A STUDY OF THE IMPACT OF STEM ON STUDENT ACADEMIC ACHIEVEMENT IN MATH AND SCIENCE IN ONE MIDDLE TENNESSEE METROPOLITAN SCHOOL DISTRICT

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A Study of the Impact of STEM on Student Academic Achievement in Math and Science In One Middle Tennessee Metropolitan School District

A Field Study Report

Presented to

The College of Graduate Studies

Austin Peay State University

In Partial Fulfillment

Of

The Requirements for the Degree

Educational Specialist

Briget Q. Ethier

May, 2013

May, 2013

To the College of Graduate Studies:

We are submitting a Field Study Report written by Briget Q. Ethier entitled "A Study of the Impact of STEM on Student Academic Achievement in Math and Science In One Middle Tennessee Metropolitan School District." We have examined the final copy of this Field Study Report for form and content. We recommend that it be accepted in partial fulfillment of the requirements for the degree of Educational Specialist Degree in School Administration and Leadership.

Dr. J. Gary Stewart, Committee Chair

Dr. Leah Whitten, Committee Member

Dr. Gina Grogan, Committee Member

Accepted for the Graduate and Research Council

Dean, College of Graduate Studies

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ACKNOWLEDGMENTS

While persisting through this journey, numerous individuals have interlaced their distinctive views and support into the final fabric of this venture. Although it would not be possible to thank everyone who has had an impact on my professional and personal life, there are a few people that this project could not have been finalized without their support.

To my academic chair, Dr. Gary Stewart, I would like to express my never-ending gratitude for all of your hard work and support to make the finalization of this project transpire. Additionally, it was an honor to be your student in several classes. The sharing of your extensive experience in the field of education and your passion as an educator has inspired me tremendously. To the remainder of my committee, Dr. Gina Grogan and Dr. Leah Whitten, your time and dedication to guiding me through this journey and your support is truly appreciated.

Dr. Tammy Shutt, I will never forget the impact that your classes and your unique pedagogy have had on my life. You have been such an inspiration, not only as a professional educator, but also as a strong woman of perseverance that could accomplish any task when challenged to do so.

Lastly, I would like to acknowledge our district's Accountability Coordinator, Kimmie Sucharski for allotting her time to this project whenever I needed any insight or questions to be answered about STEM in our district.

DEDICATION

This field study report is dedicated to my children, Jordan (14) and Savannah (5), for all of their sacrifice over these past couple of years. As a family we have all had to sacrifice a great deal of time together so that I could move forward with this degree and spend a majority of my time completing course work and other requirements to accomplish this milestone. I know that someday you both will understand that I did this to benefit your well-being and your futures. I love you both. My husband, Mike, thank you for being such a wonderful provider for all of us and dedicating so much time to our children so that I could accomplish this academic goal. Thank you and I love you.

To my mother-in-law (Daylene Powers) for always providing me with the motivation I needed to keep going, especially during my times of exhaustion and weakness. To my grandmother-in-law ("Nins") for making me laugh when I needed to and for always telling me how proud you are of me for taking on all that I do. I love you both so much and could not have ever asked for a better family. To my dad (Jim Campbell) for always motivating me and telling me how proud he is of me for accomplishing this milestone while enduring several other tasks and challenges of everyday life. I love you and am so grateful to have you in my life.

ABSTRACT

BRIGET Q. ETHIER. A Study of the Impact of STEM on Student Academic Achievement in Math and Science (Under the direction of DR. GARY STEWART).

The purpose of this study was to explore the impact that the STEM program has on student academic achievement with regards to Mathematics and Science annual assessment scores. This study entails a non-experimental, causal comparative research design (ex post facto research) to identify any statistical significance between the STEM program and student academic achievement. Archival data was retrieved from a school district in Middle Tennessee from four grade levels in the district that represents both a sample that had access to the STEM program and another sample that did not have access to the STEM program during the same academic school year.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Currently, there is an insufficient amount of research to determine whether or not the implementation of the STEM (Science, Technology, Engineering, and Math) program is related to student academic achievement in Math and Science subjects (Stotts, 2011). There is very little research on or evidence that STEM has a statistical impact on student achievement for younger students. Most research on the impact of STEM has been conducted in secondary schools and at the college level (Brown, Brown, Reardon, & Merrill, 2011). The Middle Tennessee Metropolitan school district that is the target school district for this study received a $2.5 million award under the 2012 Department of Defense Education Activity (DoDEA) grant for the improvement of STEM programs (Shelton, 2012). Research is necessary in this field to explore the impact that the STEM program has on student academic achievement with regards to Math and Science.

Purpose of the Study

The purpose of this field study was to explore the impact that the STEM program has on student academic achievement in Math and Science. The independent variable was the STEM program and the dependent variable was the TCAP (Tennessee Comprehensive Assessment Program) scores. Identifying the impact of the STEM program in this particular school district was necessary in determining whether or not the STEM program is having a positive impact on student academic achievement in Math and Science. The school district began piloting this program during the 2011-2012 school year, and it would be beneficial to the district to determine whether or not the program does have a positive impact on student academic achievement for the purpose of future planning and implementation.

Significance of the Study

The research committee in the Middle Tennessee school district in which the field study was conducted will benefit from this study. They will be able to use the analyzed data to determine which schools need more intervention and which ones need more enrichment. The Accountability Coordinator in the school district where this research was conducted will be able to use this data to identify an increase in student achievement scores for Mathematics and Science on the TCAP, or lack thereof, based upon the statistical findings of the research in this study. The Accountability Coordinator will be able to utilize this data and disperse it to others to benefit the school district. The teachers in the district will benefit from the research findings in this field study by gaining knowledge about whether their Math and Science scores improved or did not improve during a school year after implementing the STEM program. The parents and students will also benefit if the data reflects that STEM instruction assisted in the improvement of academic achievement in Math and Science. This will provide the parents with motivation and determination to support and promote the STEM program in schools. Future researchers may benefit from the research findings resulting from this field study for support in their own research studies.

Research Questions

1. Does the implementation of STEM subjects have an impact on the overall Mathematics growth for students in grades three, four, five, and eight, based upon a state standardized test, TCAP?
2. Does the implementation of STEM subjects have an impact on the overall Science growth for students in grades three, four, five, and eight, based upon the state standardized test, TCAP?
3. Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to third grade students?
4. Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to fourth grade students?
5. Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to fifth grade students?
6. Does the implementation of STEM subjects have an impact on combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to eighth grade students?

Null Hypotheses

1. There will be no statistically significant difference in the overall Mathematics growth for students in grades three, four, five, and eight on the state standardized test, TCAP, between the intervention group and the nonintervention group.
2. There will be no statistically significant difference in the overall Science growth for students in grades three, four, five, and eight on a state standardized test, TCAP, between the intervention group and the nonintervention group.
3. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between third grade students who have had access to the STEM program and third grade students who did not have access to the STEM program.
4. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between fourth grade students who had access to the STEM program and fourth grade students who did not have access to the STEM program.
5. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between fifth grade students who had access to the STEM program and fifth grade students who did not have access to the STEM program.
6. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment

between eighth grade students who had access to the STEM program and eighth grade students who did not have access to the STEM program.

Limitations

1. The first limitation in this study was that only one tool was utilized to measure growth of student academic achievement in Math and Science to determine the impact of STEM implementation. The Tennessee Comprehensive Assessment Program (TCAP) was the only test administered to third, fourth, fifth, and eighth grade students in this study to measure growth in Math and Science.
2. The second limitation was that teacher content knowledge, training access to resources, and teacher fidelity to the program differed among individuals and at each school in the 2011-2012 school year and the impact of each of these factors will remain unknown.
3. The third limitation was that the design of third, fourth, and fifth grade classrooms differed at each school in the 2011-2012 school year. Some classrooms were departmentalized while others were traditional (one teacher teaching all subjects), and a third group of classrooms were located in magnet schools (a public school which offers a specialized curriculum with high academic standards to a student body that represents a cross section of the community).
4. The fourth and final limitation in this study was that demographic sub-groups were not identified in this study. All students, regardless of race, gender, or abilities, were compared from each pair of observations.

Assumptions

1. One assumption in this study was that all students performed to the best of their abilities on the TCAP in the spring of 2012.
2. Another assumption in this study was that all teachers received the same amount of training on how to teach and implement STEM subjects effectively in their classrooms.
3. Furthermore, that these teachers bestowed fidelity to the STEM program.

Definition of Terms

1. **America COMPETES ACT:** This Act set guidelines for funding in educating future STEM professionals and emphasized the importance of investing in research experiences for undergraduates in STEM fields (The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act of 2007) (Library of Congress, 2010).
2. **Criterion-Referenced Test:** A test that includes Criterion-Referenced items that measure a student's performance according to specific standards, instead of comparing their performance to that of other test takers (Cronbach, 1970).
3. **Magnet School:** A public school, which offers a specialized curriculum with high academic standards to a student body that represents a cross section of the community (Lange & Sletten, 2002).
4. **Normal Curve Equivalent:** A way to standardize scores on a test (Mertler, 2002).

5. **STEM Program:** A program implemented in schools that places emphasis on the integration of Science, Technology, Engineering, and Math subjects (U.S. Department of Education, 2012).
6. **Tennessee Comprehensive Assessment Program (TCAP):** An annual assessment administered to students in grades 3 through 8 to evaluate academic growth and achievement (Tennessee Department of Education, 2012).

