Analysis of the Effects of the STEM Program on Ninth Grade Algebra 1 EOC Scores at Northeast High School

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An Analysis of the Effects of the STEM Program on Ninth Grade Algebra 1 EOC Scores at Northeast High School

A Field Study

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Of the Requirements for the Degree

Education Specialist

Penelope Forest Gregory
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To the College of Graduate Studies:

We are submitting a Field Study written by Penelope Gregory entitled "An Analysis of the Effects of the STEM Program on Ninth Grade Algebra 1 EOC Scores at Northeast High School." We have examined the final copy of this Field Study for form and content. We recommend that it be accepted in partial fulfillment of the requirements for the degree of Education Specialist.

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ABSTRACT

Penelope F. Gregory. An Analysis of the Effects of the STEM Program on Ninth Grade Algebra 1 EOC Scores at Northeast High School (Under the direction of Dr. Moniqueka Gold.)

Purpose

The purpose of this study was to explore the effects of STEM Programs on math achievement based on Algebra 1 EOC scores. It looks at the effects of STEM Programs in relation to the following subgroups: ethnicity, gender, and special education.

Methods

The data was collected from authorized personnel in the district. The design method used was a Three – Way ANOVA. This was used to determine if the STEM program had an effect on Algebra 1 EOC scores. The Algebra 1 scores of first time ninth graders prior to implementation of the STEM Program are compared to Algebra 1 scores after implementation of the STEM program.

Results

The results show that the STEM program did have an effect on scores although there was no significant difference or interactions between the scores of boys and girls. It did have a positive effect and interaction for the African Americans and Hispanics although the scores for Hispanic students did not rise as sharply.

DEDICATION

This Field Study is dedicated to my Lord and Savior, Jesus Christ.

ACKNOWLEDGEMENTS

I would like to acknowledge Jesus Christ, my Lord and Savior. This would not have been possible without you and the help that you sent when I needed it. I acknowledge my family, Mom and Dad, Joe and Rubbie Forest, – you never gave up on me, my brother, Dr. Reginald Forest, you inspire me, my sister – in – law, Isabel Forest, you encourage me and my nieces – Keai – you are so education minded and smart, I couldn't quit, I know you'll go further than this, Nina – your energy keeps me going and my nephew Roland – your smile makes it all worthwhile. To Dr. LaJoyce Weatherspoon – thank you for encouraging me to go back and finish; Debbie Cunningham – Thank you for your help and encouragement; To Adrienne White – you are a gift from God - Thank you for your help; To my friends Jackie Lowe and Nick and Sarah Taylor and Ariel – Thank you for the encouragement. And to my friend and my sister, Eva Martin – you always come to my rescue, even at the 11th hour. Thank you. You are indeed a blessing to me. To my Graduate Committee - Thank you for working with me. Dr. McConnell – Many thanks to you for your help. It is greatly appreciated.

And to my Advisor, Dr. Moniqueka Gold – I appreciate your kindness, your patience, understanding and encouragement. Thank you for not giving up on me and for helping me get to this point. You were indeed an answer to a prayer.

I love you all!!

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More research needs to be done to determine if this is a permanent strategy that will help improve math achievement. The research needs to be expanded to include more ethnic groups, more schools and the socioeconomic status of students.

Chapter 1

Introduction

Statement of the Problem

Today's world is a global one. People are more technologically savvy and technologically dependent than at any other time in history. This requires today's students to master the skills needed for math, science and technology. This means schools have to supply students with these skills so they will be able to compete for jobs in a global economy.

Academic performance of students in the American public school system, especially secondary schools, has been a concern founded and justified by the bleak performance on state and national assessments (Abrahamson, 2007). Performance on national and international tests was below the international average (Bernstein, 1997). Abrahamson (2007) also states the poor performance is reflected across many subgroups of students with the achievement gaps remaining consistent and present, creating a perilous situation for the future of our nation. This is a critical undertaking and has paved the way to many educational reforms, which, hopefully, will lead to academic progress (Abrahamson, 2007). These reforms have provided a motivation for many new strategies and programs to improve math achievement. One of those programs is the Science, Technology, Engineering, and Mathematics (STEM) program.

Purpose of the Study

This field study will examine the STEM Program and its effects on Math Achievement. Specifically, it examines the effects of implementing a required STEM

Program on Algebra 1 EOC scores for the following subgroups: ethnicity, gender before and after implementation of a STEM Program.

Significance of the Study

This field study will be beneficial to federal, state and local governments, as well as school districts. With the lack of funding for school budgets, are STEM Programs an effective use of the school's money and resources? Under current funding formulas, many schools do not have enough money for necessary day – to – day operations. Is it a good use of resources to spend a large proportion or even a small proportion of that funding on STEM Programs? Are STEM Programs effective? If they are effective, should schools be doing more to use this type of program? Do the concepts and methods used in STEM Programs benefit all students and schools?

Research Questions

- Is there a significant difference in math achievement based on Algebra 1 End of Course (EOC) scores after implementation of a STEM Program?
- Is there a significant difference in math achievement based on Algebra 1 EOC scores after implementation of a STEM Program for gender?
- Is there a significant difference in math achievement based on Algebra 1 EOC scores after implementation of a STEM Program for ethnic subgroups?

Hypotheses

- There is no significant difference in math achievement before and after the implementation of the STEM Program at a participating high school overall.
- There is no significant difference in math achievement before and after the implementation STEM Program at a participating high school for gender.

- There is no significant difference in math achievement before and after implementation of the STEM Program at a participating high school for ethnic subgroups.

Limitations

- The school being used in this study has a transient population because of the military. Students are moving in and out on a regular basis. This means it will not be generalized to the overall population of the district, county or state.
- There was a limited amount of time to complete the study. This study is not longitudinal.
- The STEM program at the participating school is one year old. Therefore the results of the study may be influenced by the newness of the program.

