in the study do show a significant increase in their performance in post-test EOG mathematics testing

In summary, the gifted children in this study increased their performance in mathematics as indicated by the comparison of scores from EOG testing in third grade compared to fourth grade results. The use of a Smart Board during mathematics instruction did not produce a significant difference in the EOG scores of the participants. The analysis of the data confirmed that although a significant increase between the EOG pre-test scores and EOG post-test scores was evident, it was not due to the use of SMART board technology during mathematics instruction.

CHAPTER FIVE: DISCUSSION AND SUMMARY

This final chapter restates the research problem and reviews the methodology used to investigate possible solutions to the topic. This chapter will review the methods of research, summarize the results, state the relationships to previous research, note the limitations of this study, make implications for use, and formulate suggestions for further research.

The Problem

The purpose of this research was two-fold: 1) to determine if the use of SMART Board technology during mathematics instruction would increase fourth grade gifted students' mathematics scores to a significantly greater extent than that of gifted students who received instruction without this technology, and 2) to determine if there was a significant difference in the pre-test scores and the post-test scores of the fourth grade gifted students. The impetus for conducting this study was the premise that gifted students are not challenged to meet their full potential in current, traditional classrooms. New methodologies and/or tools should be investigated to determine their potential for stimulating the cognitive abilities of gifted learners.

Methodology

As stated in Chapter Three, the method used to research this problem was a pre-test and a post-test in a specific mathematics course of study. All fourth grade gifted students were given a third grade standardized exam (pre-test) to measure their mathematics skills. This exam was used as the baseline of mathematics knowledge for students entering the fourth grade. The independent variable used in this study was the use of SMART Board technology during mathematics instruction for selected students. The test results from third grade were compared to the students' fourth grade achievement test to determine if the SMART Board positively impacted their scores. As a quasi-experimental study, the utilization of standardized testing was critical. The initial EOG test established the baseline of knowledge for each student. The fourth grade EOG test determined the degree of learning for each student as established by state requirements. This was a measure of growth in mathematics concepts and computation skills acquired over a period of one year. All students received the same EOG third grade and EOG fourth grade standardized tests. The researcher attempted to minimize variables within the study by selecting participants who shared comparable socio-economic status. The students in the study were from six elementary schools within a seven mile radius. The schools have similar resources, enrollment, parental support, and ethnic background.

The quantitative approach to this research was chosen primarily due to the extensive data supplied by the North Carolina Department of Education, Department of Accountability. Exams are standardized, identities of students are unknown, and types of instruction are not taken into account by the formulas used statewide to calculate individual student progress. Results of student performance are reported in relation to the North Carolina Standard Course of Study. These results are specific numerical measurements on a standardized scale of achievement as designated by the Department of Public Instruction. The quantitative results are reported as follows:

1. Raw Score
2. Scale Score in relation to previous end of grade exam and to peers within the individual school, the school system, and the state of North Carolina

3. Achievement Level I-IV as designated by the state
4. Percentile Rank in comparison to all North Carolina grade level test participants
5. Acceptable notice for promotion to the next grade
6. Subscale information on mastery of calculator active questions versus calculator non-active questions.

Quantitative information used in this research is extensive, unbiased, repeatable, and within an acceptable standard error of measurement. The quantitative results used in this research are the accepted methods of computing outcomes for all state mandated ABC Accountability Programs and AYP under Title 1 of NCLB.

There was no researcher bias in the study. Student and teacher participants were unaware of the research. EOG tests in the third grade and the fourth grade are strictly regulated by the state of North Carolina. Administrators and teachers do not have access to the data. This eliminates their ability to influence the reports of the North Carolina Department of Accountability.

Relationship to Previous Research and Theory

This study drew upon previous research in two areas. The initial problem was to further examine how best to meet the needs of gifted students in an instructional setting. The specific approach to this investigation was to measure the effectiveness of SMART Board technology in increasing the academic performance of gifted students in fourth grade mathematics.

