DIFFERENCES IN MATHEMATICS AND SCIENCE PERFORMANCE BY ECONOMIC STATUS, GENDER, AND ETHNICITY/RACE: A MULTIYEAR TEXAS STATEWIDE STUDY

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by

Pamela Bennett Anderson

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by

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DEDICATION

I dedicate this dissertation to my family for all of their support and encouragement over the years. My husband, Elvis, has been my rock during this process. I could not have done this without him. And to my mother, who has always found ways to help out with my two sons so that I had time to write, or to offer words of encouragement when they were needed.

This paper is also dedicated to the memory of loved ones that passed away during my dissertation process. To my father and step-father, the two men who were my greatest cheerleaders when I started this journey. To my mother-in-law and father-in-law who offered acceptance and love. I am blessed to have had these people in my life.

ABSTRACT

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Purpose

The purpose of the first study was to ascertain the extent to which differences were present in the STAAR Mathematics and Science test scores by Grade 5 and Grade 8 student economic status. The purpose of the second study was to examine differences in Grade 5 STAAR Mathematics and Science test performance by gender and by ethnicity/race (i.e., Asian, Black, Hispanic, and White). Finally, with respect to the third study in this journal-ready dissertation, the purpose was to investigate the STAAR Mathematics and Science test scores of Grade 8 students by gender and by ethnicity/race (i.e., Asian, Black, Hispanic, and White).

Method

For this journal-ready dissertation, a non-experimental, causal-comparative research design (Creswell, 2009) was used in all three studies. Grade 5 and Grade 8 STAAR Mathematics and Science test data were analyzed for the 2011-2012 through the 2014-2015 school years. The dependent variables were the STAAR Mathematics and Science test scores for Grade 5 and Grade 8. The independent variables analyzed in these studies were student economic status, gender, and ethnicity/race.

Findings

Regarding the first study, statistically significant differences were present in Grade 5 and Grade 8 STAAR Mathematics and Science test scores by student economic status for each year. Moderate effect sizes (Cohen's *d*) were present for each year of the study for the Grade 5 STAAR Mathematics and Science exams, Grade 8 Science exams, and the 2014-2015 Grade 8 STAAR Mathematics exam. However, a small effect size was present for the 2011-2012 through 2013-2014 Grade 8 STAAR Mathematics exam.

Regarding the second and third study, statistically significant differences were revealed for Grade 5 and Grade 8 STAAR Mathematics and Science test scores based on gender, with trivial effect sizes. Furthermore, statistically significant differences were present in these test scores by ethnicity/race, with moderate effects for each year of the study. With regard to each year for both studies, Asian students had the highest average test scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter, Ramirez, & Severn, 2006) was present.

Keywords: Science achievement, Mathematics achievement, Student economic status, Asian, Black, Hispanic, White, Gender, Problem-based learning, STEM.

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Over the past seven years I have received support and encouragement from several people. I would like to thank my dissertation chair, Dr. George Moore, whose patience and guidance has meant a great deal to me. I also want to thank my dissertation committee, Dr. John Slate and Dr. Cynthia Martinez-Garcia, who along with Dr. Moore, spent many hours reading and editing my work. All of my professors in the Sam Houston State University Educational Leadership program have made me a better writer, teacher, and leader. For all this and more, I am thankful.

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CHAPTER I

Introduction

The economic future of the United States and its workers depends on advances in science, technology, engineering, and mathematics (STEM). According to a report by My College Options and STEM connector (2013), jobs in science and engineering are predicted to increase at more than double the rate of the overall U.S. labor force by 2018. Moreover, the U.S. Department of Labor reported that 90% of the fastest growing employment fields in 2018 will demand at least a Bachelor degree with considerable coursework in mathematics and science (Hill, Corbett, & St. Rose, 2010). As a result of this increased demand, employment in science and engineering fields will grow more swiftly than all other occupations, especially in engineering and computer-related fields. Of concern, however, few U.S. workers have an educational background in STEM (President's Council of Advisors on Science and Technology [PCAST], 2010; Tank, 2014).

An abundance of literature (e.g., National Research Council, 2011; National Science Board, 2014; PCAST, 2010; Tank, 2011) exists in which scholars have expressed a need for reforms in education so students can master complex skills necessary for entrance into the 21st century workforce. Furthermore, **e**ducation advocates have hailed STEM as an essential program in the educational reform movement, and activists, politicians, and science and engineering proponents have been concerned with the improvement and expansion of STEM education (Atkinson, 2012; The Whitehouse, 2015). However, the intent and execution of the STEM curriculum and instruction in schools is unclear and needs further interpretation (Bybee, 2013; Koonce et al., 2011).

Beyond the issues with STEM curriculum, a particular challenge to STEM reform is the method in which STEM learning is assessed. Although STEM learning should include deeper analysis and critical thinking in all fields of science, technology, engineering, and mathematics, assessments to measure STEM knowledge are often determined through mathematics and science scores alone (NRC, 2011). Unfortunately, standardized tests, such as state, national, and international assessments, are the recognized norm for students to demonstrate academic prowess in science and mathematics (Bleich, 2012; NRC, 2011). Students in Texas are assessed each year on the State of Texas Assessment of Academic Readiness (STAAR) Mathematics test in Grades 3-8. The STAAR Science tests are administered in Grades 5 and 8. Although the STAAR Mathematics and Science tests have been administered since the 2011-2012 school year, no published research exists in which the STAAR Mathematics and Science achievement scores have been analyzed with respect to student gender, ethnicity, or socioeconomic status.

Since the publication of the No Child Left Behind Act (2001), mathematics and science have been a priority in U.S. schools, but students have historically scored lower in international assessments than students in other countries (Valerio, 2014). DeSilver (2015) observed that American students ranked 35th in mathematics and 27th in science in the 2012 Program for International Student Assessment (PISA). In another international assessment, American students performed 27th in mathematics and 20th in science among the 34 countries that make up the Organization for Economic Cooperation and Development (DeSilver, 2015). Not only are American students ranked lower than students from other countries in mathematics and science, but American students also graduate with STEM-related degrees at a much lower rate than students from other countries (NRC, 2011; Newman et al., 2015).

The Roles of Poverty, Race, and Gender

Children from poverty continue to experience a gap in academic achievement. For example, students in the highest socioeconomic status enter kindergarten with cognitive scores that are 60% higher than their peers from the lowest socioeconomic groups (Beatty, 2013). These gaps in achievement continue throughout K-12 school years. In addition to poverty achievement, ethnicity/race is also a contributing factor that contributes to the gap in academic achievement (Newman et al., 2015).

Overall, the percentage of U.S. citizens living in poverty has increased from 18% to 22% from 2008 to 2013 (Aud et al., 2013). Furthermore, the rate of poverty was almost twice as high for Black individuals than for White individuals (Potter, 2015). Children from states in the South and Southwest live in poverty at a higher rate (Potter, 2015). With regard to Texas students, an estimated 25% of the students live in poverty, and 11% of the students live in extreme poverty. In Texas, 24% of Hispanic children and 34% of Black children live in poverty, compared with 11% of White children (The Annie E. Casey Foundation, 2015). Additionally, the Texas Education Agency (2016) reports that almost 60% of Texas students are considered economically disadvantaged.

In terms of STEM education, students living in poverty, regardless of gender or ethnicity/race, lack the same opportunities that their more affluent peers have to enroll in advanced mathematics and science courses in middle and high school (Munce, 2012). Furthermore, historically, certain student populations have been underrepresented in STEM learning (Munce, 2012). Students from low socioeconomic backgrounds, students from certain racial minority populations (e.g., Black and Hispanic students), and Girls students traditionally enroll in STEM programs at a lower rate than their White, Boys counterparts (Nikischer, 2013; PCAST, 2010). As a result of the lower participation in K-12 STEM education, success in higher education STEM classes is even more difficult to attain (Hill et al., 2010).

Education, Academic Engagement, and Problem Based Learning

Students should graduate high school and college with the ability to think critically and be creative problem solvers. These life skills will benefit them as they undergo challenges and receive opportunities in life and in their careers (Kivunja, 2015). Researchers (e.g., Newman et al., 2015; Tank, 2014) indicated that the ideal learning for STEM should consist of real-life applications and experiments that highlight solutions to local problems. As technology progresses, learners must be adaptable and flexible to the changing needs of the workforce (Kivunja, 2015). Teachers who incorporate Project Based Learning (PBL) to STEM instruction create opportunities for students to learn through hands-on, interdisciplinary, and socially relevant environment, and therefore, increase STEM literacy for all (Harwell et al., 2015). Unfortunately, although a multidisciplinary approach to STEM learning is recommended by advocates, this method is rarely used in practice (Harwell et al., 2015; Tank, 2014).

Students in elementary school benefit from STEM lessons in which creativity and innovation expose them to early career possibilities (Arango, 2009; National Research Council, 2013). A concern of many STEM reform-minded activists is that science PBL lessons are limited for additional reading and mathematics lessons, which in turn, contribute to a feeling of inadequacy in science once students enter middle and high school (NRC, 2013). Students receive the greatest benefit when STEM teaching practices are incorporated into the elementary classroom (Murphy & Mancini-Samuelson, 2012).

Statement of the Problem

Improved instruction for STEM disciplines are needed (Mastascusa, Snyder, & Hoyt, 2011). Integration techniques for STEM are recommended so that authentic, real-world connections are experienced by learners (Vasquez, 2014). Even though multidisciplinary teaching is recommended by advocates of STEM education, this approach is not used widely in classrooms (Tank, 2014). Additionally, large STEM interest and achievement gaps exist among Black and Hispanic students, Girls students, and students from low socioeconomic families (Bolkan, 2015; Nikischer, 2013; PCAST, 2010).

State, national, and international assessments in science and mathematics have been used to reveal that U.S. students lag behind students from other nations. The National Assessment of Educational Progress (NAEP) results have been interpreted to mean that many high school graduates lack proficiency in subject-matter knowledge and analytical skills necessary for college-level work (Venezia & Jaeger, 2013). So many students lack academic proficiency, that one half of first-time college students in the United States enrolled in some type of remedial course, and 42% of all college students needed at least one remedial mathematics course. (National Science Board, 2014). Students must graduate from high school prepared for college-level work to compete in a global community (Gigliotti, 2012).

A particular challenge to STEM reform is the way that successes in STEM learning are assessed. Although STEM learning should include deeper analysis and critical thinking in all fields of science, technology, engineering, and mathematics, assessments to measure STEM knowledge are often determined through mathematics and science scores alone (NRC, 2011). Unfortunately, standardized tests, such as state, national, and international assessments, are the recognized norm for students to demonstrate academic prowess in science and mathematics (Bleich, 2012; NRC, 2011). The State of Texas Assessment of Academic Readiness (STAAR) tests are administered to students in Texas public schools to assess a student's college and career readiness, and to satisfy state and federal accountability requirements in several core subjects. Each school year STAAR Mathematics tests are given in Grades 3-8, and STAAR Science tests are administered in Grades 5 and 8.

To ensure students have the knowledge and skills necessary to enroll and persist in postsecondary education, a thorough examination of efforts made in K-12 school settings is needed. Furthermore, a substantial STEM interest and achievement gap persists among Black, Hispanic, and Girls students, as well as students from low socioeconomic families (Bolkan, 2015; Nikischer, 2013; PCAST, 2010). Despite encouragement from government and corporate interests, women, Blacks, and Hispanics remain underrepresented in STEM jobs, and in certain areas, the gap has widened (Neuhauser, 2015).

Purpose of the Study

The purpose of the first study was to ascertain the extent to which differences were present in the STAAR Mathematics and Science test scores by Grade 5 and Grade 8 student economic status. The purpose of the second study was to examine differences in Grade 5 STAAR Mathematics and Science test performance by gender and by ethnicity/race (i.e., Black, Hispanic, and White). Finally, with respect to the third study in this journal-ready dissertation the purpose was to investigate differences of STAAR Mathematics and Science test scores of Grade 8 student by gender and by ethnicity/race (i.e., Asian, Black, Hispanic, and White).

Significance of the Study

Science and mathematics education has largely been the focus of majority of STEM research due to the readily available data via state and national assessments (NRC, 2011). In Texas, the STAAR tests are administered to students in public schools to assess a student’s college and career readiness, and to satisfy state and federal accountability requirements in several core subjects. Each school year the STAAR Mathematics tests are given in Grades 3-8, and the STAAR Science tests are administered in Grades 5 and 8. Neither technology, nor engineering, is currently assessed on a large scale basis in schools (National Assessment Governing Board, 2014). Therefore, research in technology and engineering is more difficult to conduct because both subjects are process-oriented rather than content-driven. Limited research exists on STEM multidisciplinary approaches to education at the primary level (Tank, 2014). The results from this study might be used to contribute to the research regarding relationships of ethnicity, gender, and economic status to mathematics and science achievement.

School administrators, teachers, and legislators might use the results of this study when they consider policies and strategies for STEM education. Furthermore, school administrators, teachers, educational policymakers, and legislators might be influenced to develop new strategies for improving practice in instruction and assessment. Results from the studies included in the journal-ready dissertation might be used to influence legislators when considering the future of STEM education.

Definition of Terms

Terms that are important to the three research studies that were conducted in this journal-ready dissertation are defined below.

Achievement Gap

The achievement gap in education refers to the discrepancy in academic performance between groups of students, particularly students defined by race/ethnicity, socioeconomic status, and gender. Performance rates measured include standardized test scores, grades, drop-out rates, and rates of college completion, among others (Editorial Projects in Education Research Center, 2011).

Asian Student

According to PEIMS Data Standards (n.d.), a student's race categorization of Asian "indicates a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam."

Black Student

According to PEIMS Data Standards (n.d.), a student's race categorization of Black, or African-American, "indicates a person having a origins in any of the black racial groups of Africa."

Economic Disadvantaged

Economic disadvantaged refers to the status given to students based on free or reduced lunch criteria. According to the Texas Education Association (2014) and the Texas Department of Agriculture (n.d.), economic disadvantage is defined as eligible for free meals, eligible for reduced-price meals, or not economically disadvantaged based on the National School Lunch Program. Economic disadvantaged status must be reported each year by each district and charter school through the Texas Education Agency Public Education Information Management System.

Educational Reform

Educational reform is the name given to the goal of changing public education. Educational reform efforts increased significantly since the passage of No Child Left Behind Act in 2001 and with the Race to the Top initiative specifically designed to close the achievement gap among different races and socioeconomic groups (Hunt, Carper, Lasley, & Raisch, 2010). Current national and state reform efforts include test-based accountability, improved teacher quality, charter schools, school choice, and a more rigorous curriculum (Hunt et al., 2010).

Ethnicity

The Texas Education Agency has seven reported categories available for ethnicity: American Indian or Alaskan Native; Asian or Pacific Islander; Black or African American; Hispanic/Latino, White, or Two or More Races (Texas Education Agency, 2015). However, for this study, Asian, Black, Hispanic, and White students will be the three ethnic/racial groups whose data will be analyzed.

Hispanic Student

According to PEIMS Data Systems (n.d.), a student's ethnicity categorization of Hispanic "indicates a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race."

National Assessment of Education Progress (NAEP)

The National Assessment of Education Progress (NAEP) is the largest continuing and national representative assessment of what American students know in core subjects such as mathematics, science, reading, and writing. Results from NAEP are released as the Nation's Report Card, and provide data on student results for different demographic groups, including gender, socioeconomic status, and race/ethnicity (U.S. Department of Education, 2015).

No Child Left Behind Act

The No Child Left Behind (NCLB) Act of 2001 was a reauthorization of the Elementary and Secondary Education Act, and requires states to develop assessments in basic skills to receive federal funding.

Project Based Learning (PBL)

Project Based Learning (PBL) is a pedagogy in which students extensively explore real world problems and challenges to acquire deeper knowledge and engagement (Edutopia, 2015).

Program for International Student Assessment (PISA)

The Program for International Student Assessment (PISA) is an international assessment given every three years that measures 15-year old students' reading, mathematics, and science literacy. The PISA test also measures cross-curricular competencies, such as collaborative problem solving (NCES, 2015).

State of Texas Assessments of Academic Readiness (STAAR)

The State of Texas Assessments of Academic Readiness (STAAR) tests are state-mandated standardized tests in Texas public schools that measure student knowledge in a particular school year. The STAAR tests assess curriculum from the Texas Essential Knowledge and Skills (TEKS).

Science, Technology, Engineering, and Mathematics (STEM)

The definition of STEM, according to the National Science Foundation (NSF), is an acronym for science, technology, engineering, and mathematics disciplines (Koonce, 2011).