Assumptions

- Students who take the Algebra 1 EOC are first time ninth graders. Students who have repeated the ninth grade are not considered in the study because they will have already taken the EOC. Their scores would have been considered in the previous year.

Definitions of Terms

- Math Achievement – scores on the EOC
- EOC – End of Course standardized test used in Tennessee; It will be used to refer to Algebra 1 EOC scores only in this study
- STEM – The Science, Technology, Engineering, and Math Program integrates math and science and is hands-on and interactive. Students solve real world math and science problems using the Engineering Design process.

- SES – socioeconomic status
- Subgroups – categories for students, i.e. ethnicity, gender

Chapter 2

Literature Review

This chapter is a review of the literature regarding math achievement, the variables that affect it and the effect of STEM (Science, Technology, Engineering and Mathematics) education on math achievement. For the purposes of this study, math achievement was defined as the ability of students to score proficient on standardized tests as supported by Bell, 2011.

Background

Approximately 60 years ago, the Soviet Union launched the Sputnik satellite into orbit. This historic event caught the attention of America and forced America to review its math and science education (Abrahamson, 2007; Zhao, 2009). Businesses were concerned about America maintaining its technological superiority (Zhao, 2009). The public school system was blamed (Abrahamson, 2007) leading to a series of educational reforms, especially in science and mathematics. In response, President Eisenhower signed the National Defense Education Act of 1958. This was designed to help the United States regain scientific and technological superiority.

Math reform came in the form of "new math" which was designed to change the way the subject was taught by focusing on discovery learning (Roberts, D. & Walmsley, A., 2003). In the 1970s, the new math was found to be ineffective since children were having difficulty with computation skills. This led to the "back to basics" movement in the 1970s (Roberts, D. & Walmsley, A., 2003). From the report *A Nation at Risk: the Imperative for Education Reform* to the No Child Left Behind legislation in 2001, educational reform came to America's schools in an effort to maintain the "competitive edge" (Abrahamson, 2007; Zhao, 2009). In the 1990s, China and India arose to become the world's new economic powers. These countries focused education in the areas of science, math and engineering (Zhao, 2009). Statistics showed a distinct difference in the percentage of students receiving degrees in the natural sciences and engineering. The table below shows the percentage of science degrees awarded by nation.

Table 1
Comparison by Country of Graduates Receiving Natural Science Degrees

Country	Percentage of Graduates Receiving Natural Science Degrees
South Korea	38%
France	47%
China	50%
Singapore	67%
United States	15%

The data in the table is supported by Zhao, 2009, Raju, P. & Clayson, A., 2010. International tests like the Trends in Mathematics and Science Study (TIMSS), showed in 1995, that U.S. students outperformed students in only 2 of 21 countries in math (Abrahamson, 2007).

Obstacles to improving math achievement persisted despite the nation's desire to regain its position as a world leader, both technologically and economically. More technical and mathematical skills were needed to push forward the technological age (Herrera, T. & Owens, D., 2001). Herrera and Owens (2001) also state that the goals were to establish the United States as a world leader and to continue the technological development that had begun. One of the main concerns was student academic achievement in math as evidenced by standardized tests (Abrahamson, 2007). Another persistent issue was the achievement gap between subgroups of students. Closing this gap was one of the motivators for the recent reforms. However, closing the gap between the U.S. and other countries was a stronger motivator because of the implications it had for affecting the U.S. economy, the middle class and big businesses (Zhao, 2009). While students in the United States had improved academically, they remained behind their peers around the world (Abrahamson, 2007). Bernstein (1997) also states that students in the United States scored below the international average in math and science on standardized tests.

Other countries, like China and India were rapidly becoming economic leaders in the world. This determination was based on the rapid growth in the gross domestic product (GDP) of each country. This growth propelled China to the fourth largest economy in the world in 2006 (Zhao, Y., 2009; Raju & Clayson, 2010). Additionally, India became the center of the high tech boom. Many companies have set up research and development operations there (Zhao, Y., 2009; Raju & Clayson, 2010). Their students were outperforming those in the United States in math (Abrahamson, 2007; Trends in Mathematics and Science Study (TIMSS) & U.S. Dept. of Labor, 2004).

Technological advances had increased the accountability and demand on U.S. schools to prepare students for the future (Abrahamson, 2007). The ability of students to think quantitatively, to reason out solutions to problems and to use the tools of the information age is as needed and is as essential as the ability to read and write (Branscomb, L. & Johnson, R., 1992). Students needed higher - level math skills, not just for college but also for immediate entry into the workforce (Abrahamson, 2007). Many vocational jobs began to require higher - level math skills as a result of technological advancements (Abrahamson, 2007). These skills are also needed by the largest employer of mathematicians and scientists, the federal government (Branscomb & Johnson, 1992).

Their employees pursue the national interest in security, health, environment, and competitive economy (Branscomb & Johnson). Therefore, greater pressure was placed on the schools to produce students who are ready to be successful in college or work (Abrahamson, 2007).

Science, Technology, Engineering and Math

Science, Technology, Engineering and Math (STEM), as defined by the school and district participating in the study, is the integration of math, science, technology and engineering. The STEM program was implemented to enhance understanding of science and math. It was a method to teach math and science that prepared students for the global economy (Clarksville-Montgomery County School System, "STEM" n.d.). It was aligned with the curriculum to promote higher achievement and the development of analytical as well as critical thinking skills (Clarksville-Montgomery County School System, "STEM" n.d.).

The STEM strategies used by the participating school were based on the model STEM school in the local district. Their methods were based on similar STEM programs in other schools. STEM strategies in the participating school included collaboration among teachers (Clarksville-Montgomery County School System, "STEM" n.d.). The teachers worked together to plan challenges for students that were cross – curricular, project based, and hands on. The focus was on integrating Algebra 1 and Physical Science using the engineering design process. These are required courses for ninth graders. Additionally, technology was integrated into the curriculum. A major goal of the STEM program in the participating school is to prepare students to be competitive in the global economy (Clarksville-Montgomery County School System, "STEM" n.d.).