In the age of NCLB and AYP, the instructional emphasis appears to be on at-risk students. The gifted student often presents a completely different set of challenges for the professional educator. In order to fulfill their potential, academically gifted children should be fully engaged, consistently challenged, and have interaction with other academically gifted peers. In addition, the classroom environment should address the diverse social demands that are frequently exhibited by academically gifted students.

Research on gifted students is extensive. The existing research has a reoccurring theme; identify gifted learners early in order not to stifle their creativity and opportunities, develop instructional methods tailored to the gifted learner, provide instructors who understand the differences presented by the gifted student, and provide access to independent tools to supply constant progression. Research by Van Tassel-Baska & Brown (2007); Treffinger (1998); Tomlinson (2009); Taylor & Oakley (2007); Starkman (2006); Shaunessy (2007); Russo (2001); and Rogers (2007) has outlined the need and what is required.

The current study was somewhat unique in analyzing whether the use of a whiteboard during mathematics instruction would impact the academic success between groups of gifted students. Since there appears to be no question that gifted students require different academic approaches, this study was conducted to determine if a specific technological tool would enhance gifted students' academic performance. Gifted students must have challenging opportunities that capture their attention and increase their productivity. Research that is conducted to discover methods that meet the specific needs of gifted learners has the potential to stimulate the brightest minds and motivate prodigies who, all too frequently, underachieve in the current, traditional classroom environment.

The quantitative results of the current study support the theoretical basis for the research. The three theories that substantiate the necessity for specific instructional strategies to engage, challenge, and enrich the gifted learner are Social Cognitive Theory, Social-cultural Theory, and Social Constructivist Theory. The use of SMART Board technology during instruction addresses the relationship between these theories and classroom practice. Each theory, in its own context, supports the use of specific instructional strategies to assist gifted learners in meeting their full potential. From a theoretical perspective, SMART Board interactive technology supports contemporary, research-based educational philosophies. Current theory promotes the superiority of active engagement over passive learning methodologies (Beeland, 2001).

The social cognitive theory, in the context of gifted education, posits the necessity of a rigorous curriculum that constantly challenges the advanced analytical and problem-solving abilities of gifted students. Failure to challenge the gifted mind produces degeneration of the brain (Burney, 2008). The linkage of SMART Board technology to instantaneous information through the world-wide web provides opportunities for in-depth research. Students must utilize their analytical skills to discern the credibility of the material. Information is readily available and abundant. This enables the gifted learner to deeply investigate a topic and analytically process the validity of the content. Gifted students who possess a plethora of factual information benefit from tasks that further develop their analytical abilities. They logically separate vast quantities of information, thus continuing to develop their cognitive abilities. Processing, analyzing, and problem solving sharpen critical thinking, which stimulates metabolic activity (Eide & Eide, n.d.).

The study conducted by Rayneri, et al., (2006) investigated the underachievement of gifted students. The purpose of this research was to discover the factors that contribute to poor academic performance of gifted students. The participants were 80 middle school gifted students who were performing below their capability as determined by results on standardized tests. Data from The Learning Style Inventory were analyzed for each participant to establish their preference for learning styles and classroom environment. The results indicated various specific styles were preferred, but generally the environment needed to be interactive and the curriculum challenging. Rayneri, et al., (2006) concluded that regardless of the preferred learning style, if gifted students were not meeting their full potential, further research should be conducted to discover practices that motivate gifted students to perform to their capabilities. Given that many gifted students are underachieving, the current study investigated a specific technological tool to determine if it improved the performance of gifted students during mathematics instruction. The current study was dissimilar in that the participants were gifted elementary students. This age group was selected because Rayneri, et al. (2009) emphasized the importance of discovering methodologies that challenge and stimulate the cognitive abilities of gifted learners. Methods should be implemented as a proactive measure to entice and encourage learning before students become disengaged and disillusioned with the curriculum and learning environment. Both studies were limited by their small number of participants and emphasize the need for future research.