Texas Essential Knowledge and Skills (TEKS)

The Texas Essential Knowledge and Skills (TEKS) are the state standards for Texas public schools, and detail curriculum requirements for what students should know and be able to do at each grade level (TEA, 2015).

White Student

According to PEIMS Data Systems (n.d.), a student's race categorization of White "indicates a person having origins in any of the original peoples of Europe, the Middle East, or North Africa."

Theoretical Framework

An increasing presence of literature supporting PBL and the integration of engineering standards in K-12 classrooms exists (Newman et al., 2015; Tank, 2014). Significant focus on the E, for engineering, in STEM reinforces the project-based design ideology in the basic interpretation of STEM PBL (Capraro, Capraro, & Morgan, 2013). According to Capraro et al. (2013), the principles that affect the design of PBL are (a) making content accessible; (b) making thinking visible; (c) helping students learn from others; and (d) promoting autonomy and lifelong learning. Additionally, the foundations that influence PBL design include: (a) preexisting knowledge; (b) feedback, revision, and reflection; (c) teaching for understanding; and (d) metacognition.

Procedures

Upon approval from the doctoral dissertation committee, approval was sought from the Sam Houston State University Institutional Review Board. Subsequent approval from the Sam Houston State University Institutional Review Board, data were requested from the Texas Education Agency Public Education Information Management System. The data request included Grade 5 and Grade 8 STAAR Mathematics and Science test scores for the 2011-2012, 2012-2013, 2013-2014 and 2014-2015 school years by student ethnicity/race, gender, and economic status. These data were acquired after submitting a Public Information Request form via the Texas Education Agency website. The dataset provided was analyzed with the Statistical Package for the Social Sciences (SPSS) software for analyses. Specific variables that were analyzed in this investigation were: mathematics and science scores by ethnicity (i.e., Asian, Black, Hispanic, and White); mathematics and science scores by gender; and mathematics and science scores by economic status.

Delimitations

The delimitations for this study involve examining the STAAR Mathematics and Science test scores among specific student groups in the state of Texas. Specifically, only the mathematics and science scores, as measured by the state-mandated assessment, of Texas boys and girls in Grades 5 and Grade 8 were analyzed. Mathematics and science raw scores on the STAAR tests were analyzed for differences among students in Grade 5 and Grade 8 by gender, ethnicity/race (i.e., Asian, Black, Hispanic, and White), and socioeconomic status. Because the STAAR tests are a requirement of all public schools in state of Texas, data from students enrolled in either charter schools or in private schools were not included in this study. Four school years of data were analyzed (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015). Additionally, only the spring STAAR test results from each year were examined.

Limitations

According to Johnson and Christensen (2012), limitations of this ex-post facto causal-comparative study include limited control regarding the independent variables (i.e., ethnicity, gender, and economic status) and the dependent variables (i.e., STAAR Mathematics and Science test scores). Furthermore, data were limited to the archived data of STAAR test results available from the TEA. Onwuegbuzie (2000) stated that all studies in education have flaws in internal and external validity. Onwuegbuzie (2000) expounded,

> [I]nstrumentation can never be fully eliminated as a potential threat to internal validity because outcome measures can never yield scores that are perfectly reliable or valid. . . With respect to external validity, all samples, whether random or non-random are subject to sampling error. (p. 9)

Assumptions

For the purpose of this study, the assumption was made that the achievement data in the Public Education Information Management System were accurately reported. Moreover, the consistency in which Texas schools report and collect student data was assumed to be accurate across all schools in the state. Furthermore, the validity and consistency in which the STAAR Mathematics and Science test scores were collected from the schools across the state of Texas are aligned with the curriculum guidelines proposed by the state of Texas was assumed.

Organization of the Study

In this investigation, three research investigations were conducted. In this journal-ready dissertation, five chapters are present, from which three separate manuscripts were generated. Chapter I contains the background of the study, statement of the problem, purpose of the study, significance of the study, definition of terms, theoretical framework, delimitations, limitations, assumptions, and outline of the journal-ready dissertation. Chapter II consists of the first journal-ready article in which data from STAAR Mathematics and Science test scores of Grade 5 students and Grade 8 students were evaluated to ascertain the extent to which differences might be present in regard to economic status in the state of Texas. In Chapter III, the framework for the journal-ready research investigation on STAAR Mathematics and Science tests in regard to gender and ethnicity/race of Grade 5 students in the state of Texas will be provided. Chapter IV, the third journal-ready research investigation, is an analysis of STAAR Mathematics and Science test scores with regard to gender and to ethnicity/race of Grade 8 students in the state of Texas. Each of these three studies has its own separate Method and Data

Analysis sections. Chapter V concludes this journal-ready dissertation with implications and recommendations for each study, connections with existing literature, implications for policy and practice, recommendations for leaders, and recommendations for future research.

CHAPTER II

DIFFERENCES IN MATHEMATICS AND SCIENCE ACHIEVEMENT BY GRADE 5 AND GRADE 8 STUDENT ECONOMIC STATUS: A MULTIYEAR, STATEWIDE STUDY

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

Differences present in average raw scores of Grade 5 and Grade 8 students on the State of Texas Assessment of Academic Readiness (STAAR) Mathematics and Science exams were analyzed with regard to student economic status. Test results were examined for four school years (i.e., 2011-2012 through 2014-2015). Statistically significant results were present for all STAAR Mathematics and Science exams for each year and each grade analyzed. Represented in the analysis were moderate effect sizes (Cohen's *d*) each year of the study for the Grade 5 STAAR Mathematics scores, Grade 5 STAAR Science scores, Grade 8 STAAR Science scores, and the 2014-2015 Grade 8 exams STAAR Mathematics scores. However, the differences in the Grade 8 STAAR Mathematics scores represented a small effect size for the 2011-2012 through the 2013-2014 years.

Keywords: Science achievement, Mathematics achievement, Student economic status

DIFFERENCES IN MATHEMATICS AND SCIENCE ACHIEVEMENT BY GRADE 5 AND GRADE 8 STUDENT ECONOMIC STATUS: A MULTIYEAR, STATEWIDE STUDY

The economic future of the United States is dependent on advances in science, technology, engineering, and mathematics (STEM). According to My College Options and STEM Connector (2013), jobs in science and engineering are predicted to increase at more than twice the rate of the overall U.S. labor force by 2018. However, few U.S. workers have backgrounds in STEM (President's Council of Advisors on Science and Technology [PCAST], 2010; Tank, 2014). Therefore, the pursuit of STEM education and careers is encouraged for the United States to remain competitive in a global economy (National Research Council [NRC], 2011).

Numerous research investigations exist (e.g., NRC, 2011; National Science Board, 2014; PCAST, 2010; Tank, 2011) related to the need for a greater emphasis on students mastering complex skills required for the 21st century workforce. Of critical importance is for students to graduate from high school prepared for college-level work so one day they will be able to compete in a global community (Gigliotti, 2012). However, as revealed in the National Assessment of Educational Progress (NAEP) report, many high school graduates lack proficiency in subject-matter knowledge and analytical skills necessary for college-level work (Venezia & Jaeger, 2013). Many students lack proficiency in reading and mathematics, and one half of first-time college students in the United States enrolled in some type of remedial course. More specifically, 42% of all college students needed at least one remedial mathematics course (National Science Board, 2014).

In Texas, the State of Texas Assessment of Academic Readiness (STAAR) tests are administered to students in public schools under state and federal accountability requirements. The STAAR tests replaced the former Texas Assessment of Knowledge and Skills (TAKS) test and were implemented during the 2011-2012 school year. Included in state tests requirements are STAAR Reading and Mathematics tests administered yearly in Grades 3–8, STAAR Science tests administered in Grades 5 and 8, and STAAR Social Studies test administered in Grade 8. The STAAR tests are more rigorous than the TAKS tests and are intended to measure students' college and career readiness, starting as early as Grade 3.

However, aside from accountability measures, a thorough examination of efforts made in K-12 school settings is needed to ensure students have the knowledge and skills necessary to enroll and persist in postsecondary education. For example, STEM instructional techniques should include authentic, real-world connections experienced by learners (Vasquez, 2014). Even though multidisciplinary teaching is recommended by advocates of STEM education, this approach is not widely used in classrooms (Tank, 2014). Moreover, according to Nikischer (2013) and PCAST (2010), interest and achievement gaps in STEM exist among underrepresented students (i.e., Black, Hispanic, girls, students in poverty).

The Role of Poverty

The percentage of Americans living in poverty increased from 18% to 22% in the 5-year span from 2008 through 2013 (Potter, 2015). Researchers at the Annie E. Casey Foundation (2015) estimated 22% of America children live in poverty. Further, children from states in the south and southwest live in poverty at a higher rate. An estimated 25%

of Texas children live in poverty, and 11% in extreme poverty. Twenty-four percent of Hispanic children and 34% of Black children live in poverty in Texas, compared with 11% of White children. Nationally, the percentages of children living in poverty are the same or very close for two groups of children (i.e., Hispanic and White children); however, the percentages of poverty for Black children have increased to 38% (The Annie E. Casey Foundation, 2015).

A noteworthy gap in achievement scores exists based on student socioeconomic status. Students in the highest socioeconomic status entered kindergarten with cognitive scores that were 60% higher than their peers from the lowest socioeconomic groups (Beatty, 2013). These gaps in achievement continued throughout the students' K-12 education.

Gottfried and Williams (2013) performed a long-term study in which they compared students' math club and science club participation to their mathematics and science GPA. The researchers discovered almost all subgroups that participated in after school math or science clubs had higher GPAs, but students who participated in after school clubs and who were categorized as living in poverty did not show any GPA gains. This lack of progress was documented for students living in poverty, regardless of gender or ethnicity/race (Gottfried & Williams, 2013).

Students from economically disadvantaged homes start school with several disadvantages including (a) access to fewer educational resources at home; (b) lack of healthcare and proper nutrition; (c) slower development of language skills, letter recognition, and phonological awareness; and (d) tendency toward more absences (Farmbry, 2014). Further, existing barriers for students who are economically disadvantaged include (a) enrollment in underfunded schools, (b) an absence of educational models, (c) a culture that lacks emphasis on schooling, and (d) an inability to pay for higher education (Gaughan & Bozeman, 2015). Moreover, students who are economically disadvantaged, regardless of gender or ethnicity/race, often lack the same opportunities to enroll in advanced middle school and high school mathematics and science courses than their more affluent peers (Gaughan & Bozeman, 2015; Hill, Corbet, & St. Rose, 2010).

Beyond the obstacles students in poverty experience in school, future employment opportunities in STEM careers for individuals who are economically disadvantaged are inadequate. Gaughan and Bozeman (2015) described the hiring practices of people of poverty into fields of science and engineering as “pitiable,” and for “underrepresented minorities who are also poor, working poor, or working class–the picture is bleaker still” (p. 27). In contrast, people who can enter careers as mathematics and science specialists enjoy higher salaries and have better job stability than employees in other fields (Hill et al., 2010).

Implications of Early Interest in STEM Careers

Maltese and Tai (2010) interviewed over 100 scientists and graduate students in science and discovered that 65% of those participants indicated that their interest in science began prior to middle school. In a different study, Tai, Liu, Maltese, and Fan (2006) suggested students who indicated an interest in a career in science in Grade 8 were three times more likely to pursue a degree in a science field than students who did not express an interest in science. In another study, Archer et al. (2010) recognized the importance of students aspiring to careers in STEM long before age 14. Indeed, in one study of over 1,000 STEM professionals, 28% of participants responded that they started considering a career in STEM before the age of 11, and 35% of participants started thinking of a STEM career between the ages of 12 and 14 (Archer, et al., 2010; Office for Public Management for the Royal Society, 2006).

Purpose of the Study

The purpose of this study was to ascertain the extent to which differences, if any, were present in the STAAR Mathematics and Science test scores by student economic status. The STAAR Mathematics and Science test scores of Grade 5 students were analyzed to determine the extent to which differences were present between students who were economically disadvantaged and students who were not economically disadvantaged. Additionally, the STAAR Mathematics and Science test scores of Grade 8 students were examined to determine the extent to which differences were present based on student economic status.

Significance of this Study

Results from this investigation may be used to add to the existing literature, as no studies have been conducted in this area using the new STAAR assessments. Additionally, considerations regarding when STEM curriculum, instruction, and assessment are introduced to students might be influenced by the results of this study. Finally, school administrators, teachers, legislators, and organizations that contribute funds to expand STEM opportunities for students could use the findings of this study when they are envisioning policies and making decisions with respect to STEM education.

Research Questions

The following research questions were addressed in this investigation: (a) What is the difference in Grade 5 STAAR Mathematics test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged)?; (b) What is the difference in Grade 5 STAAR Science test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged)?; (c) What is the difference in Grade 8 STAAR Mathematics test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged)?; (d) What is the difference in Grade 8 STAAR Science test as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged)?; (e) What trend, if any, is present for Grade 5 the STAAR Mathematics test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged) for the 2011-2012 through the 2014-2015 school years?; (f) What trend, if any, is present for Grade 5 STAAR Science test performance as a function of student economic status(i.e., economically disadvantaged, not economically disadvantaged) for the 2011-2012 through the 2014-2015 school years?; (g) What trend, if any, is present for Grade 8 STAAR Mathematics test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged) for the 2011-2012 through the 2014-2015 school years?; and (h) What trend, if any, is present for Grade 8 STAAR Science test performance as a function of student economic status (i.e., economically disadvantaged, not economically disadvantaged) for the 2011-2012 through the 2014-2015 school years? The first four research questions were examined for four school years of data (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015), whereas the last four questions constituted trend questions across the four school years of data. Thus, 20 research questions are present in this research study.

Method

Research Design

For this study an ex-post facto, non-experimental, causal-comparative research design was used (Creswell, 2009). No manipulation of the independent variable can occur due to the ex-post facto nature of the study. Archived datasets for the spring STAAR Mathematics and Sciences tests from the Texas Education Agency for the 2011-2012 through the 2014-2015 school years were obtained and examined. The independent variable in this study was student economic status. Economic disadvantaged refers to student status based on eligibility for free or reduced-price lunches as outlined in the National School Lunch program (Texas Department of Agriculture, n.d.). The dependent variables for this research study were the STAAR Mathematics and Science test scores for Grade 5 students and Grade 8 students for each of the 2011-2012 through the 2014-2015 school years.

Participants and Instrumentation

Grade 5 students and Grade 8 students enrolled in Texas public school were the participants in this study. Datasets were obtained from the Texas Education Agency Public Education Information Management System for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 school years. A Public Information Request form was sent to the Texas Education Agency to obtain these data. Specifically requested were data on (a) student economic status, (b) STAAR Mathematics test scores, and (d) STAAR Science test scores. Specifically, datasets were used to examine the degree to which differences were present on the STAAR Mathematics and Science tests by student economic status.

Raw scores on the Grade 5 and Grade 8 STAAR Mathematics and Science exams were analyzed in this investigation. Field (2009) reiterated that the measurement error be kept as low as possible via analysis of reliability and validity. Score reliability is the degree that a measurement tool yields stable and consistent results, and is therefore a fundamental in an assessment tool. Score validity refers to how well a test measures what it is professed to measure. According to the Texas Education Agency (2015), "reliability for the STAAR test score was estimated using statistical measures such as internal consistency, classical standard error of measurement, conditional standard error of measurement, and classification accuracy" (p. 113). The Texas Education Agency adheres to national standards of best practice and collects validity confirmation each year of the STAAR test scores.

Results

Prior to conducting inferential statistics to determine whether differences were present in the STAAR Mathematics and STAAR Science test scores between students who were economically disadvantaged and students who were not economically disadvantaged, checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002). Although some of the data were not normally distributed, a decision was made to use parametric independent samples *t*-tests to answer the research questions. Field (2009) contended that a parametric independent samples *t*-test is sufficiently robust that it can withstand this particular violation of its underlying assumptions. Statistical results will now be presented by academic subject area.

Research Question 1

For the 2011-2012 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student economic status, $t(299126.40) = 177.76$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.60 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Mathematics test score that was more than 6 points lower than their peers who were not economically disadvantaged. Readers are directed to Table 2.1 for the descriptive statistics for this analysis.

Insert Table 2.1 about here

Regarding the 2012-2013 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student economic status, $t(306441.87) = 177.98$, $p < .001$. This difference represented a moderate Cohen's *d* effect size of 0.60 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Mathematics test score that was more than 6 points lower than their peers who were not economically disadvantaged. Included in Table 2.1 are the descriptive statistics for this analysis.

Concerning the 2013-2014 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student economic status, $t(317881.83) = 173.66$,$p < .001$.