CHAPTER II

REVIEW OF THE RELATED LITERATURE

A Study of the Evolution of Math and Science in Elementary Schools

"The American, by nature, is optimistic. He is experimental, an inventor and a builder who builds best when called upon to build greatly."

(Kennedy, n.d.)

Introduction

This research study will ascertain the impact that STEM implementation in the classroom has on student academic achievement in math and science. The following paragraphs will explore the significant features of the history of school reform, a brief history of Mathematics, a brief history of Science, a brief history of Technology, a brief history of Engineering, Math reform, Science reform, and STEM reform and research.

National Perspective

Americans are being called upon to invent, build and be innovative, more so than ever before. The United States has fallen behind the rest of the world with regards to Science, Technology, Engineering, and Mathematics and is losing its authority as an innovator. Other nations are surpassing the United States with regards to competition and globalization (Council on Undergraduate Research, 2009). The United States does not lack historical inventiveness. In the twenty-first century alone, such inventions as the Ford Model T, the washing machine, the refrigerator, the modem, and the personal computer are excellent examples of American ingenuity. However, current statistical facts indicate that the United States is being surpassed by more advanced countries in terms of innovativeness and technology. The United States has been replaced by China as the number one high-technology exporter in the world, and the number of foreign students studying engineering and physical science in the United States universities has exceeded the number of U.S. students as of 2000 (Stotts, 2011). Becker and Park (2011) specified that in the past, STEM careers and disciplines have not been appealing to American students and this is a nationally recognized crisis. The decline in these disciplines is expected to cause a deficiency of scientists and engineers in the United States in the approaching future. The U.S. Department of Education (2007) recognized this issue as being problematic and in order to prevent the declining STEM population of human resources in the United States, it has recorded that one of the STEM federal educational goals for K-12 education is to prepare all students with the STEM skills needed to succeed in a 21st-century global economy.

The federal government has invested substantial monies and resources in schools in the United States (U.S. Department of Education, 2012). However, the state of STEM education has worsened and the graduation rate in STEM subjects has declined in the past decade (Pfeiffer, Overstreet, & Park, 2010). According to an article written by Pfeiffer et al. (2010), the United States ranked 29^{th} out of 109 countries among 24-year-olds with a science or math degree. It was also reported that only 14% of degrees in STEM fields were given to U.S. students while twice that amount has been produced in some foreign countries. With regards to elementary schools, the workforce pipeline of elementary school teachers is not equipping teachers with the appropriate knowledge to teach STEM subjects to elementary school students (Epstein & Miller, 2011). Epstein and Miller suggested several ideas to remedy this dilemma such as increasing the selectivity of teacher preparation programs, requiring teacher candidates to pass Mathematics and Science licensure exams, and exploring staffing models that reach out to elementary teachers that have an attraction toward math and science subjects.

The only hope for the United States in gaining any superiority in the global leadership race in Science and Technology would be to shift the focus upon America's youth. Among the youth, the strongest focus should be placed upon the ones with a demonstrated affinity in STEM related subjects due to the fact that they will play a crucial role in the future of the global economy (Subotnik, Tai, Rickoff, & Almarode, 2010).

The need for more research on STEM and the impact the initiative has on academic achievement is scarce but necessary. While there are specialized STEM schools in 17 states, there is no existing research to provide a comprehensive analysis on the impact these schools have on academic achievement or with success of passing students through the STEM pipeline (Subotnik et al. 2010). The STEM initiative is the latest trend in reforms implemented by schools on behalf of federal government mandates. Currently, there is a scarcity of research available that correlates STEM with academic achievement. In order for the United States to compete in the global economy of the future, schools will need to change their focus and attitudes regarding the STEM Initiative and the emphasis on the STEM subjects. Furthermore, an abundance of money and other resources have been allotted to the STEM program each year to attempt to fix the problem while a minimal amount of research is available to validate its positive impact. There is a desperate need for more research to be conducted on this topic, especially at the elementary level (Epstein & Miller, 2011).

A Brief History of Mathematics

While researching the history of Mathematics, it is apparent that the history of Mathematics has evolved diversely in different countries, at different times, and under different circumstances. According to Dauben and Scriba (2002), the *Commentary on Euclid* by Proclus has been determined to be the earliest written record that could be regarded as history of Mathematics. It is believed that the *Commentary on Euclid* may have been copied in part from a now disappeared *History of Geometry*, written by Eudemus, a student of Aristotle. In the *Commentary on Euclid*, Proclus reviewed the genuine progress of Mathematics from perception, to reasoning, to understanding. This particular perception of Mathematics specifically relates to the improvement of knowledge of Mathematics, its origins and development, whether it is applied, abstract or concrete, practical or theoretical. However, according to Merzbach and Boyer (2011), one century before Aristotle speculated about Geometry being pursued by the Egyptians, a Greek traveler named Herodotus visited Egypt and viewed the ancient monuments and the achievements of men working along the banks of the Nile. Herodotus reported that the Pharaoh of Egypt would send men to examine and to determine, by measurement, the portions of a man's lot that was carried away by the Nile and, therefore, based upon this observation, Herodotus determined that Geometry first became known in Egypt and was then passed on to the Greeks. In present times, the major source of knowledge of ancient Egyptian Mathematics comes from a scribe written in hieratic script around 2000 to 1800

BC. The Egyptian hieroglyphic numeration system has been determined to be at least as old as the Egyptian pyramids, dating as far back as about 5000 years ago. While Medieval China and Medieval India both have had a notable impact on the history of Mathematics, evidence in writing of these contributions date much later than those of Ancient Egypt and Greece. Medieval China is credited with using rod numerals, the abacus, decimal fractions, values of pi, and solutions of equations, properties of right triangles, taxation, and engineering. However, the earliest written form of Mathematics in Medieval China can only be dated back to the Han Dynasty (202 BC). *A History of Mathematics* (Merzbach & Boyer, 2011) credits Medical India with using Arithmetic and Geometry, a symbol for zero, Trigonometry, multiplication, and long division. Their earliest written account of using Mathematics is dated as far back as 400 AD.

While there is significant evidence of Mathematics existing in various places in the world in both ancient and medieval times, during and after the Renaissance, and in modern times, the next portion of this brief history of Mathematics will focus on the history of Mathematics in the United States. This discourse will provide an understanding of how mathematical discoveries and practices play a role in present times in the United States and, more specifically, the American classrooms. The United States could be considered to be a late bloomer with regards to the history of Mathematics considering that the democratic republic was not founded until 1776 (Lightman, 2005). From this point until the mid nineteenth century, residents of the country utilized mathematical tools, practices, and skills inherited from England, their country of origin. Dauben and Scriba (2002) gave credit to Nathanial Bowditch as being one of the earliest significant figures that contributed to Mathematics in the United States. Bowditch studied marine navigation and wrote several volumes of works on the history of Astronomy and Mathematics (the last volume was published in 1839). However, according to Struik (1987), Benjamin Franklin was knowledgeable in astronomical computations in mid-eighteenth century and was also studying magic squares, for example, the Franklin magic square. Struik (1987) also proposed in his book, *A Concise History of Mathematics* that the United States was brought up to world standards by students that had gone to Europe in the 1880's. In the early twentieth century, Oswald Veblen started axiomatics by writing *Projective Geometry* in 1912 and later L.E. Dickson wrote an impressive three-volume *History of the Theory of Numbers* (1919-1923). The Nazi era (1933-1945) provoked a massive push of Mathematics in the United States through the immigration of significant scientists and mathematicians. Among these important individuals was Albert Einstein, who assisted cryptographers in the war effort during World War II (Struik, 1987).

The new era in working with computers began in 1937 by Howard Aiken at Harvard assisted by the International Business Machines Corporation (IBM) in the development of the Mark I Computer (Struik, 1987). Improvements were made and shortly afterward the Mark II was developed. However, it was still mainly mechanical. The first electronic computer, the Electronic Numerical Integrator and Computer (ENIAC) was developed and marketed in 1946 in Philadelphia. While these working computers were used primarily by the military and at several universities, by the 1950's computers became available for commercial purposes and hence the computer era had begun (Struik, 1987). Another significant event of the 1950's was the launch of the world's first artificial Earth Satellite, Sputnik, by the U.S.S.R. in 1957 (Dauben & Scriba, 2002). The United States Government viewed this event with a sense of urgency for the United States to increase spending for scientific research and education at all levels. Another result of the launch of Sputnik American mathematicians began to question the efficiency of traditional delivery models being used by teachers in American schools to teach Mathematics. These questions will be addressed more thoroughly in the section on Mathematics reform.