Socio-cultural theory is derived from the belief that social and cultural influences impact cognitive development. The emotional needs of individuals must be identified and addressed by teachers before students can fulfill their academic potential. Often gifted students do not feel socially adept (Bohnenberger et al., 2008). Frequently, unreal perfectionist expectations develop. When unfulfilled, the result in many cases is low self-esteem. In a study conducted by McCoach and Siegle (2003) to determine the correlation between self-concept and academic performance, 210 gifted high school students completed the School Attitude Assessment Survey Revised (SASS-R). The results indicated that students with a positive self-image exhibited higher academic performance.

Social relationships, collaboration, and interaction contributed to a confident self-perception. Gifted individuals often base their understanding of the world on personal and social interactions. The use of SMART Board interactive technology can be utilized to enhance whole-group learning experiences. It supports dialogue and collaborative learning. It provides limitless capabilities for creating projects, presentations, and authentic learning experiences. Students become active participants in their learning because the graphics, vibrant colors, videos, and music motivate even the most disengaged student (Starkman, 2006). The opportunity to interact and work collaboratively is increased with the use of SMART Board technology during instruction. It eliminates social isolation and encourages social interaction. The passion for learning is fueled by classmates.

Social constructivist theory in relation to this study accounts for the consequential and sequential stages that gifted students utilize to solve problems. Their acute ability to construct meaning by building connections is enhanced through active participation in conversation and cooperation with classmates and instructors (Vygotsky, 1978). Upon collaboration, the concepts must be associated and expanded in relation to the individual's concrete experience. SMART Board technology allows for exploration, collaboration, interaction, and inquiry-based, experiential learning. It can enrich the gifted students' idiosyncratic construction of learning through the acquisition of information at an accelerated pace. Students learn to improve their social skills during collaboration, and process the findings according to their personal experiences. The technology is a complement to instruction provided in the traditional teacher centered-classroom (Villano, 2006). In this research, the Constructivist Theory was definitive in that it was mathematics based and strictly due to the interaction with other students and the instructor. This liberal view of constructivism is often debated by Christian educators (Phillips, 1995). There is agreement that constructing knowledge should be more than a passive process, and that learning should be an active progression based on an individual's cognitive development. From the Christian perspective not all knowledge is created by humans. Through nature, truth and meaning become significant by way of discovery. This is contrary to the constructivist supposition that man is created without inborn cognitive abilities. Christian educators believe that individuals have the capacity to formulate meaning from within. Not all learning is assimilated through the organization of sequential construction. External and internal forces impact the acquisition of knowledge. Neither Christians nor radical constructivists dispute the value of tools that promote active engagement during the learning process. Consequently, this commonality supports a mutual, theoretical perspective that SMART Board interactive technology is aligned with contemporary, research-based educational philosophies.

Although based upon the aforementioned theoretical framework, the results of the current study showed no significant difference in mathematics growth scores between the treatment and control groups. This finding is unlike that of a study conducted by Marzano and Haystead (2009), who found that students receiving instruction using interactive whiteboard technology, specifically a Promethean Board, showed a significant increase in their scores versus students who received the same instruction without the use of interactive technology. Marzano and Haystead's (2009) study consisted of two phases. Phase 1 involved an analysis of student learning with and without the use of interactive whiteboard technology. Student learning was measured through the use of a pre-test and post-test on a specific unit of study. Phase 2 involved an analysis of student learning with and without the use of interactive whiteboard technology as it relates to teacher behaviors in the use of interactive technology in their classrooms. Student learning was measured through the use of a pre-test and post-test on a specific unit of study. Phase 1 of the Marzano and Haystead (2009) study was similar to the research methods of the current study. Both studies were quasi-experimental in design. A pre-test provided base-line data and a post-test determined the degree of academic learning that took place during various units of study in the Marzano and Haystead (2009) research. The pre- and post-tests in the current study measured mathematics growth over a one-year period. The independent variable in both studies was the use of interactive whiteboard technology during instruction. A Promethean Board was utilized in the Marzano and Haystead (2009) research and a SMART Board was used in this research.