This difference represented a moderate Cohen's *d* effect size of 0.58 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Mathematics test score that was almost 6 points lower than their peers who were not economically disadvantaged. The descriptive statistics for this analysis are provided in Table 2.1.

For the 2014-2015 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Mathematics test scores by student economic status, $t(329043.68) = 195.02$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.64 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Mathematics test score that was almost 7 points lower than their peers who were not economically disadvantaged. Descriptive statistics for this analysis are presented in Table 2.1.

Research Question 2

With respect to the 2011-2012 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student economic status, $t(320251.25) = 200.40$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.67 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Science test score that was almost 5 points lower than their peers who were not economically disadvantaged. Included in Table 2.2 are the descriptive statistics for this analysis.

Insert Table 2.2 about here

Concerning the 2012-2013 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Science test scores by student economic status, $t(313342.45) = 204.35$, $p < .001$. This difference represented a moderate Cohen's *d* effect size of 0.68 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Science test score that was more than 5 points lower than their peers who were not economically disadvantaged. The descriptive statistics for this analysis are provided in Table 2.2.

For the 2013-2014 school year for Grade 5 students, a statistically significant difference was yielded in the STAAR Science test scores by student economic status, $t(331415.55) = 206.92$, $p < .001$. This difference represented a Cohen's *d* of 0.68, a moderate effect size (Cohen, 1988). Grade 5 students in poverty had an average STAAR Science test score that was more than 5 points lower than their peers who were not economically disadvantaged. Readers are directed to Table 2.2 for the descriptive statistics related to this analysis.

Regarding the 2014-2015 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Science test scores by student economic status, $t(344412.34) = 208.86$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.68 (Cohen, 1988). Grade 5 students in poverty had an average STAAR Science test score that was more than 5 points lower than their peers who were not economically disadvantaged. Descriptive statistics related to this analysis are provided in Table 2.2.

Research Question 3

Concerning the 2011-2012 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student economic status, $t(271480.68) = 186.95$, $p < .001$. This difference represented a moderate Cohen's *d* effect size of 0.67 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Mathematics test score that was more than 7 points lower than their peers who were not economically disadvantaged. Revealed in Table 2.3 are the descriptive statistics for this analysis.

Insert Table 2.3 about here

For the 2012-2013 school year for Grade 8 students, a statistically significant difference was yielded in the STAAR Mathematics test scores by student economic status, $t(232486.03) = 147.88$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.56 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Mathematics test score that was over 5 points lower than their peers who were not economically disadvantaged. The descriptive statistics for this analysis are provided in Table 2.3.

Regarding the 2013-2014 school year for Grade 8 students, a statistically significant difference was present in the STAAR Mathematics test scores by student economic status, $t(262627.24) = 169.70$, $p < .001$. This difference represented a Cohen's *d* of 0.61, a moderate effect size (Cohen, 1988). Grade 8 students in poverty had an average STAAR Mathematics test score that was over 6 points lower than their peers who were not economically disadvantaged. Presented in Table 2.3 are the descriptive statistics for this analysis.

Concerning the 2014-2015 school year for Grade 8 students, a statistically significant difference was yielded in the STAAR Mathematics test scores by student economic status, $t(263455.66) = 156.04$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.56 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Mathematics test score that was almost 6 points lower than their peers who were not economically disadvantaged. The descriptive statistics for this analysis are provided in Table 2.3.

Research Question 4

For the 2011-2012 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student economic status, $t(321213.02) = 201.47$, $p < .001$. This difference represented a moderate Cohen's *d* effect size of 0.68 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Science test score that was almost 7 points lower than their peers who were not economically disadvantaged. Readers are directed to Table 2.4 for the descriptive statistics for this analysis.

Insert Table 2.4 about here

Regarding the 2012-2013 school year for Grade 8 students, a statistically significant difference was yielded in the STAAR Science test scores by student economic status, $t(326231.18) = 199.29$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.67 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Science test score that was almost 7 points lower than their peers who were not economically disadvantaged. Revealed in Table 2.4 are the descriptive statistics for this analysis.

Concerning the 2013-2014 school year for Grade 8 students, a statistically significant difference was present in the STAAR Science test scores by student economic status, $t(343406.26) = 201.67$, $p < .001$. This difference represented a moderate effect size (Cohen's *d*) of 0.67 (Cohen, 1988). Grade 8 students in poverty had an average STAAR Science test score that was almost 7 points lower than their peers who were not economically disadvantaged. Readers are directed to Table 2.4 for the descriptive statistics for this analysis.

For the 2014-2015 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student economic status, $t(355685.02) = 178.60$, $p < .001$. This difference represented a Cohen's *d* of 0.58, a moderate effect size (Cohen, 1988). Grade 8 students in poverty had an average STAAR Science test score that was over 6 points lower than their peers who were not economically disadvantaged. The descriptive statistics for this analysis are provided in Table 2.4.

Research Question 5

For the 2011-2012 through the 2014-2015 school years, the STAAR Mathematics scores of Grade 5 students by economic status (i.e., economically disadvantaged and not economically disadvantaged) were analyzed. Statistically significant differences by student economic status were present in all four school years. Figure 2.1 is a representation of student performance by economic status for the 2011-2012 through the 2014-2015 school years. Students who were economically disadvantaged as well as students who were not poor had improved test performance from the 2011-2012 through the 2013-2014 school years. Of note was that the average test scores for both groups of students were the lowest in the 2014-2015 school year. Students who were not poor had higher average test scores than did students who were poor in all four school years.

Insert Figure 2.1 about here

Research Question 6

For the 2011-2012 through the 2014-2015 school years, the STAAR Science scores of Grade 5 students by economic status (i.e., economically disadvantaged and not economically disadvantaged) were analyzed. Statistically significant results were revealed for all four school years. Represented in Figure 2.2 are the average test scores by economic status for these four school years. Students who were poor as well as students who were not poor had lower test performance from the 2011-2012 through the 2014-2015 school years, with the exception of the 2013-2014 school year. In that school year, students who were not economically disadvantaged had an average test score that was only 0.03 points higher than the previous school year. Students who were not poor had better performance in all four school years than did their peers who were economically disadvantaged.

Insert Figure 2.2 about here

Research Question 7

For the 2011-2012 through the 2014-2015 school years, the STAAR Mathematics scores of Grade 8 students by economic status (i.e., economically disadvantaged and not economically disadvantaged) were analyzed. Statistically significant differences were yielded in each of the four school years. Figure 2.3 is a representation of student achievement by economic status. Average test scores during the 2012-2013 school year were lower than the scores in the 2011-2012 school year for students of economic advantage; however, test scores were slightly higher for students of economic disadvantage. An increase in the average test scores was present for both groups in the 2013-2014 school year, and a decrease for both groups was present in the 2014-2015 school year. The average test score difference between the two student groups varied each year, with students who were economically disadvantaged scoring lower than students who were not economically disadvantaged in the 2011-2012 through 2014-2015 school years.

Insert Figure 2.3 about here

Research Question 8

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Science scores of Grade 8 students by economic status (i.e., economically disadvantaged and not economically disadvantaged) were analyzed. Of the four school years investigated, all years had statistically significant results. Figure 2.4 is a representation of test performance by economic status. Students who were economically disadvantaged and students who were not economically disadvantaged had slightly improved average scores each year from the 2011-2012 through the 2014-2015 school years, except for the 2014-2015 school year. In that school year, students who were not economically disadvantaged attained an average score slightly lower than the average score in the 2013-2014 school year. Students who were not economically disadvantaged outscored students who were economically disadvantaged in every year of the study.

Insert Figure 2.4 about here

Discussion

The purpose of this study was to determine the degree to which STAAR Mathematics and Science test scores for Grade 5 students and Grade 8 students differed as a function of economic status (i.e., economically disadvantaged, not economically disadvantaged). To determine if differences existed in STAAR Mathematics and Science test scores related to student economic disadvantage, independent samples *t*-tests were used. Four years of Texas, statewide individual level student data were obtained and analyzed for this investigation.

Regarding the STAAR Mathematics Scores for Grade 5, students who were economically disadvantaged had lower average scores than students who were not economically disadvantaged during all four years of the study. Average score differences ranged from 5.88 to 6.69 points. The largest average difference between students who were economically disadvantaged and students who were not economically disadvantaged was in the 2014-2015 school year.

Students in Grade 5 who were economically disadvantaged had lower average scores than students who were not economically disadvantaged on the STAAR Science Scores each year of the study. Students who were not economically disadvantaged outscored students who were economically disadvantaged by between 4.79 and 5.39 points. As evidenced in the Grade 5 STAAR Mathematics Scores results, the gap by economic status in average scores was the largest in the 2014-2015 school year.

Regarding the Grade 8 STAAR Mathematics exam, students who were economically disadvantaged had lower average scores than students who were not disadvantaged for all four years of the study (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015). The average score difference based on economic status was between between 5.74 and 7.15 points. Furthermore, the largest achievement gap between student groups was in the 2011-2012 school year with a difference of 7.15 average points.

Regarding the Grade 8 STAAR Science exam, students who were economically disadvantaged had average scores that were lower than students who were not economically disadvantaged all four years of the study. The average difference each year of the study ranged from 6.20 and 6.95 points. The largest average difference in test scores occurred in the 2012-2014 school year.

Connections with Existing Literature

As a result of this study, the existing student poverty research (Beatty, 2013; Farmbry, 2014; Gotfried & Williams, 2013) is reinforced. The average scores of students who were economically disadvantaged were always lower than their more affluent counterparts by several points for Grade 5 Mathematics and Science exams. Additionally, Grade 8 students who were economically disadvantaged had average scores that were several points lower than students who were not economically disadvantaged in both STAAR Mathematics and Science tests for all years of the study.

Implications for Policy and Practice

In this multiyear analysis of average raw scores of Grade 5 and Grade 8 STAAR Mathematics and Science exams, students who were economically disadvantaged outscored students who were not economically disadvantaged by several points on almost every exam. Educational policymakers should consider new strategies for improving STEM instruction and assessment. Currently, test results from assessments such as the STAAR Mathematics and STAAR Science exams are referenced by researchers as if they are a true reflection of what is learned in the science and mathematics classroom. In reality, the STAAR exams measure merely a small portion of what is taught; and, the multiple choice format is too restrictive to give a more accurate reflection of the critical thinking skills required of students today.

Recommendations for Educational Leaders

Policymakers are encouraged to write and fund a state level STEM curriculum that includes project-based, hands-on learning that simulates real world experiences. School and district leaders are encouraged to advocate for multidisciplinary lessons that include many opportunities for students to engage in real-life problem solving skills for all students. Similarly, educational leaders should consider assessments that measure critical thinking skills, rather than rote memorization. Additionally, school leaders should encourage students who are economically disadvantaged to participate in challenging STEM programs both during school, and outside of normal school hours.

Recommendations for Future Research

In this study, the STAAR Mathematics and STAAR Science test scores were analyzed by student economic status for Grade 5 students and Grade 8 students for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 school years. Results were consistent throughout each year of study for most tests, with students who were not economically disadvantaged outscoring students who were economically disadvantaged by several points. Researchers may wish to continue measuring the differences in test scores based on economic status to determine if the achievement gap will close in future assessment years. Analyzed in this study were data for the Grade 5 and Grade 8 STAAR Mathematics and Science test scores of Texas public school students. Researchers are encouraged to analyze student academic achievement at other grade levels, such as Grade 3 which is the first year in which Texas school students are administered the statewide mandated assessment, as well as high school students who are required to take End-of-Course exams. Researchers are encouraged to extend this empirical investigation to other states to ascertain the degree to which results delineated herein are generalizable.

Conclusion

The purpose of this research study was to examine the extent to which differences existed in STAAR Mathematics and STAAR Science scores for Grade 5 and Grade 8 students. Data were analyzed for four years of data (i.e., the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 school years). Statistically significant differences were present in both tests for all four years of data. During each year of data, students who were economically disadvantaged consistently had lower average test scores than students who were not economically disadvantaged. This study is important to STEM learning because the achievement gap between students who are economically disadvantaged and students who are not economically disadvantaged still exists 50 years after President Lyndon Johnson declared a War on Poverty, and more attention to curriculum, instruction, and assessment designed to promote higher achievement in STEM area is warranted.

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Table 2.1

Descriptive Statistics on the Grade 5 STAAR Mathematics Scores by Student Economic Status for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Economic Status	*n*	*M*	*SD*
2011-2012			
Economically Disadvantaged	232,896	30.43	10.10
Not Economically Disadvantaged	141,085	36.47	10.04
2012-2013			
Economically Disadvantaged	230,798	30.59	10.60
Not Economically Disadvantaged	141,925	36.85	10.32
2013-2014			
Economically Disadvantaged	234,146	31.57	10.40
Not Economically Disadvantaged	145,212	37.45	9.96
2014-2015			
Economically Disadvantaged	230,800	28.36	10.55
Not Economically Disadvantaged	150,602	35.04	10.22

Table 2.2

Descriptive Statistics on the Grade 5 STAAR Science Scores by Student Economic Status for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Economic Status	*n*	*M*	*SD*
2011-2012			
Economically Disadvantaged	233,096	30.09	7.53
Not Economically Disadvantaged	140,745	34.88	6.80
2012-2013			
Economically Disadvantaged	230,868	27.54	7.67
Not Economically Disadvantaged	141,550	33.29	7.22
2013-2014			
Economically Disadvantaged	233,821	27.88	7.91
Not Economically Disadvantaged	145,371	33.03	7.15
2014-2015			
Economically Disadvantaged	235,318	27.21	8.19
Not Economically Disadvantaged	153,918	32.60	7.66

Table 2.3

Descriptive Statistics on the Grade 8 STAAR Mathematics Scores by Student Economic Status for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Economic Status	*n*	*M*	*SD*
2011-2012			
Economically Disadvantaged	194,864	27.02	10.24
Not Economically Disadvantaged	133,783	34.18	11.13
2012-2013			
Economically Disadvantaged	186,578	27.54	9.92
Not Economically Disadvantaged	116,307	33.29	10.71
2013-2014			
Economically Disadvantaged	190,056	28.56	10.55
Not Economically Disadvantaged	127,749	35.21	11.12
2014-2015			
Economically Disadvantaged	197,900	28.20	9.97
Not Economically Disadvantaged	128,658	33.97	10.56

Table 2.4

Descriptive Statistics on the Grade 8 STAAR Science Scores by Student Economic Status for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Economic Status	*n*	*M*	*SD*
2011-2012			
Economically Disadvantaged	206,532	30.18	9.60
Not Economically Disadvantaged	149,950	36.78	9.69
2012-2013			
Economically Disadvantaged	210,494	30.94	9.73
Not Economically Disadvantaged	152,301	37.49	9.82
2013-2014			
Economically Disadvantaged	217,768	31.78	10.53
Not Economically Disadvantaged	157,641	38.72	10.33
2014-2015			
Economically Disadvantaged	225,242	31.92	10.64
Not Economically Disadvantaged	166,501	38.11	10.80

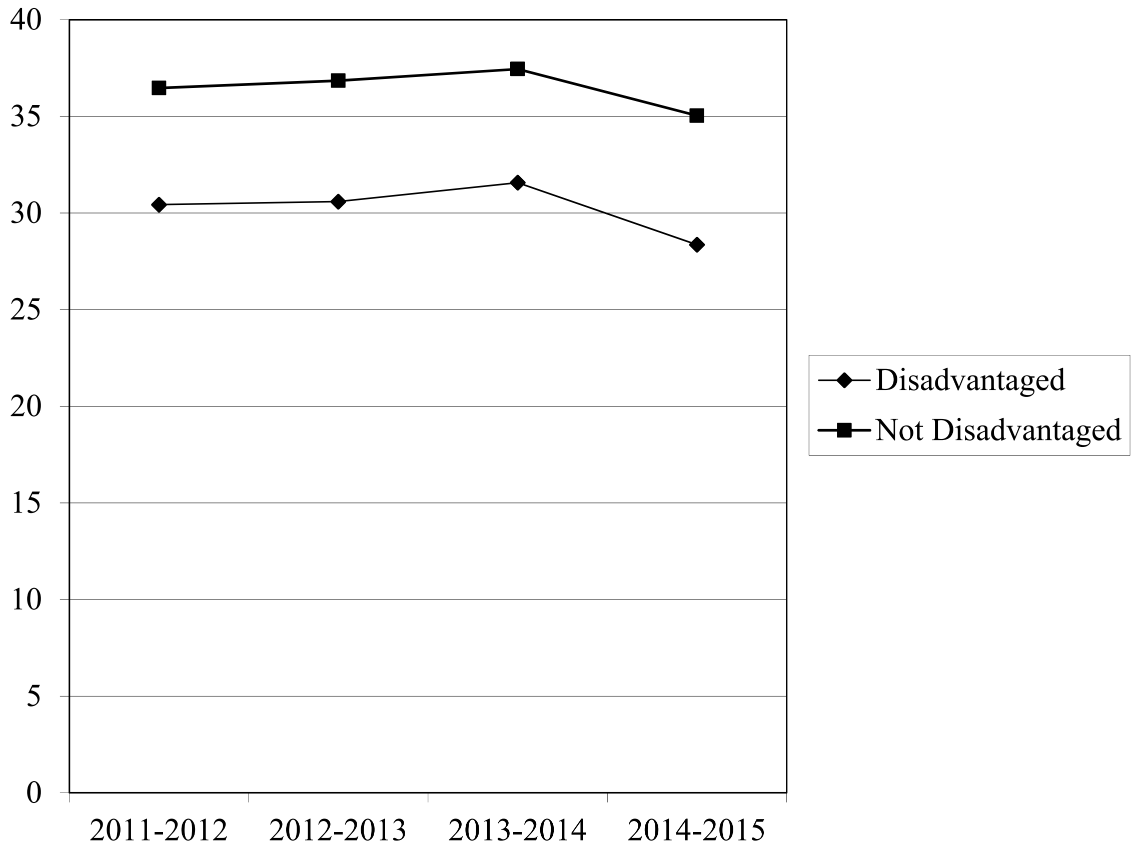

Figure 2.1. Average raw scores by student economic status for the Grade 5 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