A Brief History of Science

According to Zhmud (2006), it was the discoveries and the theories of Greek scientists, which provided the basis for the methods of Science to be understood over the centuries. Zhmud (2006) also pointed out that there are surviving fragments of evidence that support this claim. As early as the fourth century BC, the earliest works of the history of Science were written, and in the third century BC, a Greek astronomer calculated the size of the earth and its distance to the moon and to the sun. While Zhmud centered the book, *The Origin of the History of Science in Classical Antiquity* on the accomplishments and contributions to the scientific field by the Greeks, Grant (1996) provided a broader synopsis of science history in the 1996 book, *The Foundations of Modern Science in the Middle-Ages*. Grant began the History of Science with the Roman Empire and their new philosophy, Christianity. Grant explained that the Christians decided to study Philosophy and Science as a support in understanding the Holy Scripture. They labeled this study as "handmaidens to theology." Christians utilized

Greek Philosophy, particularly metaphysics, to obtain a better understanding of the Holy Scripture and to better explain and cope with faiths they considered mysterious. Greek Philosophy and Science, accommodated by Christians, provoked an intense study of natural philosophy (the study of nature and the physical universe) during the late Middle-Ages. Consequently, the rise of natural philosophy inside the university system of the Latin Middle-Ages provoked revolutionary developments in Science in the sixteenth and seventeenth centuries also known as the Scientific Revolution (Grant, 1996). After the fall of Constantinople in 1453 (AD), the Scientific Renaissance of the fifteenth and sixteenth centuries occurred bringing great advances in Astronomy, Geography, Physics, Chemistry, Mathematics and Engineering. The Scientific Renaissance, which is considered to be the early phase of another important turn for the world of Science, is now known as the Scientific Revolution. This infamous time period marked further developments in Astronomy, Physics, Chemistry, Biology, Medicine and Mathematics (McClellan & Dorn, 2006). Figures that were significant to this time period were Copernicus, Newton, Leibniz, Galileo, and Bacon. All of them contributed to the development of new theories, practices, or ideas that led to the birth of several modern sciences (Dauben & Scriba, 2002).

Following the Scientific Revolution, another important time period occurred in the world of Science known as the Age of Enlightenment. It was also known as the Age of Reason. The Enlightenment was a cultural movement in the eighteenth century, which consisted of intellectuals such as John Locke, Sir Isaac Newton, Benjamin Franklin, and Thomas Jefferson. These intellectuals were trying to utilize reason instead of tradition and faith to explain the world around them and consequently reform society. Newton's law of universal gravitation, Franklin's experiment with lightning, Jefferson's argument for natural rights, and Dalton's atomic theory are all prime examples of utilizing reason to explain the world and its phenomena (Lightman, 2005).

A Brief History of Technology

The term technology signifies the knowledge, making, and usage of tools, machines, systems, crafts, methods, and techniques to achieve a goal or solve a problem. Technology can be traced to an age of the simplest crafts and tools known as the eotechnic age. Archeologists have discovered the first tools from the beginning of the history of Homo Sapiens (Cardwell, 1995). Notable technology began with civilizations in the Near Middle East (modern Iraq, Turkey, Egypt, and Syria) during the Early Bronze Age (3300 to 3000 BC). During this era, individuals not only discovered metals, but they also discovered how to harden it and utilize it for a range of purposes (Cardwell, 1995). Additionally, according to Cardwell in *Wheels, Clocks, and Rockets* (1995), the next notable event in field of technology occurred in 600 BC when the Greeks utilized astronomical methods to discover constellations, the sun, the moon, and five of the planets in the solar system. The Greeks' utilization of epicycles and deferents (computing methods) remained as the premise of astronomy until the sixteenth century (AD). The most prominent developments in metal smelting, agriculture and some aspects of engineering occurred about one thousand years ago in China and the West Asian Countries, which were under Islamic rule at the time (Pacey, 1998). This time period experienced a large population growth, which provoked spur of technological innovation with the purpose of providing for the obligation of producing more food and other necessities. The society during this this time period produced numerous inventions during this time period to fulfill the demands of a growing population. These inventions included new cropping patters, developments affecting farm implements, and improvements in irrigation methods. These changes were imperative and were a matter of "survival technology" to support an increasing population (Pacey, 1998). By 1040 (AD) China maintained an army exceeding one million men with the primary source of weaponry being the crossbow, which had iron arrowheads. They also had some weapons which used gunpowder. By 1150 (AD), the Chinese were using gunpowder to create weapons that produced violent explosions. It was only a short period of time afterward that other countries began to incorporate these developments and enhance them for their own military purposes (Pacey, 1998). One remarkable individual in the 1500's, Leonardo da Vinci, made his own contributions to the improvement of weapons using gunpowder during the Renaissance (Misa, 2004). Although Da Vinci created drawings of several gunpowder weapons, the evolution of military weapons with gunpowder was a slow process given the expense of gunpowder, the lack of firearm accuracy, and the efficiency of the crossbow. However, in the 1600's, weapons utilizing gunpowder were introduced in battle by Nassau (Misa, 2004).

The eighteenth century marked the beginning of the Industrial Revolution when a transition occurred from hand production techniques to the development of machine tools. The second Industrial Revolution occurred shortly afterward in the nineteenth century and brought more technological progress with the development, implementation, and refinement of steam-powered boats, ships, railways, and factories (Cardwell, 1995). *Technology in World Civilization* (Pacey, 1998) expands on the second Industrial Revolution with information on the discovery and implementation of electricity, chemistry, and the internal combustion engine. Eventually the automobile was introduced and, in conjunction with cement highways that were expanding across vast stretches of American land, the demand for fuel increased vastly (Pacey, 1998). Cardwell (1995) also discussed the invention of flight by the Wright Brothers in 1903 and their capacity for carrying passengers via flight by 1905. Eventually, airplanes were used during the First World War from 1914-1919. In the 1930's, the first jet engine was developed for practical use and was initially used for mail delivery purposes. World War II changed that as German scientists improved on the practicality of jet engine use for military purposes. The jet engine was also used by German scientists in 1942 when they first launched the A4 rocket.

Technology was further advanced when it was combined with the field of Chemistry (the end of the nineteenth century). The fusion of Technology and Chemistry introduced several beneficial developments such as sulfuric chemicals, inorganic fertilizers, and soda. Chemical technology introduced a remarkable development in 1928 with the discovery of antibiotics (Cardwell, 1995).

According to Cardwell (1995), the beginning of computer development began with an individual known as Charles Babbage in the early nineteenth century with his invention of a calculating machine, which in the modern sense was a computer. Other remarkable technologies introduced during this same time period were the transistor radio and the telephone (Misa, 2004). According to Misa (2004), the age of digital computing was driven by the demands of the American military with the goal to develop code-breaking, nuclear weapons designing, artillery range-finding, missile control, and anti-missile warning systems. These projects shaped digital computing from the 1940's to the 1960's. Cardwell (1995) adds that the proliferation and the improvement of office machinery were two other major forces that contributed to the production of the modern computer. Furthermore, commerce, science, and the military were the three areas that motivated the improvement of computers. After several attempts by a number of intellectuals, the first portable computer was developed in 1973, and successful prototypes of this model led to the first commercial IBM portable microcomputer in 1975 (Cardwell, 1995).

The ability to recognize a human need or desire (actual or potential) and then to formulate a solution is at the heart of technology. It has often been stated that war has frequently been the stimulus for new technologies throughout history (Cardwell, 1995). Cardwell (1995) concluded the final chapter of *Wheels, Clocks, and Rockets* with the question, "What inventions or innovations might not have been made had there been no major wars?" (Cardwell, 1995, p. 592). Misa (2004) concluded the final pages of *Leonardo to the Internet* with some glimpses into the future of technology. Misa (2004) contended that while there are challenges ahead for mankind with regards to technology that models new thinking, there are promising new approaches in developmental and environmental thinking to be explored in the future. The professional institution of

Engineering is especially aware of the persistent need for essential changes in education and practice (Misa, 2004).

A Brief History of Engineering

The history of Engineering espouses the development of civilizations and the record of human activity, which is both cumulative and progressive. This human activity combines the use of scientific, social, economic, and practical knowledge with the purpose of building, designing, and maintaining structures, devices, machines, materials, systems, and processes (Darling, Kilgour, Kirby, & Washington, 1956).

The first evidence of human-made habitation structures discovered by archeologists has been traced back as far as 400,000-500,000 years ago in Nice, France. These excavations were built in the middle of the Pleistocene era during the geological time scale when much of the Northern Hemisphere's land surface was being reshaped by the domination of glaciation activity. This reshaping of Earth's land surface impacted the development of humans as a species (Garrison, 1991).

The next notable era, according to Darling et al. (1956), was about 6000 B.C. when people in Africa and Asia Minor began cultivating plants and animals. This was one of the most important events in history as people of the Earth, began to build houses in groups. Permanent dwellings were built in the Near East approximately 6000 to 3000 B.C. Additionally, this delineated the era when people started inventing solutions to problems of construction and irrigation. These solutions were feats of engineering and marked the beginnings of the use of hydraulic, structural, metallurgical, and transportation Engineering. The evolution in architecture during this time period is noticeable in Hassuna when houses and temples were built. Egypt also produced marked changes shortly afterward, between 2658 and 2135 (B.C.) with the building of the pyramids during the period known as the Old Kingdom. Other notable Engineering solutions that occurred during this time period were hard-surfaced streets in Babylon and Mesopotamian vessels (Garrison, 1991).

Another remarkable civilization, with regards to Engineering, was the Greeks. Greek engineering advances can be traced as far back as 3000 (B.C.) (Darling et al., 1956). Greek and Roman engineers began to use Geometry as their principle Mathematical tool in architectural Engineering (Darling et al., 1956). By 100 (A.D.), both Greece and Rome had roads, bridges, buildings, and had become the masters of developing various machines of war (Garrison, 1991).

The Middle-Ages was the next noticeable era for Engineering. It existed between the fifth and fifteenth centuries (A.D.). The efficient design of Viking ships made contributions to present day designs of great ships. England and other European nations began building great castles and Gothic cathedrals of stone, so durable that some are still standing today after almost 1200 years (Garrison, 1991).