A distinct difference in the Marzano and Haystead (2009) study from the current study was the limited scope of the research in the latter study. One hundred-seventy three gifted, fourth grade students from six schools within the same school system participated in the current study, whereas 3,338 general education K-12 students from 50 schools throughout the country participated in the Marzano and Haystead (2009) research. The current research measured student growth in one subject; the Marzano and Haystead (2009) study measured student achievement with a meta-analytic technique using seven types of moderator variables: school level, grade level, academic content area, length of teaching experience, how long Promethean technology has been used by the teacher, percentage of instructional time Promethean technology was used in the classroom, and teachers' perceived confidence in their use of Promethean technology in the classroom. The results indicated that with the presence of specific conditions, Promethean technology had a strong effect on student achievement. Conducting the study through the

Marzano Research Laboratory made the magnitude of the research possible and strengthened the results of the findings.

Limitations of the Research

Prior to providing a more specific summary of the findings, interpreting the results, and weighing the importance of this study, it is essential to understand the limitations of the research. This study was somewhat unique in comparing whiteboard academic success between gifted groups. Since research indicates that gifted students require a different academic approach from general education students, the purpose of this study was to determine if a specific tool would enhance their mathematics achievement. Gifted student should have opportunities for challenge in order to further stimulate their engagement and growth. This study was limited to gifted fourth grade students from within the same school system. To ensure that a difference in schools attended did not confound the results, similar schools were selected to participate in the study. This limited the selection to six sites. Other factors limiting the breadth of the study include the size of the sample, the use of one grade level, and the study of gifted students exclusive of general education students. The study did not include a measure of teacher confidence and experience in the use of SMART Board technology, years of teaching experience, students' academic self-perception, and participants' attitude and adaptation to technology.

The study was quasi-experimental due to the inability to randomly select the participants. The 107 students who received SMART Board instruction were gifted students from the six participating elementary schools. The 66 students who did not receive SMART Board instruction were the balance of the gifted fourth grade students in the participating schools. In addition, the study was limited to fourth grade students in a small geographical area of southwest North Carolina.

Teacher confidence and extent of utilization in whiteboard technology was not studied. All of the instructors had experience in using a whiteboard and they were instructed to use it a minimum of 80% of the time during mathematics instruction. However, teacher confidence, extent of use of all features, student hands-on participation, and overall familiarity with technology were not measured. Since all students in the study were designated gifted by the state of North Carolina, academic self-perception was considered to be strong. This self-perception, either prior to the fourth grade or at the conclusion of the fourth grade, was not measured. The increase in mathematics performance, as measured by EOG fourth grade testing, confirms the existence of a positive classroom learning environment, student learning engagement, parental support, and adaptation to technology. This study did not attempt to include measurements of these variables as factors in increasing mathematics performance.

Strength of Study

This research utilized a quantitative analysis of the use of SMART Board technology on the academic growth of gifted students during mathematics instruction. This study focused solely upon the impact of a specific technological tool and its effect on growth, not proficiency, in mathematics achievement of gifted students. The narrow range of the investigation targeted one specific sample and one specific device. It was not confounded by dissimilar school settings or diverse populations.

The schools participating in the study were selected after the researcher conducted an extensive comparative analysis of the 144 elementary schools in the school system. As referenced in Chapter Three, the defining characteristics are outlined for each school.

The principals from the participating schools signed statements granting permission for the study and attesting to the consistent application of the North Carolina Standard Course of Study for mathematics instruction. Although the principals were aware of the study, this information was not shared with the teachers or the students.

The identification of gifted students in this study is based on a standard set by the state of North Carolina. Individual schools do not have the liberty to certify students based on an interpretation of student performance, therefore ensuring a consistent application of the state requirements and qualifications.

The data for this study was supplied by the North Carolina Department of Accountability. Stringent, universal guidelines are implemented to ensure the consistency of administering the standardized assessments. All results are tabulated, verified, and the results are sent electronically to each school system within the state. Test administrators and proctors are required to sign documentation attesting to their compliance to state guidelines for administering the tests. An additional “Ethical Accountability” document is signed to verify that no inappropriate conduct took place during the standardized assessments. The use of standardized tests ensured the validity of the process and eliminated researcher bias.