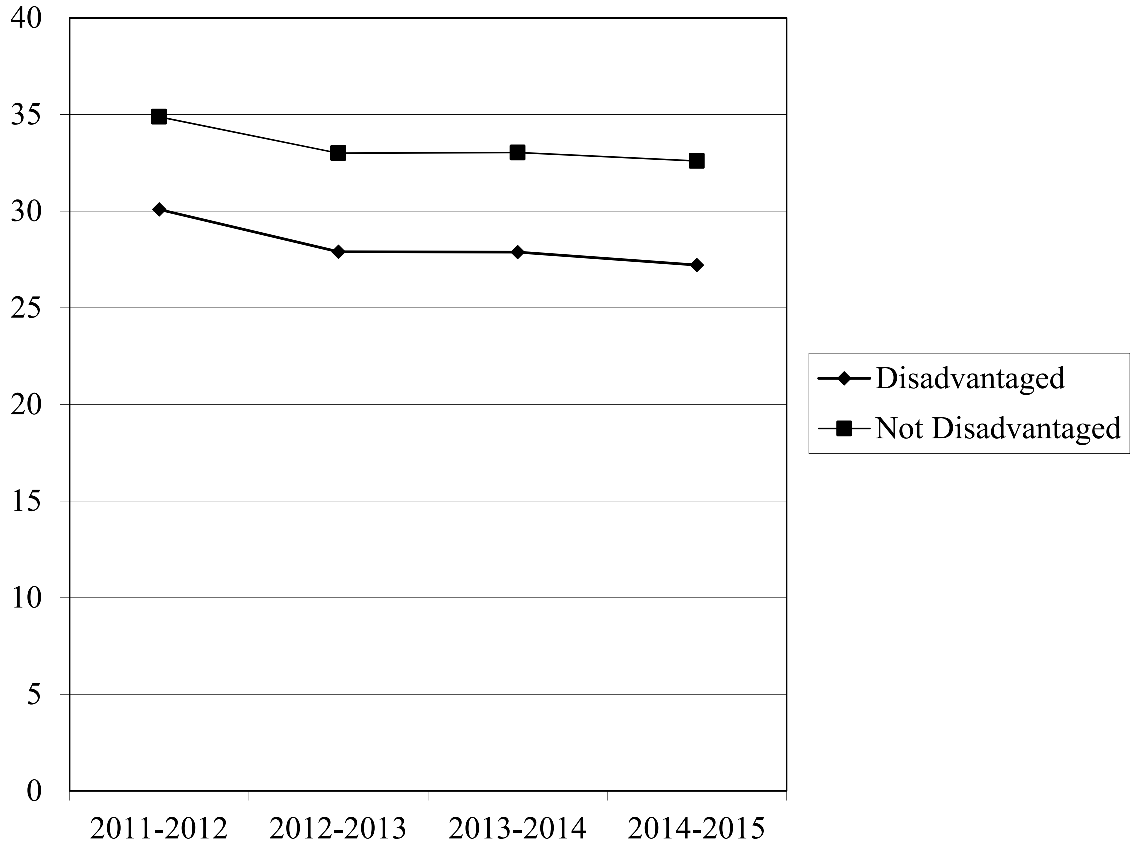

Figure 2.2. Average raw scores by student economic status for the Grade 5 State of Texas Assessment of Academic Readiness Science test for the 2011-2012 through the 2014-2015 school years

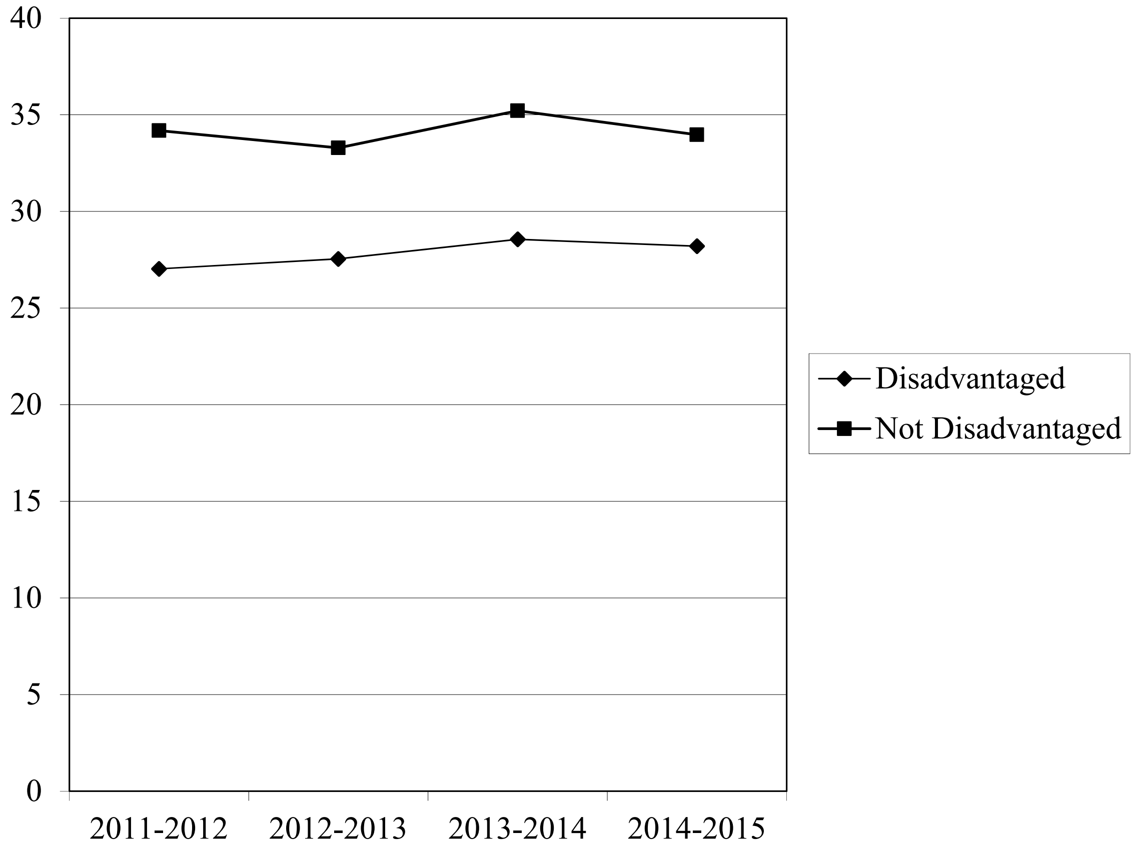

Figure 2.3. Average raw scores by student economic status for the Grade 8 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

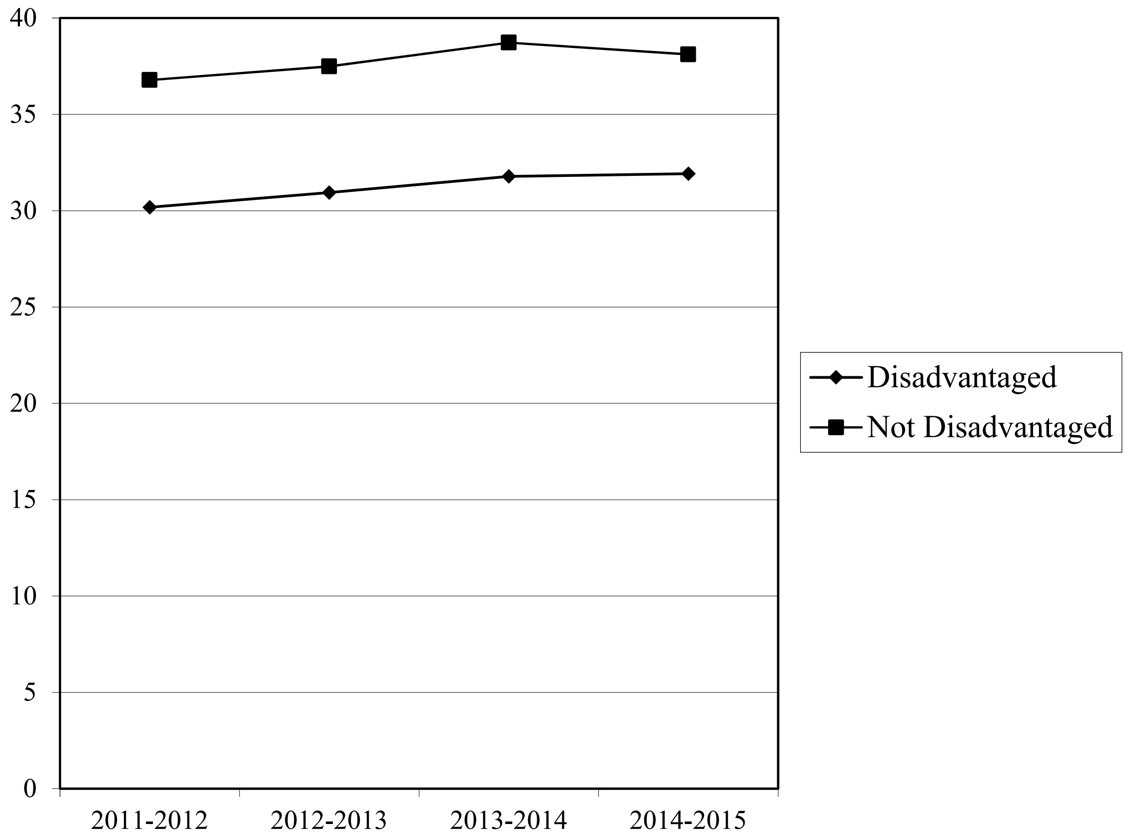

Figure 2.4. Average raw scores by student economic status for the Grade 8 State of Texas Assessment of Academic Readiness Science test for the 2011-2012 through the 2014-2015 school years.

CHAPTER III

GRADE 5 MATHEMATICS AND SCIENCE ACHIEVEMENT DIFFERENCES BY STUDENT GENDER AND ETHNICIY/RACE: A MULTIYEAR, STATEWIDE STUDY

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

Analyzed in this study were the State of Texas Assessment of Academic Readiness (STAAR) Mathematics and Science raw scores for Grade 5 students to determine the degree to which gender and ethnic/racial (i.e., Asian, Black, Hispanic, and White) differences were present. Four school years (i.e., 2011-2012 through 2014-2015) of statewide data were analyzed. For all tests, statistically significant differences were present by gender and by ethnicity/race. Trivial effect sizes were present between boys and girls for each analysis. However, medium effect sizes were revealed with regard to the raw score differences by ethnicity/race for the four years analyzed. Every year, Asian students had the highest average test score, followed by White, Hispanic, and Black students, respectively. A stair-step achievement gap (Carpenter, Ramirez, & Seven, 2006) was present in each school year analyzed.

KEY WORDS: Science achievement, Mathematics achievement, Asian, Black, Hispanic, White, Gender, Problem-based learning, STEM.

GRADE 5 MATHEMATICS AND SCIENCE ACHIEVEMENT DIFFERENCES BY STUDENT GENDER AND ETHNICIY/RACE: A MULTIYEAR, STATEWIDE STUDY

Numerous researchers (e.g., Harwell et al., 2015; Newman, Dantzler, & Coleman, 2015; Roehrig, Moore, Wang, & Park, 2012) have contended that the economic welfare of the United States is contingent upon developing a generation of Science, Technology, Engineering, and Math (STEM) professionals. The U.S. Department of Labor reported that 90% of the fastest growing employment fields in 2018 will demand at least a bachelor's degree with considerable instruction in mathematics and science (Hill, Corbett, & St. Rose, 2010). Employment in science and engineering will grow more swiftly than all other occupations, especially in engineering and computer-related fields. People who take advantage of these career fields as mathematics and science specialists will enjoy higher salaries and have better job stability than employees in other fields (Hill et al., 2010). Contradictory to the nation's need for STEM expertise, however, researchers (Atkinson, 2012; My College Options & STEM connector, 2013; President's Council of Advisors on Science and Technology [PCAST], 2010; Tank, 2014) acknowledged that American workers are not prepared to meet the needs of current STEM positions. Over one half of students who graduate with a science or engineering degree within the United States are from other countries (PCAST, 2010).

According to the National Science Foundation (NSF), science, technology, engineering, and mathematics are referenced as STEM disciplines (Koonce, Zhou, Anderson, Hening, & Conley, 2011). Education advocates have hailed STEM as a key program in the educational reform movement, and activists, politicians, and science and engineering proponents have been attracted to the idea of STEM education (Atkinson, 2012; The Whitehouse, 2015).

National organizations and business leaders have suggested an increased demand for science, technology, engineering, and mathematics (STEM) skills programs (National Research Council [NRC], 2011). Although this demand has increased, the intent and execution of the STEM curriculum is unclear and needs further interpretation (Bybee, 2013; Koonce et al., 2011). Moreover, the increased emphasis on elementary reading and mathematics skills has been on the political radar in the United States since the No Child Left Behind Act was issued in 2001 (Sikma & Osborne, 2014). As a result, instructional time has increasingly been devoted to basic skills rather than to science (Sikma & Osborne, 2014).

A particular challenge to STEM reform is the way that successes in STEM learning are assessed. Although STEM learning should include deeper analysis and critical thinking in all fields of science, technology, engineering, and mathematics, assessments to measure STEM knowledge are often determined through mathematics and science scores alone (NRC, 2011). Unfortunately, standardized tests, such as state, national, and international assessments, are the recognized norm for students to demonstrate academic prowess in science and mathematics (Bleich, 2012; NRC, 2011). The State of Texas Assessment of Academic Readiness (STAAR) tests are administered to students in Texas public schools to assess student college and career readiness, and to satisfy state and federal accountability requirements in several core subjects. Each school year STAAR Mathematics tests are given in Grades 3-8, and STAAR Science tests are administered in Grades 5 and 8.

Students from the United States have historically scored lower in international assessments than students from other countries (Fleischman, Hopstock, Pelczar, & Shelley, 2010). In an assessment given to 15-year-old students, the United States ranked 35th in mathematics and 27th in science on the 2012 Program for International Student Assessment (DeSilver, 2015). In another international assessment, U.S. students performed 27th in mathematics and 20th in science among the 34 countries that make up the Organization for Economic Cooperation and Development (DeSilver, 2015). In addition to American students ranking lower than students from other countries in mathematics and science, American students are also graduating with STEM-related degrees at a much lower rate than students from other countries (NRC, 2011; Newman et al., 2015).

According to a report on the National Assessment of Educational Progress (NAEP), many high school graduates do not meet the standards for subject matter knowledge and analytical skills required for college-level studies (Venezia & Jaeger, 2013). Therefore, some advocates (e.g., MacEwan, 2013; Tank, 2014) of STEM learning recommended learners experience authentic, real-world connections to science and mathematics as averages of increasing knowledge and analytical skills. However, this approach is seldom used in classrooms (Tank, 2014).

Another issue that may contribute to a lack of participation in STEM degrees was reported by The National Science Board (2014). One half of first-time college students in the United States enrolled in some type of remedial course, and 42% of all college students needed at least one remedial mathematics course (National Science Board, 2014). Researchers (e.g., Gigliotti, 2012; U.S. Department of Labor, 2007) caution an imperative exists for students who graduate high school to be prepared for college-level work so they might compete in a global community.