Following in the footsteps of the Middle-Ages was the Renaissance, a time period that lasted from 1400 to 1600 (A.D.). In addition to civil and military engineering, the fields that were known then as mechanical arts became incorporated into the field of engineering. The architecture of the Renaissance is considered by most historians to be equally important as was the literature and art of the era (Darling et al., 1956). While Brunelleschi is widely regarded as the first architect of the Renaissance, other phenomenal individuals followed the lead by creating monumental structures, most of which still exist today. Alberti, Palladio, Michelangelo, and Da Vinci all left footprints on this time period by designing and building structures that would be the foundation of the future (Garrison, 1991).

While France was the center of Engineering in the seventeenth century, the stage must be shared with the English in the field of Engineering (Garrison, 1991). French Engineering was prominent during this time period with the building of bridges, schools, canals, and roads. However, bridges of iron began in Britain in 1779, and by the nineteenth century, these bridges were linked to the wide-spread us of railroads (Garrison, 1991). The seventeenth century is marked with significant discoveries in hydraulics and the realization that there was a relationship between pressure and temperature. Shortly thereafter, the design and development of the world's first steam engines occurred in 1698 by Thomas Savery (Darling et al., 1956). Railways were the next noteworthy Engineering feat that was accomplished in London in 1803 (Darling et al., 1956). The United States also grasped the concept of steam engines and by 1787 the first steamboat was travelling upstream on the Potomac River (Billington, 1996). Americans adapted these ideas and developments from Great Britain and by 1830, the United States had produced their own steam locomotive and rail lines on which to travel (Billington, 1996). Other Engineering accomplishments during the late nineteenth century were dams and the Panama Canal (Darling et al., 1956). Equally important was the discovery and mass production of steel, especially in the United States but also in the other industrialized nations of the world (Billington, 1996).

The twentieth century brought about man-made Engineering inventions such as the airplane and the submarine, which were both utilized, in World War I with devastating affects. Even more advanced Engineering innovations and inventions were utilized in World War II, such as the jet and the atomic bomb, which was the forerunner of nuclear power in various forms and uses. Shortly after the automobile was introduced, tunnels were designed and engineered in New York by Alfred Nobel (Garrison, 1991). Modern skyscrapers were also introduced in the late nineteenth century in Chicago and New York City (Billington, 1996). Engineering during this period manifested itself in numerous ways. Petroleum engineering was developed and soon replaced coal and steam as the primary source of power. Fusion, and later fission, experiments were conducted by researchers with the purpose of discovering an additional method for creating power (Garrison 1991).

The current era has already seen several advances in the field of Engineering. However, one of the more prominent fields that have emerged in recent years has been in the area of biomedical engineering. Biomedical engineering is the combination of medicine and engineering that has introduced miraculous inventions such as radiology, ultrasound, pacemakers, defibrillators, and artificial organs (Garrison 1991).

The field of engineering in the twenty-first century will be an automated, cybernetic mechanized process and the computer will be the calculator for future engineers. A historical perspective on Engineering allows current and future engineers to measure the effects of their current and future developments (Garrison, 1991). Although there has been an accelerated rate of engineering developments over the past one hundred years, society is only in the infancy stages. Engineering advancements are radically changing our world and the impact on mankind approaches unbelievable. Many transformations in human activity will occur in the future due to mechanical power, new prime movers, and automatic controls in the field of engineering (Darling et al., 1956).

Modern Era

The start of the industrial revolution in the nineteenth century brought about a new era, better known as the Modern Era. This era quietly began in England in the eighteenth century. However, it was not until the nineteenth century that Science and Technology became intertwined and inseparable. Before the nineteenth century, Science and Technology were historically separate entities. Thinking and tool-making were combined in the nineteenth century to produce an industrialized world in terms of transportation, power production, military equipment, communication, and entertainment (McClellan & Dorn, 2006). The fusion of Science and Technology gained further momentum in the twentieth century with the discovery and arrangement of atoms, antibiotics, nuclear fission, the "The Big Bang Theory," the structure of DNA, and biomechanics, to name a few (Lightman, 2005). The beginning of the twenty-first century has already witnessed phenomenal advancements and engineering feats, especially when Science and Technology are interwoven. This is most evident with the first draft of the human genome and with the progression of stem cell research (McClellan & Dorn, 2006).

Historically, the list of intelligent and influential scientists and scientific accomplishments has shaped the world in which we live. This has occurred in different and vastly sophisticated ways (McClellan & Dorn, 2006). As the world has become more globally connected throughout recent history, the United States has expended an enormous amount of effort to maintain its position in the global arena with other countries in technological advancements in all areas. Included in these efforts has been the reoccurring phenomenon of the various educational reform movements, their changing objectives, and unique issues inherent to each reform. Implementing education reforms and meeting the stringent expectations of the reform legislation initiated by the government has been problematic at best and generally rather disorganized in terms of implementation and assessment. Most of the reform initiatives and efforts have been centered on the subjects of Mathematics and Science (Stotts, 2011). The following sections of the literature review will examine the historical involvement and efforts in reforming the curriculum and instruction for the subjects of Mathematics and Science by the federal government.

Mathematics Reform

Historically, the theories and ideas behind the Mathematics reform movements have fluctuated between traditional educational methods and strategies, which encompassed routine memorization and skills to the more progressive education of applying concepts. Current Mathematics initiatives have been centered on combining the two (Stotts, 2011). By definition, a reform challenges current practice and reforms in Mathematics and Science includes changes in both curriculum and instruction (Herrera & Owens, 2001). The "New Math Movement" of the 1960's and 1970's was the first Mathematics reform in public schools and was 15 years in the making. According to

Herrera and Owens (2001), there remained concerns on the international scene about high school preparation in Mathematics, especially in the wake of World War II and the advent of the Cold War that followed. To add to the concern about the inadequacy of the Mathematics curriculum in American schools to fulfill the demands of the technology needs of the future, the Soviet Union launched the world's first satellite into space in October of 1957. This particular event evoked the perception on behalf of wary Americans that the United States was behind in the world in Technology, Mathematics, and Science, as well as, our military prowess. Herrera and Owens (2008) noted that this event was commonly considered the event that launched the new Mathematics Revolution. A sense of urgency energized the public to provide the much-needed funding to begin the race in the area of Mathematics and Science; a movement that had already begun.

Headlining the New Mathematics Era were Jerome Bruner's educational theories and conceptual approach to Mathematics. Bruner claimed that if mathematical problems were chosen wisely, then students would be better served investigating and discovering rather than being provided with the relevant concepts and then being expected to practice the skills (Herrera & Owens, 2001). Critics of the New Math Program or "fuzzy math" movement took note of multiple weaknesses within the program. These weaknesses included: improper implementation of the program; textbooks that were developed without any teacher insight; little consideration for the reactions of parents and teachers; and lastly, teachers leading the assembly line when students were the products. However, the developers failed to take these considerations into account and The New Math Program became popularly known as a pedagogical failure (Stotts, 2011).

While public dissatisfaction was occurring over the New Math Program, public proponents for a back-to-the-basics program were opposed by advocates for the New Math Program. They argued that a focus on computational skills would hinder the development of application skills and critical thinking. By 1976, a balance between the new Mathematics and the old Mathematics was attempted. Of all the programs that attempted to blend the two pedagogies, Mastery Learning was resisted the least because it necessitated the least amount of changes in traditional classroom routines (Stotts, 2011). Mastery Learning is a philosophy that maintains that all students, regardless of their background, can achieve any curriculum objective if they are provided with efficient instruction and sufficient time. The primary weakness with Master Learning is that achieving a mastery objective is the endpoint of learning rather than the beginning (Verdinelli & Gentile, 2003).

According to Herrera and Owens (2001), a report from the National Advisory Committee on Mathematical Education (NACOME) in 1975 expressed concerns and recommended more work with applications and technology. These reports prompted the next reform to occur, which was the National Council of Teachers of Mathematics (NCTM) standards-based reform. Although there was not a Sputnik launch to ignite a new Mathematics reform in the 1980's, the perception of falling behind in global economic and technological standings was more than enough motivation for a new Mathematics reform (Herrera & Owens, 2001).

Another wake up call sent to Americans regarding the need for improvement in Mathematics, Science, and Technology was the publication of *A Nation at Risk* commissioned in 1983 by the National Commission for Excellence in Education (NCEE, 1983). The report from the NCEE claimed "If an unfriendly foreign power had attempted to impose on America the mediocre educational experience that exists today, we might well have viewed it as an act of war" (NCEE, 1983, p.5). In 1989, the NCTM responded to these perceptions of urgency for improvement with the publication and distribution of the *Curriculum and Evaluation Standards for School Mathematics* (Herrera & Owens, 2001). In lieu of specific topics to be covered in classrooms, these standards presented guidelines for school Mathematics, which included mathematical modeling, connections to the real-world, more integration of mathematic topics, emphasis on higher-order thinking and reasoning, and the inclusion of Geometry, patterns, and statistics in the curriculum. Changes in pedagogy included the facilitation of student involvement in discovering and constructing Mathematical concepts in lieu of just memorizing them, using visual representations and manipulatives, group work, student writing, and the teacher as a facilitator or orchestrator of learning experiences. This reform received a positive reaction from educators and a positive impact on school Mathematics. Additionally, in response to this reform, most states changed Mathematics curriculum frameworks to align with the standards published by the NCTM Herrera and Owens (2001).

While Herrera and Owens (2001) completed their article after the discussion on the two previous reforms, Stotts (2011) added information about the systematic reform-focused classroom. Stotts (2011) explained that reform encompasses the idea that the teacher is the facilitator who provides skills and concepts to students as needed and purposefully bridges students' knowledge to new contexts within the real-world.