Since the focus on student achievement, especially math achievement began, many strategies for its improvement have come to light. These strategies ranged from using manipulatives, accelerated math, standards-based instruction, to using a web-based tutoring program like the 4th Grade Massachusetts Active Learning Intelligent Tutoring System (4MALITY) to using a textbook program like the Saxon math for example. 4MALITY is designed to teach mathematical problem-solving skills and test-taking strategies to 4th grade school children with a focus on the Massachusetts Comprehensive Assessment System (MCAS) math exam. The fourth grade students who used this program showed gains of approximately 26 percent from pre - test to post - test (Maloy et al, 2010). This was due to the hands on integrated approach. One method the local school in this study uses is mathematical problem-solving skills. This is similar to the strategy mentioned in the 4MALITY Program. This was accomplished through real world, challenges that are assigned to students. The challenges were problem based with multiple solution paths (Clarksville-Montgomery County School System, "CMCSS Receives $2.5 Million DODEA Grant for STEM, n.d.). The challenges also pulled in as many core classes as possible. The 4MALITY Program appears to be the beginning of STEM thinking.

There has been a decrease in the number of students choosing to major in the natural sciences and STEM fields (Raju, P. & Clayson, A., 2010; Lam et al., 2008; Becker, K. & Park, 2011). Part of their decrease was due to the lower achievement of U.S. students in STEM areas like math and science (Raju & Clayson, 2010). This was also due to low math achievement rates (Raju & Clayson, 2010). Raju and Clayson (2010) stated that the National Science Board (NSB) reported that only16 percent of U.S.

undergraduates chose to major in the natural sciences or engineering while Europe had 25 percent and China 47 percent. Consequently, there was a federal push to identify STEM talent (Raju & Clayson, 2010).

Another solution to math reform has been to increase shared math and science standards in public schools. In the participating school, this has taken the form integrating math, science and technology into the challenges that are part of the STEM program. Students are encouraged to solve problems using many of their core classes, especially math and science using the Engineering Design Process. Additionally, students were introduced to STEM areas at an early age (Raju & Clayson, 2010).

Across the United States, several programs were developed to introduce STEM concepts and careers into the schools from elementary schools to middle schools to high schools. These included, for example, the 4MALITY program in Massachusetts, to the Texas A & M International University (TAMIU) program in Texas, to the Minority Opportunities in Research (MORE) Program in California and New Mexico. These were designed to increase the number of students entering STEM fields (Raju & Clayson, 2010). Another program was the Summer Engineering program at (TAMIU). This program was a one - week program for middle and high school students. The premise of this program was similar to the one in the participating school. Both were designed to help develop analytical skills in academically disadvantaged students and helped students get ready for college level courses (Goonatilake & Bachnak, 2012). This program served students in the area around the university, which as about 90% Hispanic. Goonatilake and Bachnak (2012) stated that there was need for a stronger focus on science, math and engineering career interests and interventions that prepared students for the rigor of

STEM disciplines. A major focus was the role of math in engineering (Goonalilake & Bachnak, 2012).

Minority students, except Asians, are severely underrepresented in the fields of science, technology, engineering and math at the national level in the U.S. (Slovacek et al., 2011). Minority students enter college less prepared than non-minority students (Slovacek et al., 2010). One of the goals of the local STEM program at the participating school is to help all students be successful in the workplace and in higher education. STEM was designed to help students think like scientists and engineers, which is an important factor to success.

Underrepresented minorities are more likely to receive financial aide and to be concerned about it. These are typically low - income students. The gap in financial aide and the cost of post-secondary education is normally made up in the work place, which can interfere with a student's studies (Slovacek et al., 2010). These factors are important to retention. While retention is important to increase the number of underrepresented minorities in STEM fields, additional interventions like MORE are needed to catapult underrepresented minorities into careers as scientists (Slovacek et. al., 2010).

Becker & Park (2011) state that integrative approaches improve student interest and learning in STEM. Another component of STEM is integrating technology with math and science (Clarksville-Montgomery County School System, "STEM" n.d.).This is incorporated into the challenges by the participating school through the use of the computer program Logger Pro and the use of Vernier equipment, for example. This also prepares students for the global economy of the 21st century and after (Becker & Park, 2011).

In a study of 4,996 ninth grade students in Turkey the effects of Information and Communications Technology (ICT) on students' math and science achievement were examined (Delen & Bulut, 2011). This study, which used data from the PISA assessment, showed that student familiarity with ICT and their exposure to ICT helped explain math and science achievement gaps between individuals and schools. Delen and Bulut (2011) also cite a study by Lee which found that one hour of computer time per day produced better math scores. Delen and Bulut (2011) also cite Kim & Chang (2010) who stated "computer use for math was associated with reducing the achievement gap among diverse backgrounds." However, technology use at school was found to be a poor predictor of math and science achievement. Student exposure to technology at home had a larger impact on their math and science achievement than their exposure at school (Delen & Bulut, 2010).

Becker and Park (2011) stated how a goal of federal STEM education was to prepare all students with the science, technology, English, and math skills needed for success in this technological society. They conducted a meta-analysis that investigated the effects of the integrative approaches of STEM subject areas. In regards to math education, Becker and Park cited Elliot et al., (2001) stating that there was no significant difference in the problem solving skills of students in the interdisciplinary course and the college algebra course although students in the interdisciplinary course had slightly higher gains in critical thinking and significantly higher positive attitudes toward math. STEM gives students the opportunity to make connections between science, technology, English, and math although math is a part of them all (Becker and Park, 2011).