Many researchers (e.g., Beasley & Fischer, 2012; Gaughan & Bozeman, 2015; PCAST, 2010; Valerio, 2014) have noted that students who are Black, Hispanic, and/or Girls demonstrate little interest in STEM subjects. Despite encouragement from government and corporate interests, women and Black and Hispanic individuals remain underrepresented in STEM jobs. Although girls represent one half of the U.S. population, only 18.5% of bachelor's degrees in engineering were awarded to women in 2008 (Gonzalez & Kuenzi, 2013). This lack of interest continues to be a concern for educators and government organizations (Diaz-Rubio, 2013; PCAST, 2010).

Additionally, an achievement gap persists among certain minority groups (e.g., Black and Hispanic) and students who are White (Chatterji, 2006; Christian, 2008; PCAST, 2010). Although the achievement gap between Black students and White students has narrowed since 1990, White students continue to outscore Black students by 26 points on the 2013 NAEP Mathematics assessments. No measurable decrease in the gap between White and Hispanic students was noted during that time (National Center for Education Statistics [NCES], 2016). Educational policymakers remain concerned about the consistent achievement gaps between White students and Black students and Hispanic students (PCAST, 2010). One positive approach has emerged; the increasing appearance of magnet schools has offered extraordinary opportunities for underrepresented students to study specific educational themes such as STEM (Sikma & Osborne, 2014).

Purpose of the Study

The purpose of this study was to determine the degree to which boys and girls differ in their performance on the STAAR Mathematics and Science tests. Specifically analyzed were the STAAR Mathematics and Science test scores to determine whether differences exist in the test scores between Grade 5 boys and girls. A second purpose of this study was to determine the degree to which Asian, Black, Hispanic, and White Grade 5 students performed differently on the STAAR Mathematics and Science tests.

Significance of the Study

Currently, no published articles exist in which the relationships of gender and ethnicity/race to performance on the STAAR Mathematics and Science tests for Grade 5 students have been addressed. The extent to which gender and ethnic/racial gaps documented on previous assessments would be generalizable to the new state-mandated assessment, the STAAR, is not known. Accordingly, it is important to ascertain the presence, if any, of achievement gaps on the STAAR Mathematics and Science assessments for Grade 5 students by their gender and ethnicity/race. Such information would be useful to determine the efficacy of any new interventions or program in the STEM curriculum and instruction. School administrators, teachers, and legislators could use the findings of this study when they envision policies and make decisions with respect to STEM education.

Research Questions

The following research questions were addressed in this investigation: (a) What is the difference between Grade 5 boys and girls in their STAAR Mathematics test performance?; (b) What is the difference between Grade 5 boys and girls in their

STAAR Science test performance?; (c) What is the difference in Grade 5 STAAR Mathematics test performance as a function of ethnicity/race (i.e., Asian, Black, Hispanic, White)?; (d) What is the difference in Grade 5 STAAR Science test performance as a function of ethnicity/race (i.e., Asian, Black, Hispanic, White)?; (e) What trend, if any, is present in Grade 5 STAAR Mathematics test performance for boys and girls?; (f) What trend, if any, is present in Grade 5 STAAR Science test performance for boys and girls?; (g) What trend, if any, is present in Grade 5 STAAR Mathematics test performance for Asian, Black, Hispanic, and White students?; and, (h) What trend, if any, is present in Grade 5 STAAR Science test performance for Asian, Black, Hispanic, and White students? The first four research questions were examined for four school years of data (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015) and the last four questions constituted an analysis across the investigation study.

Method

Research Design

For this study a non-experimental, causal-comparative research design was used (Creswell, 2009). Both the independent and dependent variables constitute past events. Due to the ex-post facto nature of the data, neither the independent variables nor the dependent variables could be manipulated. Archival datasets for the spring STAAR test scores from the Texas Education Agency Public Education Information Management System were obtained and analyzed for four school years (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015). The independent variables analyzed were student gender and ethnicity/race. The dependent variables were the Grade 5 STAAR Mathematics and Science test scores for boys and girls and by ethnic/racial membership.

Participants and Instrumentation

Texas students in Grade 5 who were Asian, Black, Hispanic, or White were the participants in this study. Datasets were obtained from the Texas Education Agency Public Education Information Management System for the 2011-2012 school year through the 2014-2015 school year. A Public Information Request form was sent to the Texas Education Agency to obtain these data. Data were requested for (a) student gender, (b) student ethnicity/race, (c) STAAR Mathematics test scores, and (d) STAAR Science test scores.

Raw scores on the Grade 5 STAAR Mathematics and Science exams were analyzed in this investigation. Field (2009) reiterated the importance of test score reliability and test score validity. According to the Texas Education Agency (2015), "reliability for the STAAR test score was estimated using statistical measures such as internal consistency, classical standard error of measurement, conditional standard error of measurement, and classification accuracy" (p. 113). The Texas Education Agency adheres to national standards of best practice and collects validity confirmation each year of the STAAR test scores. For more detailed information on the psychometric qualities of the STAAR tests, readers are referred to the Texas Education Agency website.

Results

Prior to conducting inferential statistics to determine whether differences were present in the STAAR Mathematics and STAAR Science test scores between boys and girls and among ethnic/racial groups (i.e., Asian, Black, Hispanic, and White), checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002). Although some of the data were not normally distributed, a decision was made to use parametric independent samples *t*-tests to answer the research questions. Field (2009) contended that a parametric independent samples *t*-test is sufficiently robust that it can withstand this particular violation of its underlying assumptions. Statistical results will now be presented by academic subject area and by school year.

Research Question 1

For the 2011-2012 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(374086.60) = 14.21$, $p < .001$. This difference represented a trivial effect size (Cohen's *d*) of 0.05 (Cohen, 1988). Grade 5 girls had an average STAAR Mathematics test score that was less than 1 point higher than Grade 5 boys. Revealed in Table 3.1 are the descriptive statistics for this analysis.

Insert Table 3.1 about here

Regarding the 2012-2013 school year for Grade 5 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(372835.19) = 4.02$, $p < .001$. This difference represented a trivial Cohen's *d* effect size of 0.01 (Cohen, 1988). Grade 5 girls had an average STAAR Mathematics test score that was less than 1 point higher than boys. Presented in Table 3.1 are the descriptive statistics for this analysis.

Concerning the 2013-2014 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Mathematics test scores by student gender, $t(379411.90) = 10.84$, $p < .001$. This difference represented a trivial effect size (Cohen's d) of 0.03 (Cohen, 1988). Grade 5 girls had an average STAAR Mathematics test score that was less than 1 point higher than Grade 5 boys. The descriptive statistics for this analysis are presented in Table 3.1.

For the 2014-2015 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Mathematics test scores by student gender, $t(381323.33) = 22.20$, $p < .001$. This difference represented a trivial Cohen's d effect size of 0.07 (Cohen, 1988). Grade 5 girls had an average STAAR Mathematics test score that was almost 1 point higher than Grade 5 boys. Readers are directed to Table 3.1 for the descriptive statistics for this analysis.

Research Question 2

With respect to the 2011-2012 school year for Grade 5 students, a statistically significant difference was yielded in the STAAR Science test scores by student gender, $t(373663.23) = 36.69$, $p < .001$. This difference represented a trivial effect size (Cohen's d) of 0.12 (Cohen, 1988). Grade 5 girls had an average STAAR Science test score that was almost 1 point lower than Grade 5 boys. Presented in Table 3.2 are the descriptive statistics for this analysis.

Insert Table 3.2 about here

Concerning the 2012-2013 school year for Grade 5 students, a statistically significant difference was yielded in the STAAR Science test scores by student gender, $t(372382.95) = 37.92$, $p < .001$. This difference represented a trivial Cohen's d effect size of 0.12 (Cohen, 1988). Grade 5 girls had an average STAAR Science test score that was almost 1 point lower than Grade 5 boys. The descriptive statistics for this analysis are revealed in Table 3.2.

With respect to the 2013-2014 school year for Grade 5 students, a statistically significant difference was present in the STAAR Science test scores by student gender, $t(379068.90) = 37.92$, $p < .001$. This difference represented a Cohen's *d* of 0.10, a trivial effect size (Cohen, 1988). Grade 5 girls had an average STAAR Science test score that was almost 1 point lower than Grade 5 boys. Readers are directed to Table 3.2 for the descriptive statistics for this analysis.

Regarding the 2014-2015 school year for Grade 5 students, a statistically significant difference was revealed in the STAAR Science test scores by student gender, $t(389220.21) = 18.00$, $p < .001$. This difference represented a trivial effect size (Cohen's *d*) of 0.06 (Cohen, 1988). Grade 5 girls had an average STAAR Science test score that was less than 1 point lower than Grade 5 boys. In Table 3.2 are the descriptive statistics for this analysis.

Research Question 3

To address the third and fourth research questions, an Analysis of Variance (ANOVA) procedure was calculated. Prior to conducting the ANOVA, checks for normality of data were conducted. With respect to the distribution of Grade 5 STAAR Mathematics test scores by ethnicity/race, the standardized skewness coefficients (i.e., skewness divided by the standard error of skewness) and the standardized kurtosis coefficients (i.e., kurtosis divided by the standard error of kurtosis) revealed departures from normality for the variable of interest as the standardized coefficients were not within the +/-3 range (Onwuegbuzie & Daniel, 2002). To check further for homogeneity of variance, Levene's test was performed and revealed a violation of this assumption. Field (2009), however, contends that the parametric ANOVA is sufficiently robust that these violations can be withstood.

For the 2011-2012 school year, a statistically significant difference was revealed in Grade 5 STAAR Mathematics test scores by ethnicity/race, $F(3, 365881) = 8405.30$, $p < .001$, partial $\eta^2 = .064$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.3, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian students and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Thus, a stair-step achievement gap by ethnicity/race (Carpenter, Ramirez, & Severn, 2006) was clearly evident. Readers are directed to Table 3.3 for the descriptive statistics.

Insert Table 3.3 about here

Regarding the 2012-2013 school year for Grade 5 students, a statistically significant difference was revealed in Grade 5 STAAR Mathematics test scores by ethnicity/race, $F(3, 364407) = 8728.25$, $p < .001$, partial $\eta^2 = .067$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.3, Asian students had the highest average STAAR Mathematics scores, followed White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Clearly a stair-step achievement gap (Carpenter et al., 2006) was present with regard to ethnicity/race. Revealed in Table 3.3 are the descriptive statistics this analysis.

Concerning the 2013-2014 school year, a statistically significant difference was revealed in Grade 5 STAAR Mathematics test scores by ethnicity/race, $F(3, 370292) = 7833.87$, $p < .001$, partial $\eta^2 = .06$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As reported in Table 3.11, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Thus, a stair-step achievement gap by ethnicity/race (Carpenter et al., 2006) was clearly evident. Table 3.3 contains the descriptive statistics for this analysis.

For the 2014-2015 school year, a statistically significant difference was revealed in Grade 5 STAAR Mathematics test scores by ethnicity/race, $F(3, 371951) = 11118.25$, $p < .001$, partial $\eta^2 = .082$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.3, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. In agreement with

Carpenter et al. (2006) a stair-step achievement gap was clearly evident. Revealed in Table 3.3 are the descriptive statistics for this analysis.

Research Question 4

Regarding the 2011-2012 school year for Grade 5 students, a statistically significant difference was revealed in Grade 5 STAAR Science test scores by ethnicity/race, $F(3, 365711) = 10445.44$, $p < .001$, partial $\eta^2 = .079$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.4, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Not only was an achievement gap present between Asian and Hispanic students, an even larger achievement gap existed between Asian and Black students. Thus, revealed in this analysis was a stair-step achievement gap (Carpenter et al., 2006). Readers are directed to Table 3.4 for the descriptive statistics for this analysis.

Insert Table 3.4 about here

Concerning the 2012-2013 school year, a statistically significant difference was revealed in Grade 5 STAAR Science test scores by ethnicity/race, $F(3, 364086) = 11654.21$, $p < .001$, partial $\eta^2 = .088$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.4, Asian students had the highest average STAAR Science scores, followed by White, Hispanic, and Black students, respectively. Not only was an achievement gap present between Asian and Hispanic students, an even larger achievement gap existed between Asian and Black students. Revealed in this analysis was a stair-step achievement gap (Carpenter et al., 2006). Presented in Table 3.4 are the descriptive statistics for this analysis.

For the 2013-2014 school year, a statistically significant difference was revealed in Grade 5 STAAR Science test scores by ethnicity/race, $F(3, 370121) = 11927.73$, $p < .001$, partial $\eta^2 = .088$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.4, Asian students had the highest average STAAR Science scores, followed by White, Hispanic, and Black students, respectively. Consistent with the previous school years, a stair-step achievement gap was revealed (Carpenter et al., 2006). Descriptive statistics for this analysis are presented in Table 3.4.

Regarding the 2014-2015 school year for Grade 5 students, a statistically significant difference was revealed in Grade 5 STAAR Science test scores by ethnicity/race, $F(3, 379583) = 12234.20$, $p < .001$, partial $\eta^2 = .088$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 3.4, Asian students had the highest average STAAR Science scores, followed by, in rank order, White, Hispanic, and Black students. As such, clearly present in this analysis was a stair-step achievement gap (Carpenter et al., 2006). Revealed in Table 3.4 are the descriptive statistics for this school year.

Research Question 5

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Mathematics scores of Grade 5 students for boys and girls were analyzed. Of the 4 years investigated, results from all years were statistically significant. Figure 3.1 is a representation of average test scores by gender for the 2011-2012 through the 2014-2015 school years. Girls and boys had higher average test scores for the 2011-2012 through the 2013-2014 school years; however, the average scores of both groups were the lowest in the 2014-2015 school year. Girls outscored boys in all school years analyzed. The greatest average difference was 0.78 points and the smallest average difference was 0.14 points.

Insert Figure 3.1 about here

Research Question 6

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Science scores of Grade 5 boys and girls were analyzed. Of the 4 years investigated, results from all years were statistically significant. Figure 3.2 is a representation of average test scores by gender for the 2011-2012 through the 2014-2015 school years. Girls had lower average test scores in the 2011-2012 through the 2014-2015 school years. Boys had higher average test scores than girls in each school year. The greatest average difference was 0.98 points and the lowest average difference was 0.49 points.

Insert Figure 3.2 about here

Research Question 7

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Mathematics scores of Grade 5 Asian, Black, Hispanic, and White students were analyzed. Of the 4 years investigated, results from all years were statistically significant. Figure 3.3 is a representation of the average test scores by ethnicity/race for the 2011-2012 through the 2014-2015 school years. The average scores of each student group increased slightly each year between the 2011-2012 and the 2013-2014 school years, with the exception of Black students, who had a very slight decrease (i.e., 0.04 points) in their average score in the 2012-2013 school year. However, the average scores of all student groups decreased to the lowest average score during the last school year. In each school year, Asian students earned the highest average score, followed by White, Hispanic, and Black students, respectively. In each year of the study, a stair-step achievement gap was clearly present (Carpenter et al., 2006). The largest average score difference for each school year was between Asian and Black students, which included a minimum average difference of 11.18 and a maximum average difference of 13.61.

Insert Figure 3.3 about here

Research Question 8

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Science scores of Grade 5 students by ethnicity/race were analyzed. Of the 4 years investigated, results for all school years were statistically significant. Figure 3.4 is a representation of the average test scores by ethnicity/race for the 2011-2012 through the

2014-2015 school years. The average scores of each student group decreased between the 2011-2012 school year and 2012-2013 school year; however, the average scores fluctuated under 1 point for each ethnic/racial group for the 2012-2013, 2013-2014, and 2014-2015 school years. In each year, Asian students had the highest average score, followed by White, Hispanic, and Black students, respectively. A stair-step achievement gap was clearly evident in each school year (Carpenter et al., 2006). The largest average score difference was between Asian and Black students, which included a minimum difference of 6.80 points and a maximum difference of 8.20 points. The average test score difference increased between the first and last school year of data analyzed herein.

Insert Figure 3.4 about here

Discussion

In this multiyear statewide analysis, the STAAR Mathematics and Science test scores of Grade 5 students were obtained and analyzed. The degree to which differences were present in the STAAR Mathematics and Science test scores for Grade 5 students by their gender and by their ethnicity/race (i.e., Asian, Black, Hispanic, and White) were determined. Through analyzing four school years of Texas statewide data, any trends that might be present by student gender or by student ethnicity/race were identified.