The New Mathematics Movement, Standards-Based Reform, and the Systematic Reform Movement are all part of our nation's history in the classroom and all occurred with one sole purpose; to improve student achievement. All of these reforms were born and implemented in classrooms out of discontent with student performance in Mathematics and a concern for being comparable with other nations around the world in order to compete with the global economy of the future (Stotts, 2011).

Science Reform

Mathematics moved from a skills approach to a more inclusive skills and concepts pedagogy that was linked to real-world collaboration and context. Similarly, Science reform has also been transformed into a combination of skill and application approach (Tytler, 2010).

Immediately after the launch of Sputnik in 1957, the quality of Science education came into question along with the focus on Mathematics reform. According to Buxton and Provenzo (2011), this event marked the start of the "space race" between the Soviet Union and the United States. The authors noted that there was a shift toward curriculum reform that encompassed the structure of each of the Science disciplines instead of classical liberalism with a focus on educational efficiency. The educational reforms that evolved in the 1960's were part of a national plan to shift from the past and establish a future in which the United States would have superior knowledge in Science, Mathematics, and Technology and would consequently be the prevailing global force. Buxton and Provenzo (2011) indicated that the National Science Foundation funded the development of the new curricula throughout the 1960's and the 1970's. This eventually led to the emergence of the National Standards Movement in the 1980's and 1990's. The U.S. Department of Education, the National Institute of Health, and the National Science Foundation were organizations that contributed to developing, testing, and distributing the new Science curriculum (Stotts, 2011). The Science curriculum developed during this time focused on models of open-inquiry and students were asked to construct or discover necessary concepts to learn Science similar to how scientists learn Science (Buxton and Provenzo, 2011). Although teachers were provided with professional development and high-quality curriculum materials, the popular student perception of Science was that it was not relevant to their lives or to their futures (Stotts, 2011).

In the 2000's, a more current establishment of state standards attained popularity. It managed to emphasize the teaching of distinct Science benchmarks and simplifying and de-emphasizing inquiry into a constricted notion of practicing the scientific method (Buxton & Provenzo, 2011). These specified Science goals for all students, which encompassed a rich understanding of Science-based ways of knowing and understanding Science concepts were introduced (Stotts, 2011). During this time, it was a struggle for stakeholders to align the knowledge of in-service teachers with the new National Science Education Standards (NSES), which included the use of inquiry as the primary teaching strategy (Johnson, 2009). Although the No Child Left Behind (NCLB) Act appeared almost on the heals of the National Science Education Standards, the primary focus of NCLB Act was to provide more instructional time for Mathematics and Reading. Consequently, this served to suppress the teaching of Science (Johnson, 2009). The seven years after the implementation of the standards established by NCLB, professional development programs at the school and district level, were primarily focused on Reading and Mathematics. This left the opportunities for professional development for Science scarcely available or funded at all. The shift back to focusing on teaching Science in the classroom occurred in 2007 with an assessment and reallocation of the NCLB Act (Johnson, 2009). Time allocation for teaching Science was once again provided to teachers. However, they had not been provided any opportunities to learn about and understand NSES-based methods of teaching Science. With regards to understanding effective Science pedagogy, several schools and teachers were "left behind" according to Johnson, (2009). Tytler (2010) reported that there has been a longstanding and inadequate global representation of Science in the elementary school that existed prior to the NCLB Act and the provisions for elementary Science was poorly addressed by the NCLB Act. Tytler (2010) added that there has been a lack of teacher competence and confidence in teaching Science. Additionally, those teachers would readily embrace the subject of Science if they were provided with an understanding of the benefits of Science education for their students.

Both new and veteran teachers struggle with the pedagogical and curricular pressures of accountability and high-stakes testing. This is largely because of the lack of attention to the philosophy of Science and even less attention to the history of Science in their instructional or curricular practices. The same is said for university preparation of elementary teachers and middle school teachers of Science (Buxton & Provenzo, 2011). Furthermore, the subject of Science will be diminished if elementary schools are only concerned with numeracy and literacy. The goal for schools with regards to Science should be to provide students with a comprehensive liberal conception of education that includes ways of thinking about and integrating with the world instead of providing them with direct teaching and knowledge replication (Tytler 2010).

Science education reform in the United States has a history of changing and evolving similar to those of Mathematics reforms. With regards to Mathematics and Science, the history of these reforms has been centrally focused on the progression of academic achievement of students in these subjects with the purpose of producing a population that has the abilities and capabilities of competing in the technological global future (Tytler, 2010).

STEM Reform and Research

The trend in Science and Mathematics reforms is currently in motion with the implementation of the STEM initiative. STEM is an Acronym for Science, Technology, Engineering, and Mathematics (Brown et al., 2011).

According to the U.S. Department of Education (2012), the United States Federal Government Accountability Office (GAO) discovered and revealed in 2005 that 3 billion dollars were allocated to 207 distinct federal STEM education programs in the previous 2004 fiscal year. In 2007, GAO findings put the general STEM effort at another 3 billion dollars. To help strengthen America's leadership in the twenty-first century, President

Barack Obama requested a budget for the Department of Education and Blueprint for Reform of the Elementary and Secondary Education Act for the 2013 fiscal year. President Obama has requested funding for STEM in the following areas: 150 million dollars for Effective Teaching and Learning in STEM (this would replace the current Mathematics and Science Partnerships program); 80 million dollars for STEM teacher and leader training and professional development; 190 million dollars in grants to states to support STEM scholarships; 150 million dollars for STEM projects; 30 million dollars for STEM evidence-based grant competitions; 175 million dollars for higher education programs to improve STEM in postsecondary education; and 1 billion dollars for the RACE to the Top program to better align STEM standards between high schools and colleges (U.S. Department of Education, 2012).

Although designation for funding for STEM education programs began as early as 2004, the first STEM reform in education did not occur until 2007. The America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Act became law in August of 2007 (The Library of Congress, 2010). This occurred as a response to the anxieties that the United States will not be able to economically compete with other nations in the future due to the lack of sufficient stock in STEM education and workforce preparation. To maintain and improve United States' innovativeness in the twenty-first century, the America COMPETES Act focuses on three major areas: "To increase research investment in STEM education; To fortify educational opportunities in Science, Technology, Engineering, and Mathematics from kindergarten to graduate school and beyond (postdoctoral education); and To develop an innovation infrastructure" (Council on Undergraduate Research Quarterly, 2009, p. 11).

While a plethora of programs and funding exist for STEM initiatives, simultaneously a scarcity of research literature regarding the impact of STEM implementation also exists, especially with regards to elementary schools (Stotts, 2011). There has not been enough research regarding the positive effects of integrative approaches among STEM subjects on student academic achievement. An examination of these effects may provide some solutions and solve some of the present challenges in STEM education (Becker & Park, 2011). The lack of availability of research literature on STEM initiatives is largely due to the fact that the initiatives are still in the infancy stage. There are however, college entrance exam scores, reports and research studies on identifying indicators of success in STEM majors for college students, and effects of integrative approaches among STEM subjects, as well as background information and studies on specialized STEM schools.

To demonstrate that students need to be better prepared through the STEM pipeline leading into high school, Adams (2012) revealed information from students' ACT (American College Testing) scores nation-wide for the 2011-2012 school year. The report provides performance information for students in the spring graduating class who were assessed as sophomores, juniors, and seniors. The article indicated that 52 percent (1.67 million) of the nations' seniors took the assessment the previous year and were tested in the areas of English, Mathematics, Reading, and Science. The article also indicated that the STEM curriculum helped bump the performance on Mathematics and

Science sections of the test. The percentage of students meeting benchmarks in Mathematics rose from 43 percent in 2008 to 46 percent in 2012 and in Science from 26 percent to 31 percent during that same period. While these scores do not indicate a dramatic improvement, they do display a greater improvement than the scores for English and Reading which both reflected a decrease of 1 percent (Adams, 2012).

Another example of the need for the United States to motivate student interest in STEM subjects and send them through the STEM pipeline is provided in a research study conducted at a large public institution in the State of Texas in 2009 (Thompson & Bolin, 2011). The study consisted of a population of 3,618 students labeled as the 'New From High School' group who either declared a major in Business, Education, or STEM. The researchers in this study were trying to determine if there were specific factors that could be attributed to students graduating from college, dropping out of college, or switching their majors. The researchers analyzed the population by evaluating various categories such as gender, ethnicity, major, county of residency, and high school rank. The researchers concluded that males were more likely to choose STEM majors. However, males also displayed a higher dropout from rate from college for STEM majors. While addressing the ethnicity and county of residency, the researchers determined that there was no statistically significant difference between the actions the student would take based on either of these factors. The researchers did discover that high school rank had a statistically significant relationship with the action a STEM student might take. The researchers also discovered that out of the three majors studied, Business, Education, and STEM, that STEM majors had the highest rate of students transferring to another major.

The researchers concluded that regardless of a student's gender, race, or county of residence, recruiting and admission counselors needed to encourage and recruit higher-ranking students from high school for STEM majors (Thompson & Bolin, 2011).