Interpretations of the Results

The primary hypothesis of the current study was that SMART Board technology would increase gifted students’ growth in mathematics at a rate higher than that of gifted students who were instructed without this technology. The results invalidated this hypothesis, in that the two groups did not exhibit statistically significant differences in their test scores. These results do not support the premise that the use of SMART Board technology leads to greater achievement gains in mathematics achievement.

It is not surprising that both groups showed "Expected Progress" in the North Carolina standardized EOG testing. The McCoach and Siegle (2002) study of gifted high school students reported higher academic self-perceptions, which is a factor that is generally associated with increased academic achievement. The Rayneri, et al., (2006) investigation demonstrated that learning style and classroom environment play a role in academic achievement. In this case the academic environment was enhanced through the use of interactive technology. Breeland (2002) concludes that the use of interactive whiteboards is an effective instructional tool for student engagement. In a limited fifth grade study, Amolo & Dees (2007) stated an overall increase in learning of those students instructed with whiteboards.

The purpose of this research was to ascertain if the use of Smart Board technology would increase growth in mathematics performance of fourth grade gifted students versus those gifted students not instructed with the use of SMART Boards. Based on previous research, the use of SMART Board technology is a factor in improving academic performance. The current research attempted to define the difference in growth of mathematics performance of SMART Board users versus those who were not instructed with SMART Board technology. The results indicated that there was not a significant difference between the experimental group and the control group.

Disadvantages

The use of SMART Board technology is associated with several disadvantages. The installation of this specific technology does not ensure effective implementation in the classroom setting. Many teachers are unfamiliar with the technology and need extensive training on the operation and execution of the device. A receptive attitude and a willingness to learn on the part of the instructor are essential elements for successful implementation.

Training on the device is included with the purchase price of a SMART Board package, but it is limited to a single session. Many teachers find this to be inadequate preparation to assist them in fully utilizing the vast capabilities of the interactive tool.

Another disadvantage is the maintenance costs associated with this technology. Although many components are warranted, the bulbs are not. The bulbs must be operational for the screen to display images; without them the device is inoperable. The cost of a replacement bulb is $250.00. Several teachers have found the bulbs to be rendered useless within the first year of operation.

SMART Board technology can be installed as a permanent fixture or used as a portable device. If installed permanently the device limits the area normally reserved for blackboard space. Once installed, altering of the classroom configuration becomes limited. If the SMART Board is portable and is operated from a projector, the unit may become inoperable if disturbed. Often when the tool is bumped, it becomes necessary to realign the projector so the visual images can be restored. This process can be lengthy which diminishes the time allotted for instruction.

Implications for Use

All tools need to be measured in order to be evaluated for implementation. This research measured the test results of gifted students instructed with SMART Board technology versus the test results of gifted students instructed without SMART Board technology. Within these comparisons were a series of other criterion used in the educational setting.

NCLB and AYP have introduced a matrix of standards required and expected to be met. State Education Departments, school systems, school administrators, classroom teachers and students are all affected by educational legislation and the formulas in place to quantify performance. Professional educators across the country and the communities they serve are searching for tools to not only better serve their constituents, but to also obtain certain standards of instruction. This is being done in an atmosphere of fiscal review in an era of particular budgetary restraint and reduction.

This study was conducted in the culture of quantification of learning. As a measuring tool, the study took the accepted standards of "Gifted Student" in the state of North Carolina. It took the accepted standardized measuring tool of EOG testing in the third grade and the accepted measuring tool of EOG testing in the fourth grade. The study also used the accepted Course of Study for fourth grade students in the state of North Carolina. Against these yardsticks, the instrument to be measured was the use of SMART Board technology.

This research showed no significant difference in the EOG mathematics test scores between the experimental and control groups. Lacina (2009) states that empirical, scientific studies are limited regarding the benefit of using technology as an instructional tool. Additional studies are necessary to determine the value of using technology in the classroom.

Educators are searching for the best vehicles with which to reach all students. Gifted students are a meaningful subset of those who comprise every school. As educators strive to find the means to optimize the interest and the intellectual growth of these students, they are offered a wide variety of options. SMART Board technology appears to have a solid base in improving efforts to instruct gifted students.