Regarding Grade 5 STAAR Mathematics and Science exams by gender, all results were statistically significant, albeit with trivial effect sizes. The average Grade 5 Mathematics test scores of girls were consistently higher than for boys by under 1 point in all four school years. In contrast to the mathematics results, the average Grade 5

STAAR Science test scores of boys were consistently higher than for girls in all four school years, by less than 1 point difference each year.

With respect to the Grade 5 STAAR Mathematics test by student ethnicity/race, statistically significant differences were yielded for all four school years. Effect sizes were moderate for all analyses. Achievement gaps were documented among the four ethnic/racial groups on this exam. In each school year, Asian students had the highest average test score, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. The largest gap was between Asian and Black students with average score difference of between 11.18 and 13.61. Asian students had average scores that ranged from 39.97 to 41.02; White students had average scores that ranged from 34.06 to 36.40; Hispanic students had average scores that ranged from 29.63 to 32.70, and Black students had average scores that ranged from 26.37 to 29.85.

Regarding the Grade 5 STAAR Science exams for the 2011-2012 through the 2014-2015 school years, a stair-step achievement gap (Carpenter et al., 2006) was also clearly evident, although the gap was not as wide as in the Grade 5 STAAR Mathematics exam. Moderate effect sizes were present for all four school years. Asian students consistently had the highest average test scores, followed by White, Hispanic, and Black students, respectively. The largest gap was between Asian and Black students with average score differences ranging from 6.80 points to 8.20. For each year of the study, Asian students had average scores ranging from 34.13 to 35.98; White students had average scores ranging from 32.43 to 34.55; Hispanic students had average scores ranging from 27.94 to 30.62, and Black students had average scores ranging from 26.07 to 29.18.

Connections to Existing Literature

Researchers (e.g., Beasley & Fischer, 2012; Gaughan & Bozeman, 2015; PCAST, 2010) have noted the underrepresentation of women in STEM fields of employment; however, only minimal achievement gaps were documented herein between the average test scores of boys and girls on the Grade 5 STAAR Mathematics and Science exams for all four school years. The average scores of girls were slightly higher than the average scores of boys each year on the STAAR Mathematics exam; however, average score differences all four years were under 1 point. Regarding the Grade 5 Science exams, the average test scores of boys were slightly higher than the average scores of girls, with also an average difference of under 1 point for all years.

As a result of this study, the existing research regarding achievement gaps among Black and Hispanic students (Chatterji, 2006; Christian, 2008; Diaz-Rubio, 2013; NCES, 2016; PCAST, 2010) is reinforced. The average scores of Black and Hispanic students were consistently lower than Asian and White students on both the STAAR Mathematics Scores and the STAAR Science Scores for Grade 5 students for all four school years. Asian students had the highest average test scores, followed by White, Hispanic, and Black students, respectively.

Implications for Policy and Practice

In this multiyear analysis of Grade 5 STAAR Mathematics and Grade 5 STAAR Science test scores, Black and Hispanic students consistently scored lower on all tests. Although large differences were not present in the average test scores between boys and girls on the Grade 5 STAAR Mathematics and Science exams, it is a concern that women are not more represented in STEM employment fields. Educational policymakers could ensure that STEM-related programs are available that give these underrepresented groups (i.e., girls, Black, and Hispanic students) multiple opportunities to learn and practice mathematics and science inside and outside of school. Additionally, how students are assessed in mathematics and science could be reevaluated, with consideration given to authentic assessments that measure skills that standardized tests cannot measure such as creativity, problem-solving, and collaboration.

Recommendations for Educational Leaders

Policymakers are encouraged to write and fund a state STEM curriculum that is comprised of project-based lessons with many opportunities for students to solve real-world problems using technology. School and district leaders are encouraged to advocate for authentic STEM learning for all students. Teachers are encouraged to build relationships with students while teaching them STEM subjects, particularly with groups of students who have shown a lower interest in STEM careers (i.e., girls, Black and Hispanic students). School leaders should ensure that girls, Black, and Hispanic students are enrolled in advanced mathematics and science courses with Asian and White students. All students must have opportunities to think critically and to solve problems, teachers are encouraged to develop lesson ensure this higher level of learning. Furthermore, school and district curriculum leaders, and state leaders, in conjunction with teachers are encouraged to find and/or develop alternative assessments to measure those skills related to thinking and real world or authentic problem solving.

Recommendations for Future Research

Researchers are encouraged to replicate this investigation each school year to determine the degree to which the achievement gaps documented herein continue to be present. Furthermore, researchers may want to continue examining differences in test scores regarding gender and ethnicity to determine if achievement gaps continue among certain minority students (e.g., Black and Hispanic). Additionally, because only Grade 5 Mathematics and Science STAAR Scores data were analyzed in this investigation, researchers are encouraged to extend this study to other grade levels, both early elementary grade levels as well as secondary grade levels. Another recommendation for future research is to extend this study to other states with different assessments than are present in Texas. Such research may provide information regarding the degree to which results from this study are generalizable to students in other states. A final recommendation would be for researchers to analyze the mathematics and science performance of students who are economically disadvantaged and English Language Learners, primarily because the percentage of these two groups of students with respect to student enrollment is rapidly increasing.

Conclusion

The purpose of this research study was to examine the extent to which differences existed in STAAR Mathematics and STAAR Science scores for Grade 5 students, based on gender and ethnicity/race. Data were analyzed for four school years of data (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015). Statistically significant differences were present for all four school years. On the STAAR Mathematics exam, girls outscored boys all years by under 1 point each year. On the STAAR Science exams, boys outscored girls all years by under 1 point each year. Marked achievement gaps were present on the STAAR Mathematics and Science exams concerning ethnicity/race. All four years of the study, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Each year, Asian students had the highest average scores, followed by White, Hispanic, and Black students, respectively. As such, results from this multiyear, statewide investigation are supportive that achievement gaps continue to exist among ethnic/racial groups and between boys and girls.

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Table 3.1

Descriptive Statistics on the Grade 5 STAAR Mathematics Scores by Gender for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Gender	*n*	*M*	*SD*
2011-2012			
Girls	183,132	32.96	10.30
Boys	190,972	32.47	10.67
2012-2013			
Girls	182,377	33.05	10.76
Boys	190,533	32.90	11.09
2013-2014			
Girls	185,941	34.01	10.42
Boys	193,474	33.64	10.82
2014-2015			
Girls	186,917	31.40	10.59
Boys	194,531	30.61	11.22

Table 3.2

Descriptive Statistics on the Grade 5 STAAR Science Scores by Gender for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Gender	*n*	*M*	*SD*
2011-2012			
Girls	183,086	31.42	7.55
Boys	190,842	32.34	7.66
2012-2013			
Girls	182,286	29.33	7.83
Boys	190,414	30.31	7.95
2013-2014			
Girls	185,891	29.42	7.95
Boys	193,380	30.27	8.09
2014-2015			
Girls	190,112	29.09	8.28
Boys	199,217	29.57	8.53

Table 3.3

Descriptive Statistics on the Grade 5 STAAR Mathematics Scores by Ethnicity/Race for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Ethnicity/Race	*n*	*M*	*SD*
2011-2012			
Asian	13,615	40.20	9.88
White	113,439	35.40	10.29
Hispanic	191,992	31.49	10.08
Black	46,839	28.78	10.17
2012-2013			
Asian	13,615	40.20	9.88
White	113,439	35.40	10.29
Hispanic	191,992	31.49	10.08
Black	46,839	28.78	10.17
2013-2014			
Asian	14,773	41.02	9.96
White	111,597	36.40	10.15
Hispanic	197,206	32.70	10.34
Black	46,720	29.85	10.63
2014-2015			
Asian	15,457	39.97	9.13
White	109,757	34.06	10.44
Hispanic	199,956	29.63	10.52
Black	46,785	26.37	10.64

Table 3.4

Descriptive Statistics on the Grade 5 STAAR Science Scores by Ethnicity/Race for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Ethnicity/Race	*n*	*M*	*SD*
2011-2012			
Asian	13,601	35.98	7.19
White	113,346	34.55	6.97
Hispanic	191,968	30.62	7.44
Black	46,800	29.18	7.67
2012-2013			
Asian	13,806	34.13	7.77
White	111,553	32.77	7.32
Hispanic	192,180	28.48	7.64
Black	46,551	26.81	7.69
2013-2014			
Asian	14,751	34.73	7.34
White	111,515	32.76	7.22
Hispanic	197,135	28.52	7.88
Black	46,724	26.72	7.92
2014-2015			
Asian	15,860	34.27	7.63
White	111,850	32.43	7.72
Hispanic	203,710	27.94	8.17
Black	48,167	26.07	8.28

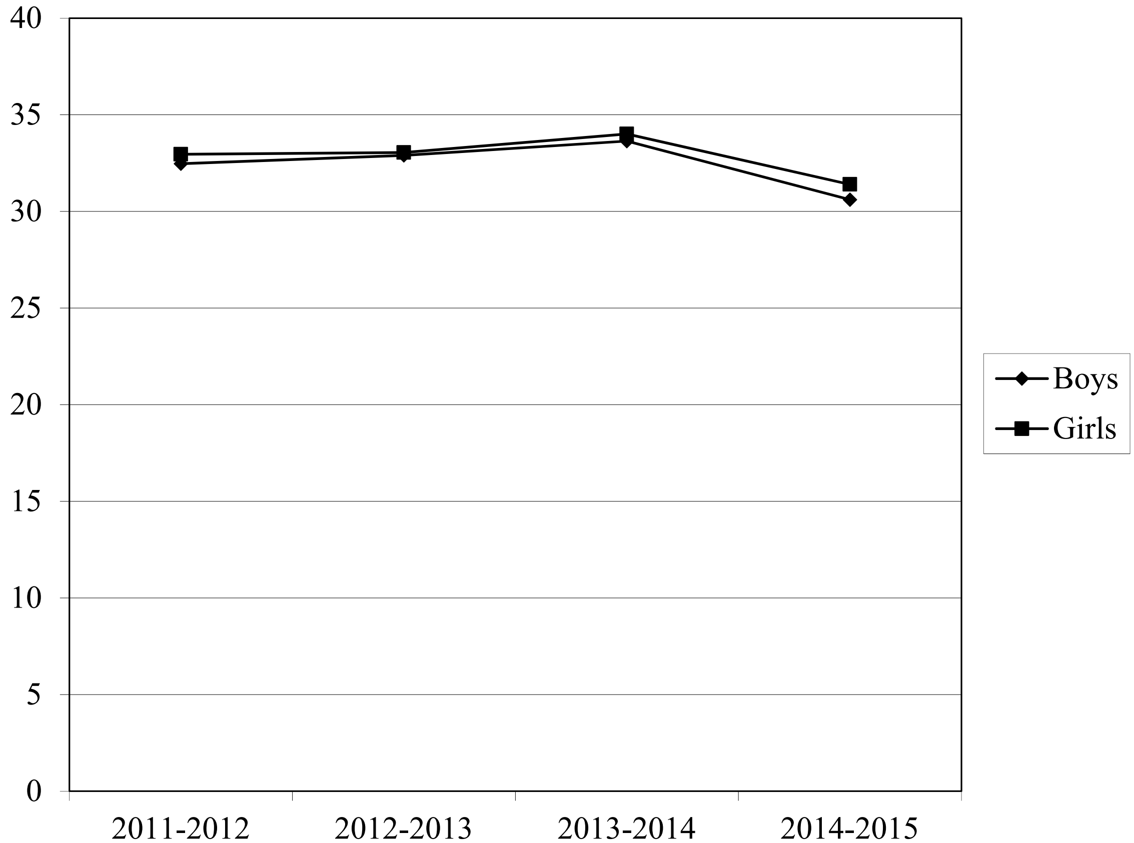

Figure 3.1. Average raw scores by gender for the Grade 5 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

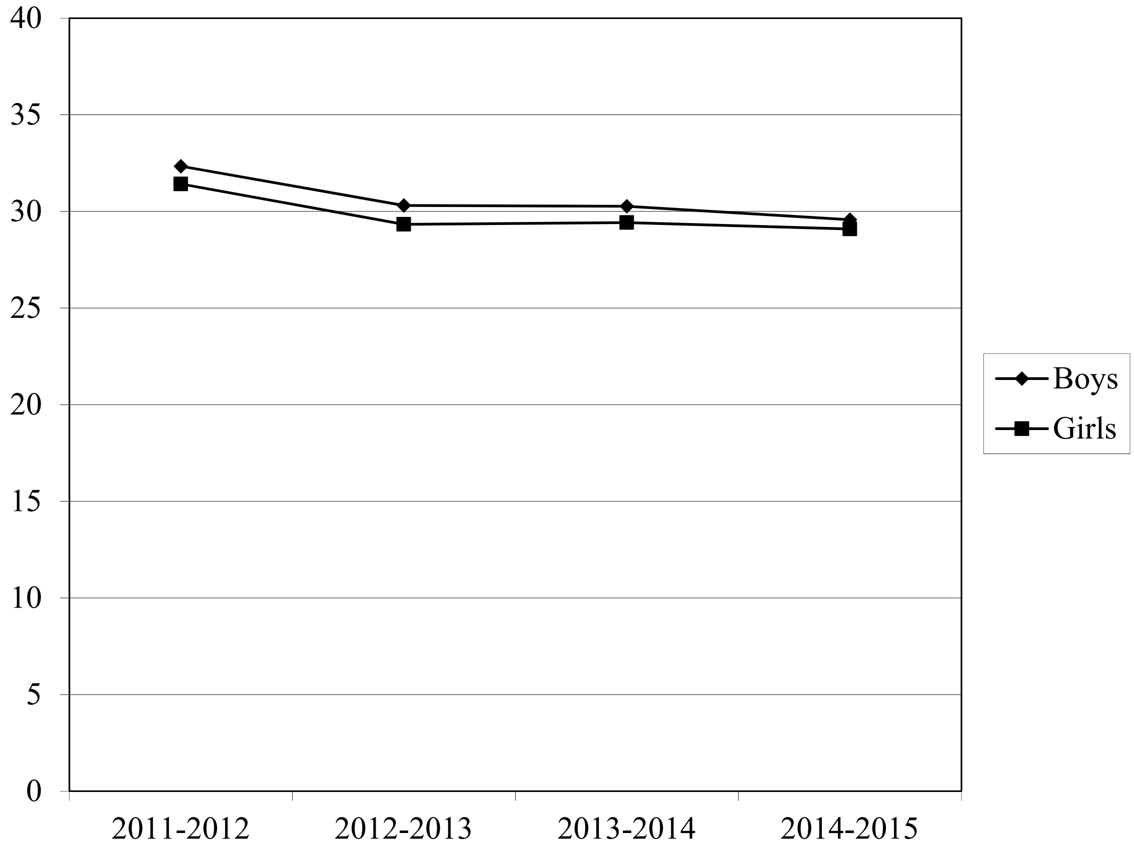

Figure 3.2. Average raw scores by gender for the Grade 5 State of Texas Assessment of Academic Readiness Science test for the 2011-2012 through the 2014-2015 school years.