Students who were exposed to integrative approaches showed greater achievement in STEM subjects, (Becker and Park, 2011). Earlier exposure may yield higher achievement scores (Becker and Park, 2011). The lowest effect of STEM integration was shown at the secondary and college level while the highest was the elementary and middle school levels, (Becker and Park, 2011). The highest effect sizes was the integration of the four STEM subject areas while the lowest is math, (Becker and Park, 2011). The effect sizes of student achievement were small when math was added (Becker and Park, 2011). Students attitudes toward math improved which influenced student achievement in math, (Becker and Park, Elliot et al., 2001)); the STEM approach would motivate students to see real world applications of math in STEM even though student achievement did not see improvement (Becker and Park, Farrior et al, 2007). Math is the STEM subject that benefits the least from integration approaches (Becker and Park, 2011).

Gender

Gender is another factor that may influence math achievement. This is primarily due to the fact that there are different learning styles correlated with gender and ethnicity (Bell, 2011). The traditional mode of teaching math is good for the relatively high socio-economic white male on his way to college (Bell, 2011). The teaching strategies used with them works because the males learned better deductively in a competitive environment (Bell, 2001). Girls and minority students do not learn best this way (Bell, 2011). Girls, however, do learn best in a collaborative effort using inductive reasoning (Bell, 2011; Klein, 2010).

There is a decrease in the number of girls going into STEM fields. Underrepresented students in engineering programs included minorities and females (Goonatilake & Bachnak, 2010).

Ethnicity

As concerns about student achievement grew, so did concerns about minorities. There was an achievement gap between these subgroups of students. Zhao (2009) defines the achievement gap as the difference in performance between African American and Hispanic students and white students as well as the difference between low - income and high - income families on test scores, grades, dropout rates and college completion rates. Racial inequalities in math had implications for racial differences in the STEM fields (Covey, 2011). Another effort to increase STEM talent was to introduce students from different demographics (subgroups) to STEM education.

These factors affected the achievement rate: dropout rate, graduation rate and test scores. A strong link was shown between high - income jobs and education (Bussey, 2007; Abrahamson, 2007). If African American students continue to lag behind other students, they will lose opportunities and choices for their futures in terms of jobs (Bussey, 2007). Completing a course beyond Algebra 2 more than doubled the chances that students who went to college finished (Bussey, 2007). This factor will help ensure the academic success of minority students. In a study by Clifford Adelman (2006), academic rigor in the high school curriculum was the most important pre-collegiate factor providing momentum toward completing a bachelor's degree (Tsui, 2007). Minorities tend to be less prepared for a rigorous academic program in college because they are much less likely than Whites or Asian Americans to pursue a rigorous academic course of study or to take advanced placement (AP) mathematics and science courses during high school (Wilson, R., 2000; Tsui, 2007). Either way, the gaps in dropout and graduation rates put Hispanic and African American minorities at a disadvantage (Zhao, 2009). This achievement gap was studied for years. The focus was on ensuring minority and poor students had equal access to public education (Abrahamson, 2007). The focus recently changed to closing the achievement gap.

Between the third and sixth grades, Bussey (2007) wrote that all students slow in rates of academic achievement. But, African American students lagged worst and never closed the achievement gap (Bussey, 2007). The majority of American children (about 60%) and the bulk of minority children (about 85%) are channeled out of advanced mathematics and science classes by the time they are 13 years old (Campbell, G., 1996; Tsui, 2007). Covey (2011) stated that black students left school with fewer math skills than their white peers, even when they took advanced math classes. This gap had important implications for the future diversity of STEM fields (Covey, 2011). STEM will be addressed later in this review.

Standardized tests also presented a significant area of concern (Abrahamson, 2007).

> Math is a gateway subject and the poor performance of our urban youth in mathematics further exacerbates the lack of opportunities they already face, as well as their future access to higher education. This information presents an increased disadvantage and challenge for these "at-risk" groups in terms of future economic, social, and political standing. (Abrahamson, 2007, p. 2)

Bussey also wrote that Algebra and geometry are primary 'gatekeepers' and 'critical filters' of who will have minimum entrance requirements to a post secondary school.

Abrahamson (2007) stated that there was some improvement in math performance. This was based on the 2003 TIMSS which showed eighth grade students from the United States demonstrated growth in science and math from 1995 – 2003 in as well as improved performance relative to other participating countries (Abrahamson, 2007). It also identified a reduction in the achievement gap between white students compared to Latino and African American students although the gap remains significant (Abrahamson, 2007). Bussey (2007) stated that progress was made in raising the level of courses taken and the achievement of all racial groups but little was done to reduce the gaps among them.

Testing

Test scores in the 1950's and 1960's showed that students were not excelling academically. Once math reforms were enacted, a method to measure math achievement was put in place. Math achievement was measured by using standardized tests. Several tests measured achievement internationally, while others measured student progress nationally. Still other tests, like the EOC, which is the standardized test for Tennessee, measured student achievement statewide.

Abrahamson (2007) stated that academic performance in math was significantly lower in several urban schools in California. This was revealed by test scores and the percentages of students not passing the math portion of the California High School Exit Exam. In California, efforts to improve math performance included the passing of the high school exit exam. The Florida Comprehensive Exam (FCAT) tested curriculum from kindergarten to the 10th grade. In June 2006, approximately 30 percent, about

56,000 students, of high school seniors did not receive a standard diploma – this includes a large number of minorities and students with low SES (Miller-Gorman, 2011). Achievement tests used as the dependent variable were often biased toward traditionally high achieving students because the questions were tested and rejected if low achieving students performed well on them (Lubienski, 2002).

There were many biases and discrepancies in state achievement tests. The national test used to measure achievement in Lubienski's (2002) study was the National Assessment of Educational Progress (NAEP). It was the only nationally representative on - going assessment of academic achievement in the U.S. (Lubienski, 2002). It provided information from student and teacher questionnaires regarding mathematical backgrounds, beliefs and instructional practices (Lubienski, 2002). It assessed student performance on both multiple choice and open - ended questions over the five strands by the National Council of Teachers of Mathematics: number/operations, geometry, measurement, data analysis and algebra functions (Lubienski, 2002). Abrahamson (2007) stated the NAEP has become a required assessment to monitor student achievement growth and given disaggregated data by subgroups. It had also become the tool (through No Child Left Behind (NCLB)) to monitor state adherence to the mandatory accountability system defined by the NCLB (Abrahamson, 2007).