While Thompson and Bolin (2011) conducted a study on the indicators of success for STEM majors at a university, Becker and Park (2011) conducted a study on the effects of integrative approaches among STEM subjects on students' learning. The researchers' purpose for conducting this initial meta-analysis was projected to "facilitate a greater understanding of the effects of integrative approaches among STEM subjects, and the findings will shed light on students' learning in STEM subjects" (Becker & Park, 2011, p. 1). The researchers conducted a meta-analysis that consisted of selecting twenty-eight previously conducted studies by other researchers and thirty-three effect sizes to evaluate the impact of integrative approaches among STEM subjects. The researchers claimed that integrative approaches (methods that implement teaching and learning across two or more STEM subject areas) to teaching STEM not only enhance students' interest and learning, but also provide students with a solid STEM education that will fulfill the strong need to prepare them for the future.

This particular investigation by Becker and Park (2011) has merit in that it does report on existing research on the topic. However, there were not more than twenty-eight valuable investigations on which to report due to the fact that most research studies involving STEM were theoretical and not based upon actual research. Therefore, the researchers discovered they were limited by relying on documentation and information provided by primary authors as well as by the amount of research. After calculating the amount of sources utilized in this investigation (seventy-six), and then calculating the amount of sources that are ten years or older (thirty-five), and being that implementing STEM in the classroom is a fairly new concept, the findings for this investigation should have been separated into two categories: recent findings and previous findings. While the researchers concluded that integrative approaches among STEM subjects do have a positive effect on academic achievement, they also recommend further research in this particular field (Becker & Park, 2011).

Conclusion

To gain a better understanding of the historical and current elements of STEM, several topics were explored in the literature review; the history of Mathematics, the history of Science, Mathematics reforms, Science reforms, STEM reforms and STEM research. The purpose of this study was to explore the impact of the STEM initiative in elementary classrooms in schools in a school district in Middle Tennessee. The study sought to identify the impact the STEM initiative has on student Mathematics scores on the state standardized test. Additionally, it sought to determine the impact the STEM initiative had on student Science scores on the state standardized test. The research project was intended to contribute to the disparity of existing research on the STEM initiative and the impact that it may have on student academic achievement.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this field study was to identify the impact that the STEM program has on Mathematics and Science academic achievement. The independent variable was the STEM program and the dependent variable was the TCAP (Tennessee Comprehensive Assessment Program) scores. To ascertain the impact STEM has on student academic achievement in Mathematics and Science, more research is necessary in the school district where the study will be conducted, especially at the elementary level.

Research Design

This was a quantitative study, which provided averages and distributions of data. The researcher used a non-experimental, causal-comparative research design (ex post facto research). Only archival data was utilized to determine an impact that STEM implementation may have had on student academic achievement in Mathematics and Science. A t-test was utilized to determine whether the difference between means for classes that implemented STEM and for those that did not implement STEM was statistically significant for each grade level (third, fourth, fifth, and eighth). The t-tests also determined whether or not the null hypotheses should be retained or rejected. The independent variable in this study was the STEM program and its implementation in the classroom. The dependent variable in this study was the TCAP (Tennessee Comprehensive Assessment Program).

Population

The population for this study consisted of third, fourth, fifth, and eighth grade students in one school district selected from schools that did and did not participate in the STEM program. Although there were 21 elementary schools in this particular school district in the 2011-2012 school year, all four grade levels did not have the STEM program implemented at every school. Some of the schools implemented the STEM program in the third grade while other schools implemented the STEM program in the fourth, fifth, or eighth grades. Additionally, there were some schools that implemented the STEM program in more than one of these particular grade levels. There were five schools that implemented the STEM program at the third grade level (approximately 125 students) and these schools were matched with five schools that did not implement STEM at the third grade level. There were eight schools that implemented STEM at the fourth grade level (approximately 200 students) and these schools were also matched with eight schools that did not implement STEM at the fourth grade level. Lastly, there were seven schools that implemented the STEM program at the fifth grade level (approximately 175 students) and these schools were also matched with seven schools in the same district that did not implement the STEM program at the fifth grade level.

The population at each elementary or middle school varies with regards to socio-economic status, ethnicity, gender, and mobility of students and therefore schools were divided into separate categories. After the schools were labeled and divided, they were matched. Schools that implemented STEM in a particular grade level were matched and compared to that same grade level at a school that did not implement the STEM program.

The sample for each grade level is appropriate for generalizing the population because the sample is located in the same school district as the population.

Instrument

The instrument that was utilized in this study to gather standardized test data in Mathematics and Science was the TCAP (Tennessee Comprehensive Assessment Program). The TCAP is an annual assessment administered to students in grades third through eighth throughout the State of Tennessee, and more specifically, in the school district where the study was conducted. This particular assessment used multiple-choice questions in Reading, Language Arts, Mathematics, Science, and Social Studies to measure students' knowledge and application skills. Each of the items on the test included Criterion-Referenced items that were aligned with the state content standards. The purpose of the assessment was to provide results on individual student academic growth and achievement. The data was recorded for individual students at the state level and contained results on academic achievement for the English Language Arts, Mathematics, Science, and Social Studies subjects.

Procedure

The data utilized for this study was obtained from the school district's Accountability Coordinator. This particular individual spent hundreds of hours reviewing several factors for each school with the purpose of adequately matching schools as close as and as accurate as possible. Schools were matched with consideration to the following factors: socio-economic status, ethnicity, gender, and mobility of students. With regards to socio-economic status, schools divided into four categories;

70-90% low-income, 50-69% low income, 30-49% low income, and less than 30% low income. With regards to ethnicity, schools were divided into five separate categories: 50/50% majority/minority, 40/60% majority/minority, 30/70% majority/minority, 60/40% majority/minority, and 70/30% majority/minority. Gender is essentially equivalent throughout the school district with all schools containing approximately 50/50% male/female. Lastly, with regards to mobility rate, schools were divided into three categories: high mobility (greater than 50%), mid mobility (30 – 49%), and low mobility (Lees than 30%). After each school was identified and labeled within each category they were matched together. Schools that implemented STEM in a particular grade level were matched and compared to the same grade level at another school that did not implement the STEM program at that grade level. After each of the schools were matched and compared, two tables were created. A STEM Value Added Data table was created to display the grade level growth in both Mathematics and Science for third, fourth, fifth and eighth grades for the schools that implemented STEM and also a table was created for Non-STEM Value Added Data that was created to display grade level growth in both Mathematics and Science for third, fourth, fifth, and eighth grades for the schools that did not implement the STEM program.

The researcher utilized the data displayed on both tables to generate six separate t-tests. A t-test was conducted to determine whether or not there was a statistical significance on the overall growth in Mathematics for all four grade levels combined. The second t-test was conducted to determine whether or not there was a statistical significance on the overall growth in Science for all four grade levels combined. There were four additional tests conducted (one for each grade level) to compare the STEM Value Added Data to the Non-STEM Value Added Data from the 2011-2012 school year. The results of the t-tests are reported in Chapter Four of this field study and were provided to the school district.

Null Hypotheses

1. There will be no statistically significant difference in the overall Mathematics growth for students in grades three, four, five, and eight on the state standardized test, TCAP, between the intervention group and the nonintervention group.
2. There will be no statistically significant difference in the overall Science growth for students in grades three, four, five, and eight on a state standardized test, TCAP, between the intervention group and the nonintervention group.
3. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between third grade students who have had access to the STEM program and third grade students who did not have access to the STEM program.
4. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between fourth grade students who had access to the STEM program and fourth grade students who did not have access to the STEM program.
5. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment

between fifth grade students who had access to the STEM program and fifth grade students who did not have access to the STEM program.

6. There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between eighth grade students who had access to the STEM program and eighth grade students who did not have access to the STEM program.

Data Analysis Plan

A two-tailed t-test was utilized to compare the value added scores of students from grade levels three, four, five, and eight. A t-test was administered to determine statistical significance in student achievement scores for Mathematics and Science on the TCAP assessment in grades three, four, five, and eight.

The researcher compared the value added scores to determine whether they were statistically significant. Math value added scores on the TCAP were compared for the groups who had access to the STEM program and those that did not. Also, Science value added scores on the TCAP were compared for the groups who had access to the STEM program and those that did not. The researcher evaluated the data to determine whether or not there was a significant statistical difference between the value added scores of Mathematics and Science between the students that did have access to the STEM program and those that did not. Depending upon the findings, the researcher either rejected or retained each null hypothesis.

CHAPTER IV

RESULTS

Reasoning for the Data Utilized

This chapter presents the results for academic achievement in Mathematics and Science on a state standardized test on behalf of students in in third, fourth, fifth and eight grades in a county in Middle Tennessee for the 2011-2012 academic school year. A t-test was conducted to answer each research question and to determine whether each null hypothesis in this study would be accepted or rejected. The purpose of the independent samples t-test was to determine if the two sets of data in this study (NCE scores on behalf of students exposed to the STEM program and NCE scores for students that were not exposed to the STEM program) were significantly different. The independent samples t-test was used to determine if a causal-comparative relationship existed between student academic achievement in Mathematics and Science and the participation of students in the STEM program versus those who did not participate in the STEM program. Statistical significance was determined using an alpha value of $p = .05$. Students' Mathematics and Science scores were combined in each t-test instead of observed independently to utilize a larger pool of data and with the purpose of presenting a keener argument.

Description of the Data Sets

The data utilized in this study consisted of two data sets. The first data set presented NCE scores (a method of standardizing test scores) on a state standardized test for students in third, fourth, fifth, and eighth grades that were in classrooms where the

STEM program was implemented. The second data set displayed NCE scores on a state standardized test for students in third, fourth, fifth, and eighth grades that were in classrooms where the STEM program was not implemented.