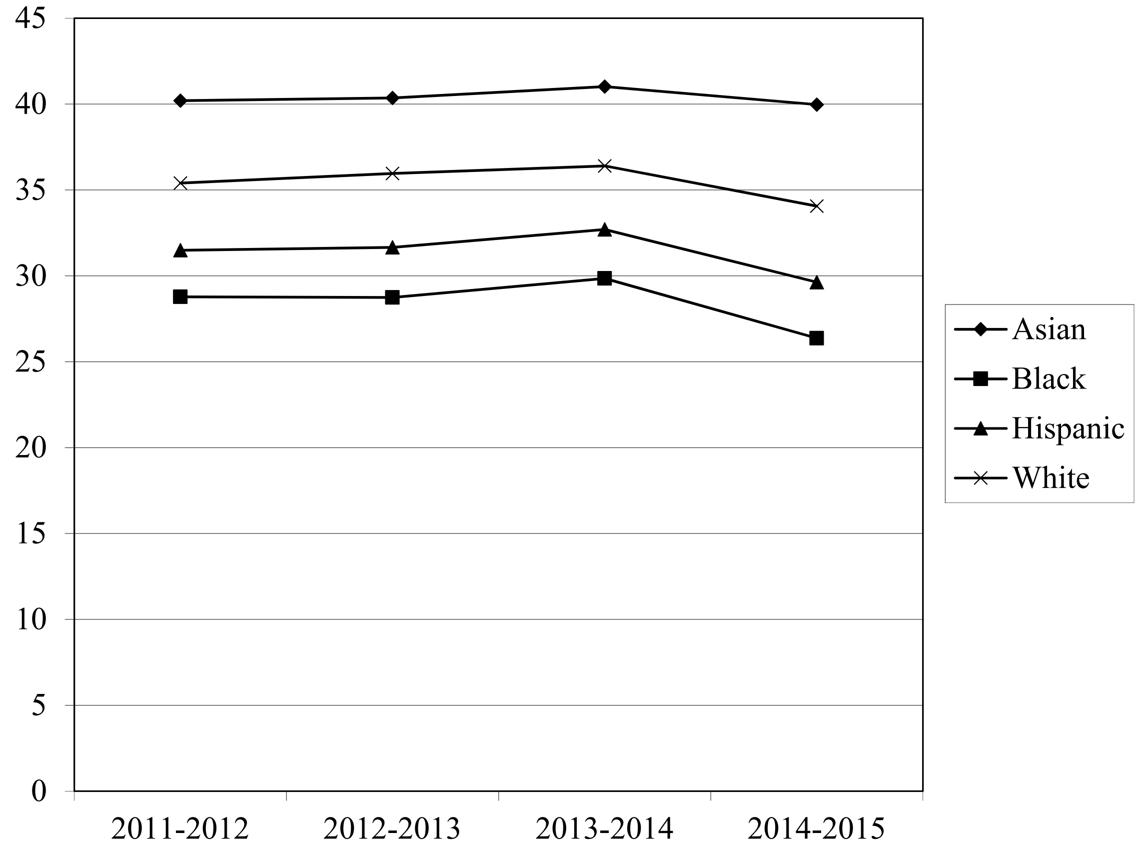

Figure 3.3. Average raw scores by ethnicity/race for the Grade 5 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

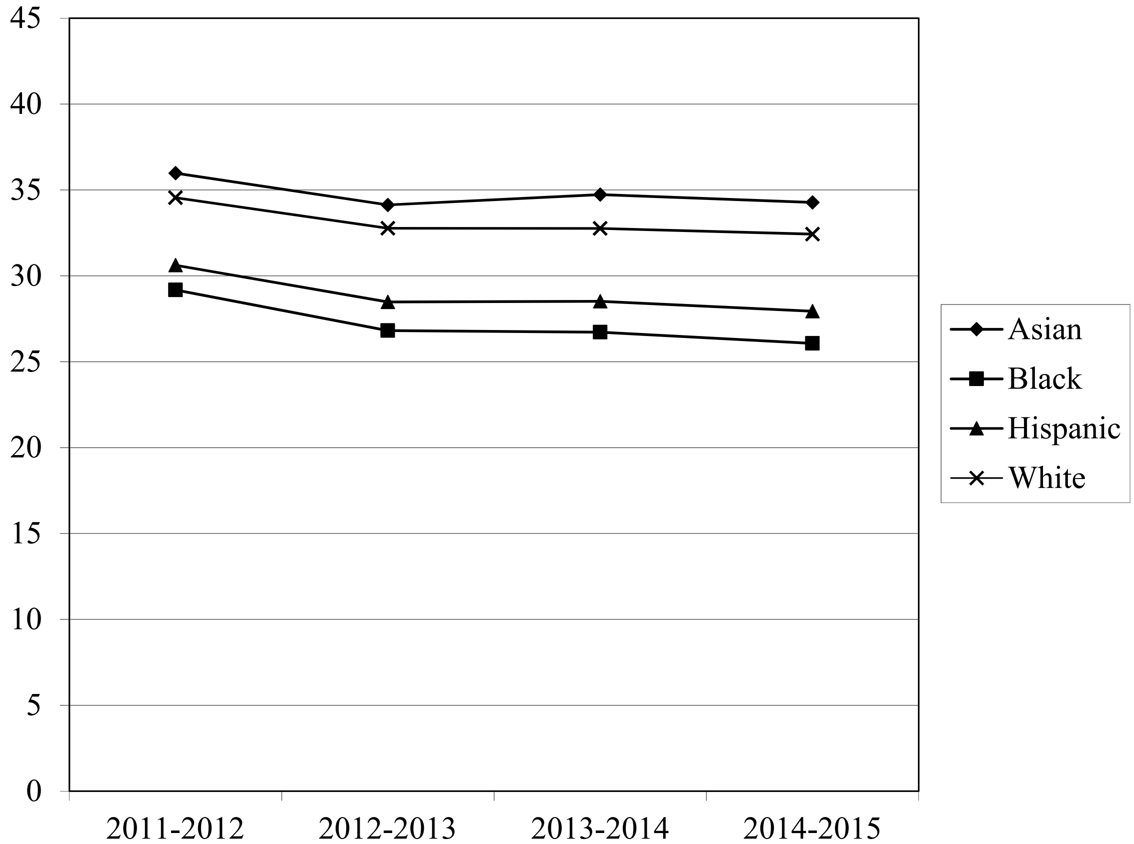

Figure 3.4. Average raw scores by ethnicity/race for the Grade 5 State of Texas Assessment of Academic Readiness Science test for the 2011-2012 through the 2014-2015 school years.

CHAPTER IV

GENDER AND ETHNIC/RACIAL DIFFERENCES IN GRADE 8 MATHEMATICS AND SCIENCE PERFORMANCE: A TEXAS, MULTIYEAR ANALYSIS

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

Analyzed in this study were the State of Texas Assessment of Academic Readiness (STAAR) Mathematics and Science test scores of Grade 8 students by gender and ethnicity/race (i.e., Asian, Black, Hispanic, and White). Four school years (i.e., 2011-2012 through 2014-2015) of statewide data were obtained and analyzed. For all tests, statistically significant differences were present by gender and by ethnicity/race. In the four years analyzed, boys outperformed girls on mathematics and science scores with the exception of the 2014-2015 STAAR Mathematics test. The effect sizes for these gender differences were trivial. Asian students had the highest average mathematics and science scores, followed by White, Hispanic, and Black students, respectively. Every year, a stair-step achievement gap (Carpenter, Ramirez, & Seven, 2006) was present. Effect sizes for these ethnic/racial differences were moderate.

KEY WORDS: Science achievement, Mathematics achievement, Student economic status, Asian, Black, Hispanic, White, Gender, Problem-based learning, STEM.

GENDER AND ETHNIC/RACIAL DIFFERENCES IN GRADE 8 MATHEMATICS AND SCIENCE PERFORMANCE: A TEXAS, MULTIYEAR ANALYSIS

The National Science Foundation (NSF) broadly defined STEM as an acronym for science, technology, engineering, and mathematics disciplines (Koonce, Zhou, Anderson, Hening, & Conley, 2011). The STEM pursuit is referred to by several educational reform-minded activists, politicians, and science and engineering advocates alike as one solution to current educational shortcomings (National Science Board, 2014; Tank, 2014; U.S. Department of Labor, 2007). However, educators, policymakers, and legislators must clarify the purpose and practice of STEM education (Bybee, 2013; Koonce et al., 2011).

Since the No Child Left Behind Act was enacted in 2001, an increasing emphasis on reading and mathematics in U.S. schools has taken place (Sikma & Osborne, 2014; Valerio, 2014). Increasingly, politicians and business leaders alike have encouraged more emphasis on science, technology, engineering and mathematics (STEM) courses and experiences in schools (National Research Council [NRC], 2011). However, too few U.S. students graduate with backgrounds in STEM (My College Options & STEMconnector, 2013; President's Council of Advisors on Science and Technology [PCAST], 2010; Tank, 2014). Over one half of science or engineering graduates from U.S. universities are students who come from other countries (PCAST, 2010).

Enthusiastic support has been given by national and private businesses for increased STEM opportunities in the classroom (Harwell et al., 2015; Roehrig et al., 2012). Although science and mathematics education has been a priority for the United States, students have consistently ranked low in international assessments (DeSilver, 2015; Valerio, 2014). For example, the 2012 Program for International Student Assessment results were an indication that out of 64 countries, the United States ranked 35th in mathematics and 27th in science (DeSilver, 2015). Through the National Assessment of Educational Progress, a clear record exists that American high school students do not have the subject matter knowledge and analytical skills necessary for postsecondary success when they graduate from high school (Venezia & Jaeger, 2013). Additionally, American students are not graduating from college with STEM or STEM-related degrees commensurate to students from other countries (NRC, 2011; Newman et al., 2015).

Women and some underrepresented groups, specifically Blacks and Hispanics, have not been attracted to STEM education or fields (Bidwell, 2015). Furthermore, women, Black and Hispanic students, have scored lower on state and national assessments in science and mathematics (Diaz-Rubio, 2013; PCAST, 2010). In addition to achievement gaps based on gender and ethnicity, researchers from both the President's Council of Advisors on Science and Technology (2010) and the National Science Board (2014) caution that students who do not make a personal connection to STEM during the K-12 school years will not pursue STEM in college or as a career (Raju & Clayson, 2010). It is of concern that students of color, students from low income families, and girls participate in STEM learning opportunities much less often than their more affluent, White, male counterparts (Lyon, Jafri, & St. Louis, 2012).

In 2013, 22% of children in America were living in poverty, with the rate of poverty almost double among Black individuals, of whom 39% were living in poverty (Potter, 2015; The Annie E. Casey Foundation, 2015). Twenty-four percent of Hispanic children and 34% of Black children live in poverty in Texas, compared with 11% of White children (The Annie E. Casey Foundation, 2015). Achievement gaps exist for students in underserved groups including Black and Hispanic student groups (Newman et al., 2015). These students, boys and girls, are less likely to have opportunities to take advanced mathematics and science classes in middle and high school, which, in turn, makes success in higher education STEM courses more difficult to achieve (Hill et al., 2010).

Statement of the Problem

Numerous studies (e.g., Harwell et al., 2015; Newman, Dantzler, & Coleman, 2015; Roehrig, Moore, Wang, & Park, 2012), documents, and policies exist to support the supposition that continued prosperity and future welfare of the United States is dependent upon developing a future-generation of STEM professionals. The U.S. Department of Labor (2007) reported that by 2018, 90% of the fastest growing employment fields will require a minimum bachelor's degree with additional education in mathematics and science (Hill, Corbett, & St. Rose, 2010). Careers in science and engineering particularly in engineering and computer-related fields will have a faster growth than all other vocations. Moreover, employees in mathematics and science fields earn higher salaries and have better job security than employees in other fields (Hill et al., 2010).

However, well-known achievement gaps exist among certain underrepresented student groups (e.g., Black and Hispanic), girls, and students from low socioeconomic families (Bolkan, 2015; Nikischer, 2013; PCAST, 2010). This achievement gap is highlighted by researchers who analyze data from state and national assessments with regard to underrepresented groups (PCAST, 2010). Students in Texas are assessed each year on the State of Texas Assessment of Academic Readiness (STAAR) Mathematics test in Grades 3-8. The STAAR Science tests are administered in Grades 5 and 8. Although the STAAR Mathematics and Science tests have been administered since the 2011-2012 school year, no published research exists in which the STAAR Mathematics and Science achievement scores have been analyzed with respect to student gender and ethnicity/race.

In addition to the achievement gap, women, Blacks, and Hispanics continue to be underrepresented in STEM education. Moreover, these same groups are underrepresented in jobs, and in specific areas the gap has widened (Neuhauser, 2015). According to researchers (e.g., Maltese & Tai, 2011), current policy efforts to reform high school STEM learning may be misguided, as many graduate students and scientists reported that their interest in STEM subjects developed in middle school. Consequently, students in Grade 8 who considered science to be beneficial to their future were more likely to pursue STEM degrees than Grade 8 students who did not consider science beneficial to their future. (Maltese & Tai, 2010).

Purpose of the Study

The purpose of this study was to determine the degree to which differences might exist in the STAAR Mathematics and Science test scores among specific student groups in the state of Texas. One purpose of this study was to ascertain whether Grade 8 boys and girls differ in their STAAR Mathematics and Science test scores. A second purpose of this study was to determine the extent to which the STAAR Mathematics and Science test scores differ for Grade 8 students by ethnicity/race (i.e., Asian, Black, Hispanic, and White).

Significance of the Study

To date, no published empirical investigations in which the STAAR Mathematics and Science test scores have been analyzed with regard to student gender and ethnicity/race. The degree to which previously documented achievement gaps in these areas is generalizable to this new Texas state-mandated assessment is not known. As such, ascertaining detailed information regarding differences, if any, between boys and girls and among ethnic/racial groups on the STAAR tests is essential. Results from this investigation concerning any differences between boys and girls in their mathematics and science performance may be used to inform current practices in instruction. Furthermore, results from this study regarding achievement gaps for Black, Hispanic, and White students in mathematics and science may also be used to inform current instructional practices. School administrators, teachers, and policymakers might use the findings of this study when they envision policies and strategies with respect to STEM education integration, specifically as it relates to middle school students.

Research Questions

The following research questions were addressed in this investigation: (a) What is the difference in Grade 8 STAAR Mathematics test performance between boys and girls?; (b) What is the difference in Grade 8 STAAR Science test performance between boys and girls?; (c) What is the difference in Grade 8 STAAR Mathematics test performance as a function of ethnicity/race (i.e., Asian, Black, Hispanic, White)?; (d) What is the difference in Grade 8 STAAR Science test performance as a function of ethnicity/race (i.e., Asian, Black, Hispanic, White)?; (e) What trend, if any, is present in Grade 8 STAAR Mathematics test performance for boys and girls?; (f) What trend, if any, is present for Grade 8 STAAR Science test performance for boys and girls?; (g) What trend, if any, is present in Grade 8 STAAR Mathematics test performance for Asian, Black, Hispanic, and White students?; and, (h) What trend, if any, is present in Grade 8 STAAR Science test performance for Asian, Black, Hispanic, and White students? The first four research questions were examined for four school years of data (i.e., 2011-2012, 2012-2013, 2013-2014, and 2014-2015) and the last four questions constituted a trend analysis across the four school years. Thus, 20 research questions were present in this study.

Method

Research Design

For this study a non-experimental, causal-comparative research design (Creswell, 2009) was used. Archived datasets of the STAAR Mathematics and Science test scores from the Texas Education Agency Public Education Information Management System for four school years (i.e., the 2011-2012 school year through the 2014-2015 school year) were examined. Therefore, because archival data was analyzed herein, the independent variables could not be manipulated. The independent variables analyzed in this study were gender and ethnicity/race. The dependent variables were the STAAR Mathematics and Science test scores for Grade 8 boys and girls.

Participants and Instrumentation

Participants in this study were Grade 8 Asian, Black, Hispanic, and White students in Texas. Datasets were obtained from the Texas Education Agency Public

Education Information Management System for the 2011-2012, 2012-2013, 2013-2014, and the 2014-2015 school years. These data were requested through a Public Information Request form that will be sent to the Texas Education Agency. Specific data requested were: (a) student gender; (b) student ethnicity/race; (c) STAAR Mathematics test scores; and (d) STAAR Science test scores. The datasets were then analyzed to determine whether Grade 8 boys and girls differed in their STAAR Mathematics and Science performance and to ascertain whether Grade 8 Asian, Black, Hispanic, and White students differed in their STAAR Mathematics and Science performance.

According to the Texas Education Agency (2015), "reliability for the STAAR test score was estimated using statistical measures such as internal consistency, classical standard error of measurement, conditional standard error of measurement, and classification accuracy" (p. 113). Validity refers to how well a test measures what it is supposed to measure, and the Texas Education Agency adheres to national standards of best practice and collects validity confirmation each year of the STAAR test scores. Readers are referred to the Texas Education Agency website for more detailed information regarding the psychometric qualities of the STAAR tests.

Results

Prior to conducting inferential statistics to determine whether differences were present in the STAAR Mathematics and STAAR Science test scores between girls and boys, checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002). Although some of the data were not normally distributed, a decision was made to use parametric independent samples *t*-tests to answer the research questions. Field (2009) contends that a parametric independent samples *t*-test is sufficiently robust that it can withstand this particular violation of its underlying assumptions. Statistical results will now be presented by academic subject area.

Research Question 1

Concerning the 2011-2012 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(379571.35) = 7.43$, $p < .001$. This difference represented a trivial effect size (Cohen's *d*) of 0.02 (Cohen, 1988). Grade 8 girls had an average STAAR Mathematics test score that was less than 1 point lower than Grade 8 boys. Included in Table 4.1 are the descriptive statistics for this analysis.

Insert Table 4.1 about here

For the 2012-2013 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(393545.03) = 7.89$, $p < .001$. This difference represented a trivial Cohen's *d* effect size of 0.03 (Cohen, 1988). Grade 8 girls had an average STAAR Mathematics test score that was under 1 point lower than Grade 8 boys. The descriptive statistics for this analysis are provided in Table 4.1.

Regarding the 2013-2014 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(398314.35) = 6.53$, $p < .001$. This difference represented Cohen's *d* of 0.02, a trivial effect size (Cohen, 1988). Grade 8 girls had an average STAAR Mathematics test score that was less than 1 point lower than Grade 8 boys. Included in Table 4.1 are the descriptive statistics for this analysis.