Lubienski (2002) reported that in 2000, the 8th grade white students scored a significant eight points higher than the 12th grade black student. Black students completed high school then with less mathematical knowledge than white 8th graders possessed (Lubienski, 2002). In 2005, this achievement gap had grown with the gap between white 8th grade students and African American students increased to 29 percent while the gap between Latinos and whites increased to 20 percent (Abrahamson, 2007; NAEP, 2005; U.S. Dept. of Educ. NCES 2005). In California in 2005, the gap between white students and African American students and Latino 8th grade students had increased to 30 percent and 24 percent (Abrahamson, 2007). To close the gap, schools needed to exponentially improve the academic performance of African American and Latino students (Abrahamson, 2007).

A result of NCLB was state mandated tests like the FCAT, CAHSEE in California, and the End of Course (EOC) test in Tennessee. These tests were used, along with the NAEP, to determine student achievement, especially in math at the state level and nationwide where tests like the TIMSS compare the U.S. to other countries. Overall, a student's scores on these tests measured math achievement. Standardized tests are used to measure student achievement at the local level while the NAEP and other standardized math tests are used to measure tests at the national level. The TIMSS and the Programme for International Student Assessment (PISA) were tests that are used for international assessment of student achievement, especially in math.

Summary of Literature

The literature has shown the integrative hands-on approach used to teach STEM has been beneficial in raising math achievement. The articles have revealed that there are gaps in achievement especially math which need to be filled. Gaps exist in achievement between boys and girls, as well as between ethnicities. The literature review on this study has shown that the STEM Programs improved the math achievement of each subgroup of students although Becker and Park (2011) have shown in their meta-analysis that integrative approaches least benefit math (Becker and Park, 2011).

Chapter 3
Methods and Procedures

This study looks at the effect of the STEM Program on Algebra 1 EOC scores. The Algebra 1 EOC scores are based on first time 9th graders in an Algebra 1 course. It is taken at the end of the school year.

The data was collected from the administrative offices of the district. All participants are anonymous. The data reflects gender, ethnicity, and whether or not a student was in a special education program or a general education program for the 2010 - 2011 school year or the 2011 -2012 school year. The 2010 - 2011 school year was prior to the STEM Program being implemented while the 2011 - 2012 school year was the first year the STEM Program was implemented.

The research took place in the fifth largest town in the state of Tennessee. The population was approximately 142, 357 and 98% urban and 2% rural. The ethnicity of the town was approximately 61% Caucasian, 21% African-American and 10% Hispanic. The school as a Title I school. The school population was approximately 37% African-American, 13% Hispanic, and 41% Caucasian, 9% other ethnicities. Additionally, 51% of the students are male and 49% are female. The community was transient due to proximity to a military base. The students are entering the 9th grade for the first time and the EOC test is administered at the end of the 9th grade year.

Variables

The goal of this research is to determine the effects of the STEM program on math achievement as measured by the Algebra 1 EOC test scores of first time 9th graders. Students who repeated the 9th grade will have taken the EOC the previous year and therefore will not be included in this study. The dependent variable is the EOC test score. The EOC score is used as a continuous variable. This measurement is used because it is the standardized test for Algebra1for the state of Tennessee. The test is valid and reliable in that it is aligned with curriculum standards and measures mastery of those standards, skills and concepts (Long, D., & Tidwell, M., 2015). Additionally, item validity is determined during field-testing (Long & Tidwell, 2015). Additionally, the test is designed by the Educational Testing Service (ETS) who develop, analyze and validate all content according to each program's specifications according to guidelines based on standards in the field of educational measurement (ETS, 2016). This ensures validity as well as reliability.

This field study has three independent variables: participation in the STEM Program, gender, and ethnicity. The STEM Program is now required for all 9th grade Algebra 1 students. This began in the school year 2011 -2012. Gender was chosen to see if there was an effect between boys and girls. There were seven options for ethnicity to see if there was an effect according to ethnicity or cultural background: African-American, American Indian, Asian, Caucasian, Hawaiian/Pacific Islander, Hispanic, or Unspecified. However, due to lack of data, American Indian, Asian, and Unspecified categories were inconclusive. Therefore, the focus is on African-American, Caucasian, and Hispanic students.

Research Design

The statistical analysis used was the Three-Way ANOVA. This statistical analysis was performed to determine the effect the STEM Program had on EOC scores in the categories of ethnicity and gender and year of implementation of the STEM Program.

The instrument used was the Algebra 1 EOC test that is given at the end of the school year to first time ninth graders before and after implementation of the STEM Program.

Chapter 4
Data Analysis

The purpose of this field study was to analyze the effects of the STEM Program on Algebra 1 EOC scores for subcategories of students. An observation of the data in Figures 1 and 2 shows that there were no outliers for the 2010 – 2011 school year nor the 2011 – 2012 school year. It also shows the data were normally distributed. Table 2 shows mean scores for gender, ethnicity and year of implementation of the STEM program. Table 2 also shows there were no outliers.