Table 1 Results

Table 1 displays the data for student academic growth in Mathematics for each grade level. Value Added Data results for student Mathematics scores are noted for the students who participated in the Science, Technology, Engineering, and Mathematics (STEM) Programs and also the scores for those students who were in schools that did not provide the STEM Program for the students in the study. The NCE scores are provided for the students in the STEM and Non-STEM schools for the third, fourth, fifth, and eighth grades.

Table 1

Value Added Data for Mathematics

Grade Level	STEM Schools	Non-STEM Schools
Third Grade	6.9 NCE	4.8 NCE
Fourth Grade	4.7 NCE	3.3 NCE
Fifth Grade	5.0 NCE	1.4 NCE
Eighth Grade	0.9 NCE	4.9 NCE

Table 2 Results

Table 2 displays the data for student academic growth in Science for each grade level. Value Added Data results for student Science scores are noted for the students who participated in the Science, Technology, Engineering, and Mathematics (STEM) Programs and also the scores for those students who were in schools that did not provide the STEM Program for the students in the study. The NCE scores are provided for the students in the STEM and Non-STEM schools for the third, fourth, fifth, and eighth grades.

Table 2

Value Added Data for Science

Grade Level	STEM Schools	Non-STEM Schools
Third Grade	7.4 NCE	5.8 NCE
Fourth Grade	3.6 NCE	3.5 NCE
Fifth Grade	4.3 NCE	1.6 NCE
Eighth Grade	2.2 NCE	2.2 NCE

Table 3 Results

Table 3 provides the results of each t-test administered. Table 3 presents the results for comparing the overall Mathematics and Science Normal Curve Equivalency (NCE) gains or growth for all students where all grade levels are combined. The *p* value is noted to determine the level of statistical significance for the data set.

Table 3

Comparison of NCE Gains in Overall Mathematics and Science Growth

Grade Level	t	*p*
Mathematics	3.482	.040
Science	3.982	.028

p = .05

Table 4 Results

Table four presents the results of each *t*-test for the combined Mathematics and Science NCE scores for each individual grade level. This data was utilized to answer the six research questions in this study and to determine whether or not each of the null hypotheses should be retained or rejected.

Table 4

Comparison of Combined NCE Gains in Mathematics and Science

Grade Level	N	t	*p*
Third	317	28.600	.022
Fourth	553	7.545	.084
Fifth	433	13.286	.048
Eighth	2023	2.385	.253

p =.05

Research Questions and Results for Each Null Hypothesis

Research Question 1: Does the implementation of STEM subjects have an impact on the overall Mathematics growth for students in grades three, four, five, and eight, based upon a state standardized test, TCAP?

Null Hypothesis 1: There will be no statistically significant difference in the overall Mathematics growth for students in grades three, four, five, and eight on the state standardized test, TCAP, between the intervention group and the nonintervention group.

An independent samples *t*-test was conducted to evaluate the null hypothesis that there would not be a statistically significant difference on the overall Mathematics growth for students in grades three, four, five, and eight on a state standardized test that had access to the STEM program. The *t*-test indicated a statistical significance, $t\ (3383) = 3.482$, $p = .040$. The results were significant at the .05 level and, therefore, research question 1 was satisfied and the Null Hypothesis was rejected. Based on the data and the statistical results it is suggested that students in grades three, four, five, and eight that had access to the STEM program did show more academic growth on the Mathematics portion of the TCAP than their counterparts in classrooms that did not have access to the STEM program. Table 3 provides the test results for Mathematics.

Research Question 2: Does the implementation of STEM subjects have an impact on the overall Science growth for students in grades three, four, five, and eight, based upon the state standardized test, TCAP?

Null Hypothesis 2: There will be no statistically significant difference in the overall Science growth for students in grades three, four, five, and eight on a state standardized test, TCAP, between the intervention group and the nonintervention group.

An independent samples *t*-test was conducted to evaluate the null hypothesis that there would not be a statistically significant difference on the overall Science growth for students in grades three, four, five, and eight on a state standardized test that had access to the STEM program. The *t*-test indicated statistical significance, t (3383) = 3.982, p = .028. The results were significant at the .05 level and, therefore, research question 2 was satisfied and the null hypothesis was rejected. Based on the data and the statistical results it is suggested that students in grades three, four, five, and eight that had access to the STEM program did show more academic growth on the Science portion of the TCAP than their counterparts in classrooms that did not have access to the STEM program. Table 3 provides the results for Science.

Research Question 3: Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to third grade students?

Null Hypothesis 3: There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between third grade students who have had access to the STEM program and third grade students who did not have access to the STEM program.

An independent samples *t*-test was conducted to evaluate the null hypothesis that third grade students that were in classrooms where the STEM program was implemented would not show more academic growth on the combined Mathematics and Science NCE scores on the TCAP assessment than their peers in classrooms where the STEM program was not implemented. The *t*-test indicated statistical significance, $t\ (317) = 28.600$, $p = .022$. The results were significant at the .05 level and, therefore, research question 3 was satisfied and the null hypothesis was rejected. Based on the data and statistical results it is suggested that students in the third grade that had access to the STEM program (Mathematics NCE = 6.9 and Science NCE = 7.4) did show more academic growth on the TCAP than their counterparts in classrooms that did not have access to the STEM program (Mathematics NCE = 4.8 and Science NCE = 5.8). Table 4 provided the results for Mathematics and Science for third grade.

Research Question 4: Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to fourth grade students?

Null Hypothesis 4: There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between fourth grade students who had access to the STEM program and fourth grade students who did not have access to the STEM program.

An independent samples *t*-test was conducted to evaluate the null hypothesis that fourth grade students that were in classrooms where the STEM program was implemented would not show more academic growth on the combined Mathematics and Science NCE scores on the TCAP assessment than their peers in classrooms where the STEM program was not implemented. The *t*-test did not indicate any statistically significant differences, t (553) = 7.545, p = .084. The results were not significant at the .05 level and, therefore, research question 4 was satisfied and the null hypothesis was retained. Based on the data and the statistical results it is suggested that students in the fourth grade that had access to the STEM program (Mathematics NCE = 4.7 and Science NCE 3.6) did not show more academic growth on the TCAP than their counterparts in classrooms that did not have access to the STEM program (Mathematics NCE = 3.3 and Science NCE = 3.5). Table 4 provides the results for Mathematics and Science for fourth grade.

Research question 5: Does the implementation of STEM subjects have an impact on the combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to fifth grade students?

Null Hypothesis 5: There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between fifth grade students who had access to the STEM program and fifth grade students who did not have access to the STEM program.

An independent samples t-test was conducted to evaluate the null hypothesis that fifth grade students that were in classrooms where the STEM program was implemented would not show more academic growth on the combined Mathematics and Science NCE scores on the TCAP assessment than their peers in classrooms where the STEM program was not implemented. The t-test indicated statistical significance, t (433) = 13.286, p = .048. The results were significant at the .05 level and, therefore, research question 5 was satisfied and the null hypothesis was rejected. Based on the data and the statistical results it is suggested that students in the fifth grade that had access to the STEM program (Mathematics NCE = 5.0 and Science NCE = 4.3) did show more academic growth on the TCAP than their counterparts in classrooms that did not have access to the STEM program (Mathematics NCE = 1.4 and Science NCE = 1.6). Table 4 provides test results for Mathematics and Science for fifth grade.

Research Question 6: Does the implementation of STEM subjects have an impact on combined Mathematics and Science NCE (normal curve equivalent) scores, based upon the state standardized test, TCAP, administered to eighth grade students?

Null Hypothesis 6: There will be no statistically significant difference in the combined Mathematics and Science NCE (normal curve equivalent) scores on the TCAP assessment between eighth grade students who had access to the STEM program and eighth grade students who did not have access to the STEM program.

An independent samples *t*-test was conducted to evaluate the null hypothesis that eighth grade students that were in classrooms where the STEM program was implemented would not show more academic growth on the combined Mathematics and Science NCE scores on the TCAP assessment than their peers in classrooms where the STEM program was not implemented. The *t*-test did not indicate any statistical significance, $t\ (2080) = 2.385, p = .253$. The results were not significant at the .05 level and, therefore, research question 6 was satisfied and the null hypothesis was retained. Based on the data and the statistical results it is suggested that students in the eighth grade that had access to the STEM program (Mathematics NCE = 0.9 and Science NCE 2.2) did not show more academic growth on the TCAP than their counterparts in classrooms that did not have access to the STEM program (Mathematics NCE = 4.9 and Science NCE = 2.2). Table 4 provides the results for Mathematics and Science for eighth grade.

Summary

This chapter presented the results for academic student achievement for Mathematics and Science on behalf of students in the third, fourth, fifth, and eighth grades that had access to the STEM program or did not have access to the STEM program. The results addressed each research question and uncovered whether academic student achievement in each grade level was impacted by the STEM program or if it was not impacted. Each individual grade level was observed as well as overall growth on behalf of all four grade levels in both Mathematics and Science. The next chapter will present a precise approach to view these results and offer recommendations for practice for future research on the impact of the STEM program on academic student achievement in Mathematics and Science.

CHAPTER V

SUMMARY AND CONCLUSIONS

STEM Impact on Student Academic Achievement

This chapter presents the findings of a case study that examined the impact that the STEM program has on student academic achievement in Mathematics and Science for third, fourth, fifth, and eighth grade students in one school district in Middle Tennessee. This chapter serves as an extension of the chapter four results. The sections below describe where statistically significant differences were observed and where statistically significant differences were not observed. The purpose of this field study was to explore and identify impact that the STEM program has on student academic achievement in Mathematics and Science on a state standardized test.