Recommendations for Future Research

Additional research in the area of the impact of technological tools on the academic performance of gifted students is warranted. Specifically, the impact of SMART Board technology on the categorical academic performance of gifted students deserves further study.

There is extensive research on gifted students that shows instructional methods must be tailored to the unique characteristics of learning for this group of children. Recommendations for future research fall into the two broad categories of analysis of students and the analysis of instructors. Thus, the research could be captured for the recipient and the facilitator.

This research hypothesized that gifted students who received instruction with SMART Board technology would exhibit higher growth on EOG mathematics assessments than their fourth grade gifted colleagues who did not receive mathematics instruction with SMART Board technology. There are issues limiting this study and future research addressing these points is warranted.

Recommendations for further research of gifted students as recipients of SMART Board technology could include the following:

1) Replicating this research with a dramatically larger sample. The sample may also have a wider breadth of ethnic components.
2) Replicating this research with other grade levels.
3) Replicating this research in other subject areas.
4) Research in the area of student behavior related to their interaction with the technology.
5) Replication of this research in schools of different socio-economic levels.

6) Measuring the technological experience and familiarity of the students prior to beginning of the research time period.
7) Measure of parental support to the student for technological instruction.

Recommendations for further research of instructors of gifted students as facilitators of SMART Board technology could include the following:

1) Measuring the degree of training and the degrees of experience of SMART Board classroom instructors.
2) Measuring the actual percent of time utilizing the technology in the classroom.
3) Research teacher attitudes toward SMART Board instruction.
4) Research of administrative and staff support of technological instruction.
5) Research of teaching methods, types of lessons implemented and standards for best practices of SMART Board use.

Research shows gifted students need creative opportunities and instructors who acknowledge the needs of accelerated learners. A wide variety of technological instructional programs have been proposed for school systems and individual classrooms. Further research is warranted to analyze the specific advantages and implementation of SMART Boards.

Summary

This study did not show a significant difference in the growth scores between the two groups of gifted students who participated in the research. Despite the quantitative results, the review of credible studies validated the researcher's belief that gifted students possess unique characteristics that frequently are unmet in today's classroom. Innovative methodologies should be implemented to engage and challenge gifted learners if they are to meet their full academic potential.

The use of interactive technology has the potential to challenge the minds of gifted students by providing instant access to vast resources and unlimited information. The gifted mind provides students with the ability to deeply analyze problems in the attempt to discover solutions. Incorporating technological devices into classroom settings enable students to access extensive information immediately. Gifted students can quickly exercise their abilities to think critically and solve problems as they assimilate the material at an accelerated pace. As potential world leaders, gifted students should be given every opportunity to expand their mental capacity to the highest possible degree.

Educators who plan to adequately prepare students for the twenty-first century should recognize the value of technology and include it as an integral part of the curriculum. In many school districts budgetary constraints have impeded technology integration because the devices are viewed as a luxury instead of a necessity. Educators cannot afford to ignore the fact that technological devices are utilized on a daily basis by students from diverse cultures and various socio-economic statuses. While students interact with the latest devices outside of the school house, within the classroom the tools are antiquated or non-existent. It is unrealistic to expect students to fulfill their capability to learn if the curriculum does not include the most up to date information or utilize modern methodology or devices. Technology has transformed the world (Friedman, 2005) and students need exposure to the tools in order to prepare for the future. The challenge for educators is to convey the importance of equipping our schools with modern technology so that engaging, relevant lessons that reflect current reality are the norm. All students deserve the best education possible. Educators should recognize that meeting the needs of one group should not supplant the needs of another. Currently many gifted students are not being challenged; a fact substantiated by their underachievement and statistically documented drop-out rate (Russo, 2001). Educators should recognize that the needs of our brightest students are not being met. Investigation of methods that will inspire and motivate gifted learners should be on-going and deliberate. Failure to pursue strategies to engage and stimulate the gifted mind should not be an option for responsible educators and school systems throughout the nation.