Table 2

Cell Means for EOC Scores

		2010 - 2011 School Year	2011 – 2012 School Year	Row Mean
Girls	African American	689.08	717.91	703.50
	Caucasian	716.42	733.16	724.79
	Hispanic	725.71	706.29	716.00
	Mean	710.40	719.12	714.76
Boys	African American	689.69	707.00	698.35
	Caucasian	708.03	726.44	717.24
	Hispanic	676.84	715.08	695.96
	Mean	691.52	716.17	703.845

Additionally, the data is within parameters for use of the ANOVA. An analysis of the data shows that the STEM Program had no significant effect on EOC scores for the three-way interaction of year, gender, and ethnicity. EOC scores for girls increased. So did scores for boys. Girls scored the highest on the EOC both before and after the STEM Program. Additionally, there was a statistically significant difference on scores for ethnicity. In reference to Table 2, the raw, mean EOC scores for gender and ethnicity were higher after implementation of the STEM program in 2011 – 2012. Further analysis, however, showed that there was no statistically significant difference for gender after implementation of the STEM program in 2011 – 2012.

Table 3

Tests of Between-Subjects Effects

Dependent Variable: EOC

Source	*SS*	*df*	*MS*	*F*	*p*
Year	18387.456	1	18387.456	7.900	*.005*
Gender	7870.613	1	7870.613	3.381	.067
Ethnicity	33178.647	2	16589.324	7.127	.001
Year*Gender	4195.386	1	4195.386	1.802	.180
Year*Ethnicity	1805.194	2	902.597	.388	.679
Gender*Ethnicity	2013.588	2	1006.794	.433	.649
Year*Gender*Ethnicity	10786.054	2	5393.027	2.317	.100
Error	856548.843	368	2327.578		
Total	192613155.0	380			

3-Way Analysis of Variance for EOC Scores

Upon reviewing the results of the Three-Way ANOVA, the three - way interaction shows there was no statistically significant interaction ($p = .100$) between year, gender, and ethnicity. This is greater than the level ($p > .05$) which indicated the lack of a statistically significant interaction. The 2-way interactions of year and gender, year and ethnicity, and gender and ethnicity show no statistically significant difference ($p = .180$, $p = .679$, and $p = .649$) respectively. When the main effects were analyzed there were statistically significant differences for EOC scores between years ($p = .005$) and ethnicities ($p = .001$). Gender showed no statistically significant difference ($p = .067$).

This led to Post Hoc tests for additional analysis. The number of Hispanics in the study violated the requirements for sample size. Although the test of the assumption of equal variances showed a statistically significant difference ($p = .029$), the ANOVA is robust against a violation of this assumption. Therefore, Hispanics were included in this field study. There were no outliers in the data. This can be seen in the histogram of EOC scores for the school year 2010 – 2011 and 2011 – 2012 in Figures 1 and 2. The test for Multiple Comparisons was applied and revealed that there was a statistically significant difference between the scores of Caucasians and Hispanics ($p = .045$). Additionally, there was a statistically significant difference among the scores for Caucasians and African – Americans ($p = .001$). This is also evident in Figures 3 & 4.

In summary, a Three - Way ANOVA test determined there were differences in the effect of the STEM program on Algebra 1 EOC scores. Implementation of the STEM program did not have a statistically significant effect on EOC scores overall. Nor did it have a statistically significant effect on gender, although scores for both boys and girls rose. There was no statistically significant of the STEM program on ethnicity, although additional analysis showed that there was a statistically significant difference in the EOC scores for African-American, Caucasian, and Hispanic students.

Chapter 5

Summary, Findings, Conclusions and Recommendations

Math achievement has been an issue of concern in the United States since the launching of Sputnik into space. Several programs have been implemented to try to improve the math achievement levels of America's students. This study researched the effect of the STEM Program on math achievement scores across gender and ethnicity.

Discussion

The second and third research questions address the effect of the STEM Program on Algebra 1 EOC scores for gender and ethnicity. The analysis showed that there was no statistically significant difference for the three – way interaction of STEM, gender and ethnicity $F(2,368) = 2.317$, ($p > .100$). The null hypothesis, H_o, that the STEM Program has no effect on the Algebra 1 EOC scores for STEM, has been accepted. Therefore the alternate is not true: the STEM program has not had a statistically significant effect on Algebra 1 EOC scores overall. Additionally, for the research question involving gender, there was no interaction between males and females. The two-way interaction for gender showed no statistically significant difference ($p = .180$) and the main effect for gender was no statistically significant difference ($p = .067$). Girls scored higher than boys on the Algebra 1 EOC before and after the STEM Program was implemented as seen in Figure 3 in Appendix A. Both of their scores increased after the implementation of STEM. For the research question involving ethnicity, Caucasian students scored the highest both before and after implementation of the STEM program, followed by African – Americans and then Hispanics. The main effect for ethnicity showed a statistically significant difference ($p = .001$) although year and ethnicity showed no statistically significant difference with (p = .679). Scores for each of the ethnic subgroups increased after the implementation of the STEM program. Both Caucasian and African - American Algebra 1 EOC scores rose although the achievement gap is still there. Although Hispanic scores were higher than African - American scores prior to the STEM program, they rose more slowly and were under the scores for African – Americans after the STEM program was implemented. This is seen in Figure 4 in Appendix A.

Conclusions

More research is needed in this area to determine the effects of the STEM program on Math Achievement. While STEM has had a statistically significant effect on each subgroup, more research is needed to determine why it didn't have the same impact on Hispanic students. What other interactions could have inhibited the rate of change in their scores, a language barrier? Why didn't the program close any of the achievement gaps between ethnicities? Additional research is needed that includes other ethnic groups and also includes the socioeconomic status of students.

To broaden the scope of this project, more schools across the district should be included. Additionally, the scores from additional years should be included. This could help in generalizing it to the population.