There was a statistically significant difference in overall Mathematics scores. The NCE scores for all four grade levels were combined from both data sets (STEM value added data and non-STEM value added data) and after conducting a *t*-test with this specific data, a suggested casual-comparative relationship was identified between the implementation of the STEM program and student academic achievement in Mathematics ($p = .028$). Therefore, it was concluded that the STEM program may have a positive impact on student academic achievement in Mathematics across all grade levels.

There was also a statistically significant difference observed in overall Science scores. The NCE scores for all four grade levels were combined from both data sets (STEM value added data and non-STEM value added data) and after conducting a *t*-test with this specific data, a suggested casual-comparative relationship was identified between the implementation of the STEM program and student academic achievement in Science (p = .040). Therefore, it was concluded that the STEM program may have a positive impact on student academic achievement in Science for all four combined grade levels.

There was a statistically significant difference in the combined Mathematics and Science scores for students in the third grade. The combined NCE scores for Mathematics and Science for third grade students were compared from both data sets (STEM value added data and non-STEM value added data). After conducting a *t*-test with this specific data, a suggested casual-comparative relationship was identified between the implementation of the STEM program and student academic achievement in Mathematics and Science (p = .022). Therefore, it was suggested that the STEM program may have a positive impact on student academic achievement in Mathematics and Science for third grade students.

There was not a statistically significant difference in the combined Mathematics and Science scores for students in the fourth grade. The combined NCE scores for Mathematics and Science for fourth grade students were compared from both data sets (STEM value added data and non-STEM value added data). After conducting a *t*-test with this specific data, a suggested casual-comparative relationship was not identified between the implementation of the STEM program and student academic achievement in Mathematics and Science (p = .084). Therefore, it was suggested that the STEM program may not have a positive impact on student academic achievement in Mathematics and Science on behalf of fourth grade students.

There was a statistically significant difference in the combined Mathematics and Science scores on behalf of students in the fifth grade. The combined NCE scores for Mathematics and Science for fifth grade students were compared from both data sets (STEM value added data and non-STEM value added data). After conducting a *t*-test with this specific data, a suggested casual-comparative relationship was identified between the implementation of the STEM program and student academic achievement in Mathematics and Science (p = .048). Therefore, it was suggested that the STEM program may have a positive impact on student academic achievement in Mathematics and Science for fifth grade students.

There was not a significant statistical difference in the combined Mathematics and Science scores on behalf of students in the eighth grade. The combined NCE scores for Mathematics and Science for eighth grade students were compared from both data sets (STEM value added data and non-STEM value added data). After conducting a *t*-test with this specific data, a suggested casual-comparative relationship was not identified between the implementation of the STEM program and student academic achievement in Mathematics and Science (p = .253). Therefore, it was suggested that the STEM program may not have a positive impact on student academic achievement in Mathematics and Science on behalf of eighth grade students.

Recommendations for Future Research

Several future research opportunities emerge from the findings of this research and the country's continuous focus on STEM education. This study could be considered as a pilot study and further investigation and research could be conducted to determine which factors were present in the third and fifth grades that were not present in the fourth and eighth grades with regards to the STEM program. This study combined the Mathematics and Science scores for each grade level. Future researchers should consider gathering a larger sample size and compare Mathematics and Science NCE scores separately for each grade level.

Future research could explore culture and gender academic optimism. Future research could also investigate other factors that may have an impact such as STEM clubs and participation in STEM competitions to understand the impact on student engagement. Additional research could also track current and past students in the county or the state where this research was conducted for trend analysis in regards to underrepresented minorities and gender balance in STEM fields.

Lastly, future research could be conducted on teacher fidelity to the STEM program in this district. Additionally, future research could investigate which classrooms have been most successful and therefore determine the strategies that are most effective.

Conclusion

The purpose of this field study was to explore the impact that the STEM program had on student academic achievement in Mathematics and Science on behalf of students in the third, fourth, fifth, and eighth grades in a school district in Middle Tennessee. The independent variable was the STEM program and the dependent variable was the TCAP (Tennessee Comprehensive Assessment Program) scores. The study suggests that the STEM program may have a positive impact on student academic growth in Mathematics and Science on the TCAP in the third and fifth grades. The study also suggests that the

STEM program may not have a positive impact on student academic growth in Mathematics and Science on the TCAP in the fourth and eighth grades. However, when all of the NCE scores for all four grade levels were combined from the STEM value added data and compared to all of the NCE scores for all four grade levels combined from the non-STEM value added data, it was suggested that the STEM program may have a positive impact on student academic growth on the TCAP for both Mathematics and Science. Further research is necessary to determine the key factors in the STEM program that promote student academic growth and success in Mathematics and Science.

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TABLES

Table 1

Value Added Data for Mathematics

Grade Level	STEM Schools	Non-STEM Schools
Third Grade	6.9 NCE	4.8 NCE
Fourth Grade	4.7 NCE	3.3 NCE
Fifth Grade	5.0 NCE	1.4 NCE
Eighth Grade	0.9 NCE	4.9 NCE

Table 2

Value Added Data for Science

Grade Level	STEM Schools	Non-STEM Schools
Third Grade	7.4 NCE	5.8 NCE
Fourth Grade	3.6 NCE	3.5 NCE
Fifth Grade	4.3 NCE	1.6 NCE
Eighth Grade	2.2 NCE	2.2 NCE

Table 3

Comparison of NCE Gains in Overall Mathematics and Science Growth

Grade Level	t	*p*
Mathematics	3.482	.040
Science	3.982	.028

p = .05

Table 4

Comparison of Combined NCE Gains in Mathematics and Science

Grade Level	t	*p*
Third	28.600	.022
Fourth	7.545	.084
Fifth	13.286	.048
Eighth	2.385	.253

p =.05

APPENDICES

APPENDIX A

Institutional Review Board (IRB) Approval Letter

Date: December 4, 2012

RE: Study number _12-074______

Dear Briget Ethier,

Thank you for your recent submission to the IRB. We appreciate your cooperation with the human research review process.

Congratulations! This is to confirm that your proposal has been approved and that your study is exempt from further review by the APIRB.

You may conduct your study as described in your application, effective immediately.

Please note that any changes to the study must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. If you have any questions or require further information, you can contact me by phone (931-221-6106) or email (shepherdo@apsu.edu).

Again, thank you for your cooperation with the APSU IRB and the human research review process. Best wishes for a successful study!

Sincerely,

Omie Shepherd

Omie Shepherd, Chair
Austin Peay Institutional Review Board

Cc: Dr. J. Gary Stewart

Appendix B

Letter to CMCSS for Permission to Conduct Research

Dear CMCSS Research Committee, October 15, 2012

My name is Briget Ethier and this is my fourth school year employed as a teacher in CMCSS. I am currently attending Austin Peay State University to obtain an Education Specialist Degree in School Leadership and I am in the beginning stages of conducting my field study. I would like to ask the research Committee for permission to obtain data and conduct research on the STEM (science, technology, engineering, and math) program that we have begun to implement in our school system.

A. The general target population of the study would be students that participated in STEM last year and those that did not. For instance, I would like to review data for the TCAP scores from students in third grade from schools that did participate in STEM and those that did not from as many schools that the committee will allow. I would like to focus on science and math scores only.
B. The purpose of the study would be to identify the difference in academic achievement for science and math between the students that did participate in the STEM program versus those that did not.
C. Individual students will not be identified in this study and therefore it may not be necessary to inform parents or obtain parents' written consent.
D. The results of the research will be displayed in my field study project in text, charts, and graphs.
E. The results of my research will be provided to the Research Committee in CMCSS and be published in my field study project for APSU.

I appreciate the Research Committee's time in this matter and would greatly appreciate the opportunity to conduct research on the STEM program in CMCSS.

Sincerely,

Briget Ethier
Pre-Kindergarten Teacher
Sango Elementary School

APPENDIX C

Permission to Conduct Research from CMCSS

CLARKSVILLE

SCHOOL SYSTEM

Briget Ethier

Monday, October 22, 2012 9:54 AM

Dr. Armstrong,

I am currently in the beginning stages of working on my field study project for APSU. I would like to ask the Research Committee for permission to access and utilize data to conduct my field study project on STEM and how it is related to academic achievement in the areas of math and science at the elementary level. Attached is my letter to ask the Research Committee of CMCSS for permission to conduct a field study project to complete the requirements for APSU. I would like to thank you very much for your time in this matter.

Briget Ethier
Pre-k Teacher
Sango Elementary School

... for APSU

Briget Ethier

Dear Dr. Armstrong,

I emailed a permission letter to conduct a field study for APSU on STEM and its impact on academic achievement a couple of weeks ago. I have not received a reply and was wondering if perhaps it may have been sent to your Spam account. I am attaching it again just in case. I really appreciate your time and help.

Sincerely,

Briget Ethier
Pre-k Teacher
Sango Elementary School

... APSU

Sallie Armstrong

Will you use only archival data?

Briget Ethier

Tuesday, November 13, 2012 3:41 PM

Yes Mam.

Briget Ethier
Pre K Teacher
Sango Elementary School

Sallie Armstrong

You have permission to conduct this research.

Briget Ethier

Tuesday, November 13, 2012 3:44 PM

Thank you very much Dr. Armstrong. I really appreciate it.

Briget Ethier
Pre K Teacher
Sango Elementary School