The results of this study did not conclusively demonstrate the value of SMART Board technology on the growth of mathematics scores in gifted elementary students. Further studies should be pursued to determine strategies that stimulate the unique needs of the gifted mind. The ever-evolving world of technology has the potential to challenge the innate abilities of the gifted student. Research on the myriad of devices should be continued to promote the success of this special population.

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Appendix A

cms®

Mr. Greer Dickerson
Client Development Manager
Smarter Systems Creative Audio Visual Solutions
greer@smartsys.com

Dear Mr. Dickerson,

I am conducting a research study to determine if the use of interactive whiteboard technology, when used in an instructional setting, impacts the performance of students on standardized tests.

The student participants in the study were divided into two groups. One group received instruction that was complemented by the use of interactive whiteboard technology and the other group received instruction without the technology.

The whiteboard technology that was used in the classrooms was specifically from SMART Board Inc.

I would like your permission to use the SMART Board name in my research study. I appreciate your assistance in this matter.

Sincerely,

Patricia Riska
Principal

Signature ______________________ Date 9/5/2010

Appendix B

cms®

March 2, 2010

Dear Principal Sharon Damare

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the . Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, Sharon Damaré Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

Appendix C

March 2, 2010

Dear Principal Steve Drye

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, ______________________________ Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

Appendix D

cms®

March 2, 2010

Dear Principal <u>Rhonda Gomez</u>

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, Dr. Rhonda Gómez Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

Appendix E

cms®

March 2, 2010

Dear Principal Lane Price

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, Lane Price Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

cms®

March 2, 2010

Dear Principal Diane Adams

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, Diane F Adams Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

Appendix G

cms®

March 2, 2010

Dear Principal Patricia Riska

I am seeking your permission to utilize your current fourth grade Talent Development (T D) student's math scores in a research study. If these students attended your school in third grade, their third grade 2008-2009 math EOG score will be compared to their fourth grade 2009-2010 math EOG score to determine if a higher growth factor occurred as a result of the use of technology during instruction. The variable in this study is the use of SMART Board technology. Scores from three similar schools that utilize SMART Boards during math instruction in fourth grade will be compared to three similar schools that do not utilize SMART Boards during math instruction in fourth grade. The purpose of this study is to determine if the use of SMART Board technology impacts the degree of growth in certified gifted students. The identity of the students will be disclosed to the Office of Accountability, but their identity will not be released to the researcher. The scores will be sorted based on TD certification and use, or non-use, of SMART Board technology.

Your participation in this study will involve granting permission for the research to take place in your school. By signing this document you attest that your teachers consistently follow the Standard Course of Study for math instruction. You will receive a copy of the data and a copy of the results that will indicate if the use of SMART Board technology impacted the growth of the TD students.

I, Patricia Riska Principal agree to allow my school to be a part of this research study.

I deeply appreciate your assistance with this study.

Sincerely,

Patricia Riska

Patricia Riska
Principal

Appendix H

Office of Accountability

May 18, 2010

Patricia Ann Riska

RE: **"The Impact of SMART Board Technology on Growth in Math Achievement of Gifted Learners"**

Dear Ms. Riska:

Thank you for your interest in conducting research in the Your proposal summary and application for **"The Impact of SMART Board Technology on Growth in Math Achievement of Gifted Learners"** has been reviewed and approved by the Office of Accountability.

At the researcher's request, 2008-2009 3rd grade EOG math scores and 2009-2010 4th grade EOG math scores as well as demographic variables (i.e., date of birth, ethnicity, gender, and school attendance - # of days attended for the entire year) will be provided from the following schools:

once payment in received.

Given the increasing level of accountability placed upon schools, and the need to recruit and retain quality teachers, identifying programs and strategies that work is of paramount importance. CMS asks that you share your results within 30 days of completion, including any recommendations for the district based upon your findings.

Please sign and return one copy of the enclosed "Memorandum of Understanding" indicating your agreement with its terms. Please retain the remaining copy for your records. Should you have any questions or future needs, please feel free to contact Dr. Lynne Tingle . Best wishes and continued success as you begin your study.

Yours sincerely,

Robert M. Avossa
Chief Accountability Officer