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Appendices

APPENDIX A

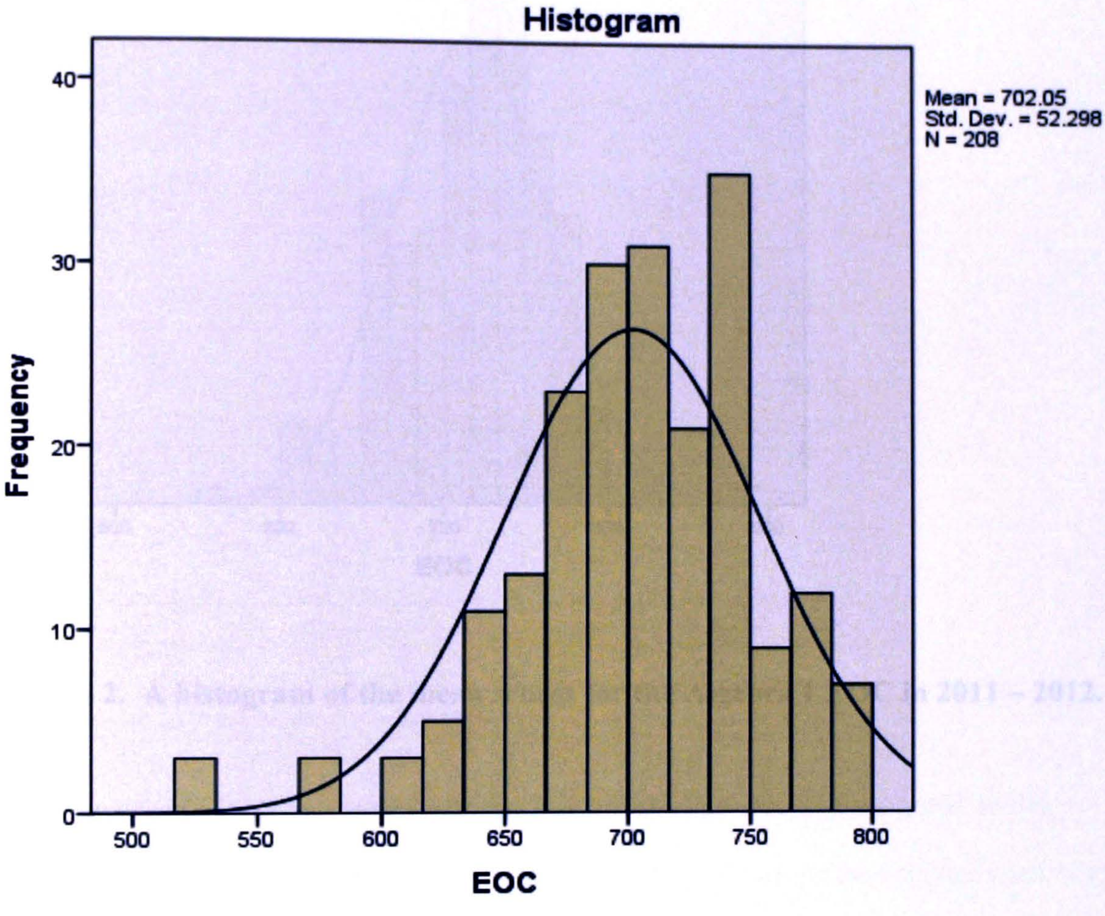

Figure 1. A histogram of the mean scores for the Algebra 1 EOC in 2010 – 2011.

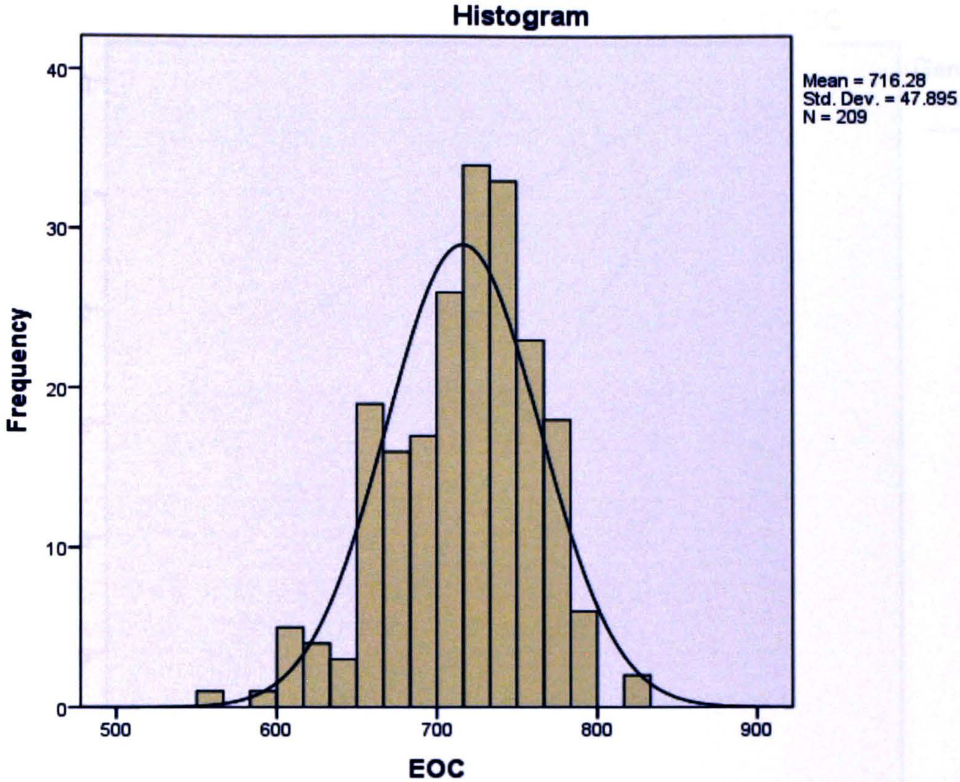

Figure 2. A histogram of the mean scores for the Algebra 1 EOC in 2011 – 2012.

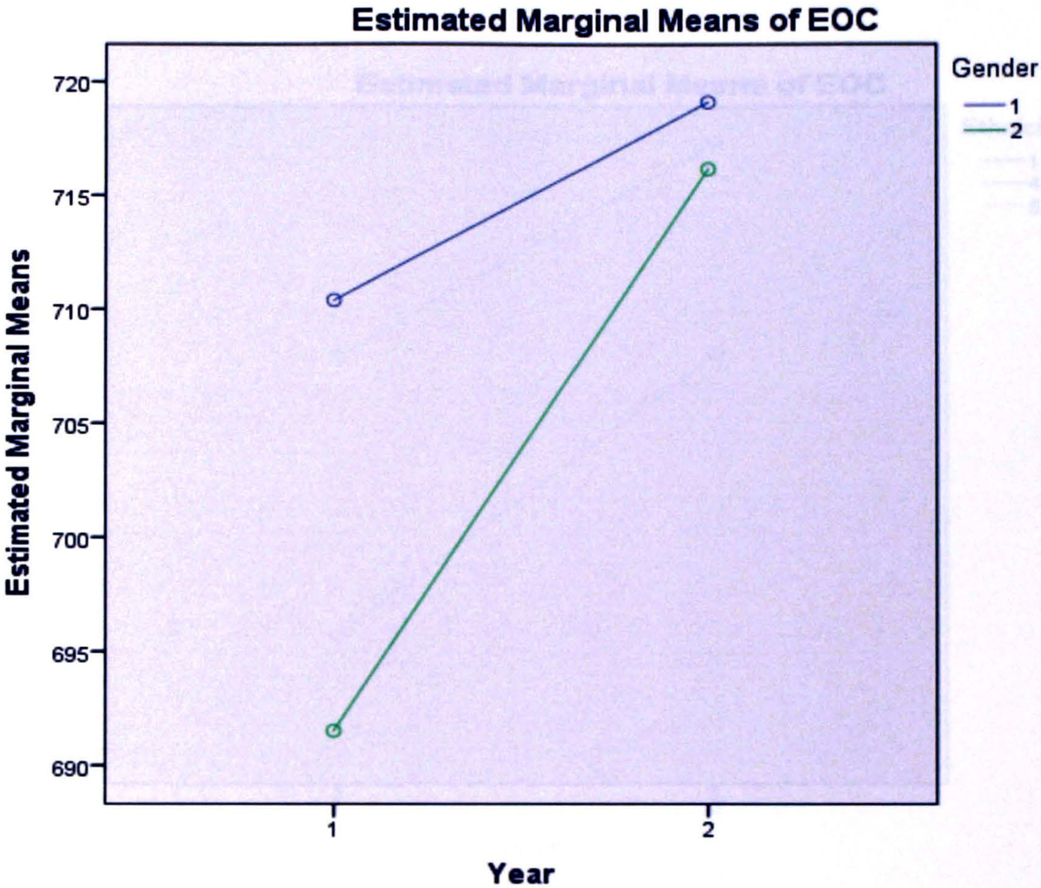

Figure 3. The interaction of scores for females (gender 1 in blue) and males (gender 2 in green). Year 1 is the 2010 – 2011 school year before the implementation of the STEM program. Year 2 is the 2011 – 2012 school year after implementation of the STEM program.

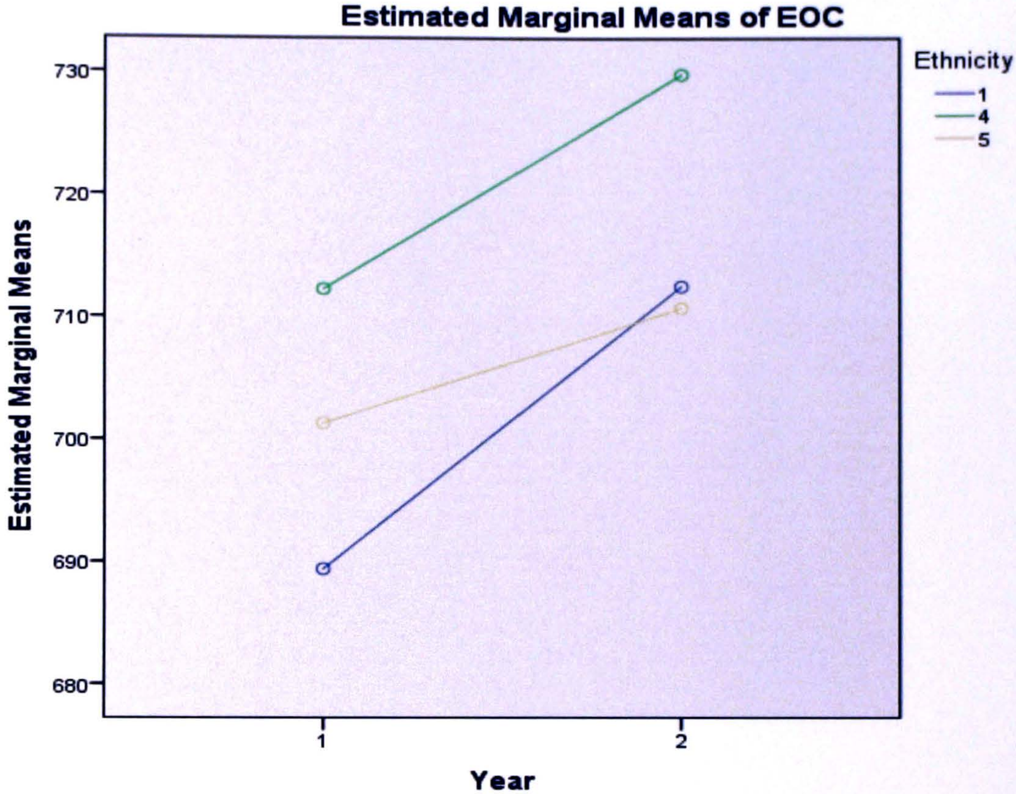

Figure 4. The interaction of scores for ethnicity (Ethnicity 1 in blue – African American; Ethnicity 4 in green – Caucasian; Ethnicity 5 in gold - Hispanic). Year 1 is the 2010 – 2011 school year before the implementation of the STEM program. Year 2 is the 2011 – 2012 school year after implementation of the STEM program.