Concerning the 2014-2015 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Mathematics test scores by student gender, $t(326438.62) = 33.71$, $p < .001$. This difference represented a trivial effect size (Cohen's *d*) of 0.12 (Cohen, 1988). Grade 8 girls had an average STAAR Mathematics test score that was over 1 point higher than Grade 8 boys. The descriptive statistics for this analysis are provided in Table 4.1.

Research Question 2

For the 2011-2012 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student gender, $t(356433.10) = 39.28$, $p < .001$. This difference represented a trivial Cohen's *d* of 0.13, a trivial effect size (Cohen, 1988). Grade 8 girls had an average STAAR Science test score that was over 1 point lower than Grade 8 boys. Readers are directed to Table 4.2 for the descriptive statistics for this analysis.

Insert Table 4.2 about here

Regarding the 2012-2013 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student gender, $t(363056.74) = 34.21$, $p < .001$. This difference represented a trivial effect size (Cohen's *d*) of 0.11 (Cohen, 1988). Grade 8 girls had an average STAAR Science test score that was over 1 point lower than Grade 8 boys. Included in Table 4.2 are the descriptive statistics for this analysis.

Concerning the 2013-2014 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student gender, $t(375566.34) = 22.55$, $p < .001$. This difference represented a trivial Cohen's *d* effect size of 0.07 (Cohen, 1988). Grade 8 girls had an average STAAR Science test score that was almost 1 point lower than Grade 8 boys. Table 4.2 contains the descriptive statistics for this analysis.

For the 2014-2015 school year for Grade 8 students, the parametric independent samples *t*-test revealed a statistically significant difference in the STAAR Science test scores by student gender, $t(391875.52) = 5.61$, $p < .001$. This difference represented a Cohen's *d* of 0.02, a trivial effect size (Cohen, 1988). Grade 8 girls had an average STAAR Science test score that was under 1 point lower than Grade 8 boys. The descriptive statistics for this analysis are provided in Table 4.2.

Research Question 3

To address the third and fourth research questions, an Analysis of Variance (ANOVA) procedure was calculated. Prior to conducting the ANOVA, checks for normality of data were conducted. With respect to the distribution of Grade 8 STAAR Mathematics test scores by ethnicity/race, the standardized skewness coefficients (i.e., skewness divided by the standard error of skewness) and the standardized kurtosis coefficients (i.e., kurtosis divided by the standard error of kurtosis) revealed departures from normality for the variable of interest as the standardized coefficients were not within the +/-3 range (Onwuegbuzie & Daniel, 2002). A check of the homogeneity of variance, the Levene's test, was performed and revealed a violation of this assumption. Field (2009), however, contends that the parametric ANOVA is sufficiently robust that these violations can be withstood.

For the 2011-2012 school year, a statistically significant difference was revealed in Grade 8 STAAR Mathematics test scores by ethnicity/race, $F(3, 321612) = 12376.80$, $p < .001$, partial $\eta^2 = .104$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 4.3, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, Black students, respectively. Asian students had an average test score that was over 5 points higher than the average test score of White students. White students had an average test score that was more than 6 points higher than the average test scores of Hispanic students. Hispanic students had an average test score that was over 2 points higher than the average test score of Black students. The greatest gap occurred between Asian and Black students, with almost a 14 point difference in raw scores. Similar to previous years, a stair-step achievement gap (Carpenter, Ramirez, & Severn, 2006) was present. Readers are directed to Table 4.3 for the descriptive statistics for this analysis.

Regarding the 2012-2013 school year for Grade 8 students, a statistically significant difference was revealed in Grade 8 STAAR Mathematics test scores by ethnicity/race, $F(3, 296326) = 7828.18$, $p < .001$, partial $\eta^2 = .073$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures were used to determine which ethnic/racial groups differed from each other. As evidenced in Table 4.3, Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap existed as reported by Carpenter et al. (2006). Table 4.3 contains the descriptive statistics for this analysis.

Concerning the 2013-2014 year, a statistically significant difference was revealed in Grade 8 STAAR Mathematics test scores by ethnicity/race, $F(3, 316624) = 10450.96$, $p < .001$, partial $\eta^2 = .09$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Revealed in Table 4.3 are the descriptive statistics for this analysis.

For the 2014-2015 school year, a statistically significant difference was revealed in Grade 8 STAAR Mathematics test scores by ethnicity/race, $F(3, 319287) = 8620.48$, $p < .001$, partial $\eta^2 = .075$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Clearly evident in this analysis was a stair-step achievement gap (Carpenter et al., 2006). Presented in Table 4.3 are the descriptive statistics for this analysis.

Research Question 4

Regarding the 2011-2012 school year for Grade 8 students, a statistically significant difference was revealed in Grade 5 STAAR Science test scores by ethnicity/race, $F(3, 348559) = 12365.29$, $p < .001$, partial $\eta^2 = .096$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Moreover, an achievement gap between Asian and Hispanic students was revealed, and a larger achievement gap existed between Asian and Black students. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Readers are directed to Table 4.4 for the descriptive statistics.

Insert Table 4.4 about here

Concerning the 2012-2013 school year, a statistically significant difference was revealed in Grade 8 STAAR Science test scores by ethnicity/race, $F(3, 354734) = 12100.82$, $p < .001$, partial $\eta^2 = .09$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Table 4.4 contains the descriptive statistics for this analysis.

For the 2013-2014 school year, a statistically significant difference was revealed in Grade 8 STAAR Science test scores by ethnicity/race, $F(3, 366945) = 12027.31$, $p < .001$, partial $\eta^2 = .09$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Revealed in Table 4.4 are the descriptive statistics for this analysis.

Regarding the 2014-2015 school year for Grade 8 students, a statistically significant difference was revealed in Grade 8 STAAR Science test scores by ethnicity/race, $F(3, 382826) = 9831.84$, $p < .001$, partial $\eta^2 = .072$, a medium effect size (Cohen, 1988). Scheffe` post hoc procedures revealed that Asian students had the highest average STAAR Mathematics scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident. Presented in Table 4.4 are the descriptive statistics for this analysis.

Research Question 5

For the 2011-2012 through the 2014-2015 school years, differences in the STAAR Mathematics scores of Grade 8 students for boys and girls were analyzed. Of the four years investigated, results from all four school years were statistically significant. Figure 4.1 is a representation of the average test scores for boys and girls in the 2011-2012 through the 2014-2015 school years. Both boys and girls had lower average test scores from the 2011-2012 to the 2012-2013 school years; however, the average test scores of both groups increased each year following through the 2014-2015 school year. Boys outscored girls by under one point from the 2011-2012 school year through the 2013-2014 school year; however, Grade 8 girls outscored Grade 8 boys during the 2014-2015 school year by 1.25 average points.

Insert Figure 4.1 about here

Research Question 6

Concerning the 2011-2012 through the 2014-2015 school years, the STAAR Science scores of Grade 8 students for boys and girls were analyzed. Of the four years investigated, results from all four school years were statistically significant. Figure 4.2 is a representation of the average test scores for boys and girls in the 2011-2012 through the 2014-2015 school years. Both Grade 8 boys and girls had increased average test scores from the 2011-2012 through the 2014-2015 school years; except for a slight decrease in average points for boys during the 2014-2015 school year. Grade 8 boys outscored Grade 8 girls in all four years of the study. The greatest average point difference of 1.34 points occurred during the 2011-2012 school year, and that average difference decreased each year of the study to a 0.20 average difference in the 2014-2015 school year.

Insert Figure 4.2 about here

Research Question 7

For the 2011-2012 through the 2014-2015 school years, the STAAR Mathematics scores of Grade 8 Asian, Black, Hispanic, and White students were analyzed. Of the 4 years investigated, results from all four school years were statistically significant. Figure 4.3 is a representation of average test scores by ethnicity/race for the 2011-2012 through the 2014-2015 school years. The average test scores of Asian, Black, Hispanic and White students decreased slightly from the 2011-2012 school year to the 2012-2013 school year, but then increased in the 2013-2014 school year. The highest average scores for Asian, Hispanic, and White students occurred during the 2013-2014 school year.

Black students scored their highest average score on the 2014-2015 exam. Every year of the study Asian students had the highest average score, followed by White, Hispanic, and Black students, respectively.

Insert Figure 4.3 about here

Research Question 8

Regarding the 2011-2012 through the 2014-2015 school years, the STAAR Science scores of Grade 8 Asian, Black, Hispanic, and White students were analyzed. Of the 4 years investigated, results from all four school years were statistically significant. Figure 4.4 is a representation of average test scores by ethnicity/race for the 2011-2012 through the 2014-2015 school years. The average scores of each student group increased slightly between the 2011-2012 school year and 2013-2014 school year. During the 2014-2015 school year Asian, Black, and White students recorded a slight decrease in average scores, and Hispanic students produced a slight increase in average score. The largest average score difference each year of study was between Asian and Black students, which included a minimum average difference of 10.09 and a maximum average difference of 10.97 during the years of study. Each year of the study, Asian students outscored White, Hispanic, and Black students respectively.

Insert Figure 4.4 about here

Discussion

In this investigation, Texas statewide data on the state-mandated mathematics and science assessments were obtained for Grade 8 boys and girls for four school years (i.e., the 2011-2012 school year through the 2014-2015 school year). These data were analyzed to determine the degree to which differences might be present in the STAAR Mathematics and Science test scores for Grade 8 students by their gender and ethnicity/race (i.e., Asian, Black, Hispanic, and White). By examining four school years of statewide data, the extent to which any trends might be present in Grade 8 boys' and girls' mathematics and science performance were ascertained.

Regarding the Grade 8 STAAR Mathematics exam, the average score of boys was higher than girls by under 1 point (i.e., ranging from 0.33 to 0.39) in the first three school years (i.e., the 2011-2012 through 2013-2014 school years); however, the average score of girls was higher by 1.25 points in the 2014-2015 school year. Regarding the Grade 8 STAAR Science exam, the average score of boys was higher than the average score of girls each year of the study, however, the gap closed each year, with the 2011-2012 school year showing a 1.33 points difference to the 2014-2015 school year, in which there was a 0.20 point difference. The effect sizes for both the STAAR Mathematics and STAAR Science tests for boys and girls were trivial.

Statistically significant differences were present in Grade 8 STAAR Mathematics exams and STAAR Science exams with regard to ethnicity/race. Moderate effect sizes were present for these differences. A stair-step achievement gap (Carpenter et al., 2006) was clearly evident for each year of the study regarding ethnicity/race. Asian students consistently outscored White, Hispanic, and Black students.

Connections with Existing Literature

As a result of this study, the existing achievement gap research (Bolkan, 2015; Nikischer, 2013; PCAST, 2010) regarding Black and Hispanic students is reinforced. Indeed, an achievement gap was present between White, Hispanic, and Black students every year of the study (i.e., the 2011-2012 through the 2014-2015 school years). On the STAAR Mathematics exam, White students had an average point difference ranging from 6.41 to 8.35average point difference from Black students. White students had an average score difference ranging from 4.53 to 6.23 average points higher than Hispanic students.

Implications for Policy and Practice

In this multiyear analysis of Grade 8 STAAR Mathematics and Science test scores based on ethnicity/race, noticeable achievement gaps were present. Although the gap between the average scores of boys and girls was trivial, women continue to be underrepresented in STEM education. Policymakers could consider implementing a strong STEM curriculum in which underrepresented groups (e.g., girls, and Black and Hispanic students) are encouraged to form personal connections to STEM. Policymakers could also reconsider assessment practices that measure science and math learning with standardized tests, and instead consider more authentic assessments to measure critical thinking skills, problem-solving skills, and other skills not measured by current state and national assessments.

Recommendations for Educational Leaders

Although the Grade 8 Mathematics and Science statistical analyses yielded trivial effect sizes, women continue to remain underrepresented in STEM education (Neuhauser, 2015). Maltese and Tai (2010) reported that students in Grade 8 who considered science to be relevant to their future were more likely to pursue a STEM degree. District and school leaders are encouraged to work with mathematics and science teachers to give multiple opportunities for middle school girls and underrepresented minority students (e.g., Black and Hispanic) to make a personal connection to STEM subjects during the impressionable middle school years. Mathematics and science teachers should participate in meaningful professional development in which problem solving and project-based learning are emphasized. In addition to overseeing quality STEM programs, school leaders and teachers should consider alternative assessments that allow students to exercise their creativity, collaboration, and problem solving skills.

Recommendations for Future Research

In this study, differences in Grade 8 STAAR Mathematics and Science scores were analyzed by gender and ethnicity/race. Results were consistent when examining scores by ethnicity/race. Asian students consistently had higher average scores followed by White, Hispanic, and Black students, respectively. In this investigation, data on only Grade 8 students in Texas public schools were analyzed. Future researchers might expand the study to other grades or other subjects. Future researchers might include longitudinal studies that follow scores of students as they progress through the educational system to examine any trends. Additionally, researchers are encouraged to examine differences in gender and ethnicity/race in other states as well.

Conclusion

In this multiyear research investigation, the STAAR Mathematics and STAAR Science scores of Grade 8 students were analyzed to ascertain whether differences were present by gender and ethnicity/race (i.e., Asian, Black, Hispanic, and White). Texas statewide data were obtained and analyzed for four school years of. Statistically significant differences were present in all analyses for all four school years Grade 8 boys and girls differed in their average TAKS Mathematics and Science test performance, albeit with trivial effect sizes. Of note in this study were the statistically significant differences, with moderate effect sizes, in the STAAR Mathematics and Science scores among Asian, White, Hispanic, and Black students. The average scores of Asian students were consistently highest followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident for each school year in this study. As such, results from this multiyear, statewide investigation are congruent with the extant literature of achievement gaps between boys and girls and among ethnic/racial groups.

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Table 4.1

Descriptive Statistics on the Grade 8 STAAR Mathematics Scores by Gender for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Gender	*n*	*M*	*SD*
2011-2012			
Girls	185,954	25.69	14.62
Boys	194,443	26.04	14.59
2012-2013			
Girls	193,892	22.64	15.77
Boys	200,782	23.04	15.48
2013-2014			
Girls	195,883	25.10	16.02
Boys	203,755	25.43	15.74
2014-2015			
Girls	157,855	31.12	10.35
Boys	168,807	29.87	10.78

Table 4.2

Descriptive Statistics on the Grade 8 STAAR Science Scores by Gender for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Gender	*n*	*M*	*SD*
2011-2012			
Girls	173,660	32.27	9.91
Boys	182,788	33.61	10.37
2012-2013			
Girls	178,009	33.09	9.99
Boys	185,123	34.25	10.54
2013-2014			
Girls	183,747	34.27	10.77
Boys	191,828	35.08	11.20
2014-2015			
Girls	191,123	34.44	10.85
Boys	200,756	34.64	11.42

Table 4.3

Descriptive Statistics on the Grade 8 STAAR Mathematics Scores by Ethnicity/Race for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Ethnicity/Race	*n*	*M*	*SD*
2011-2012			
Asian	9,917	39.45	11.68
White	103,509	34.05	10.98
Hispanic	164,850	27.83	10.46
Black	43,340	25.69	9.79
2012-2013			
Asian	7,927	38.42	11.72
White	89,985	33.07	10.56
Hispanic	156,751	28.25	10.09
Black	41,667	26.27	9.54
2013-2014			
Asian	9,248	41.25	11.49
White	94,665	35.04	10.93
Hispanic	169,430	29.48	10.74
Black	43,285	26.95	10.10
2014-2015			
Asian	9,726	40.45	10.83
White	91,539	33.57	10.43
Hispanic	174,612	29.04	10.10
Black	43,414	27.16	9.82

Table 4.4

Descriptive Statistics on the Grade 8 STAAR Science Scores by Ethnicity/Race for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 School Years

School Year and Ethnicity/Race	*n*	*M*	*SD*
2011-2012			
Asian	12,329	39.70	10.36
White	113,483	36.71	9.63
Hispanic	176,244	30.85	9.70
Black	46,507	29.61	9.40
2012-2013			
Asian	12,786	40.40	10.77
White	114,310	37.43	9.73
Hispanic	180,971	31.62	9.83
Black	46,671	30.30	9.57
2013-2014			
Asian	14,063	42.17	10.82
White	115,248	38.59	10.31
Hispanic	189,862	32.57	10.64
Black	47,776	31.20	10.20
2014-2015			
Asian	15,358	41.87	11.62
White	115,945	37.97	10.69
Hispanic	202,225	32.78	10.73
Black	49,302	31.11	10.53

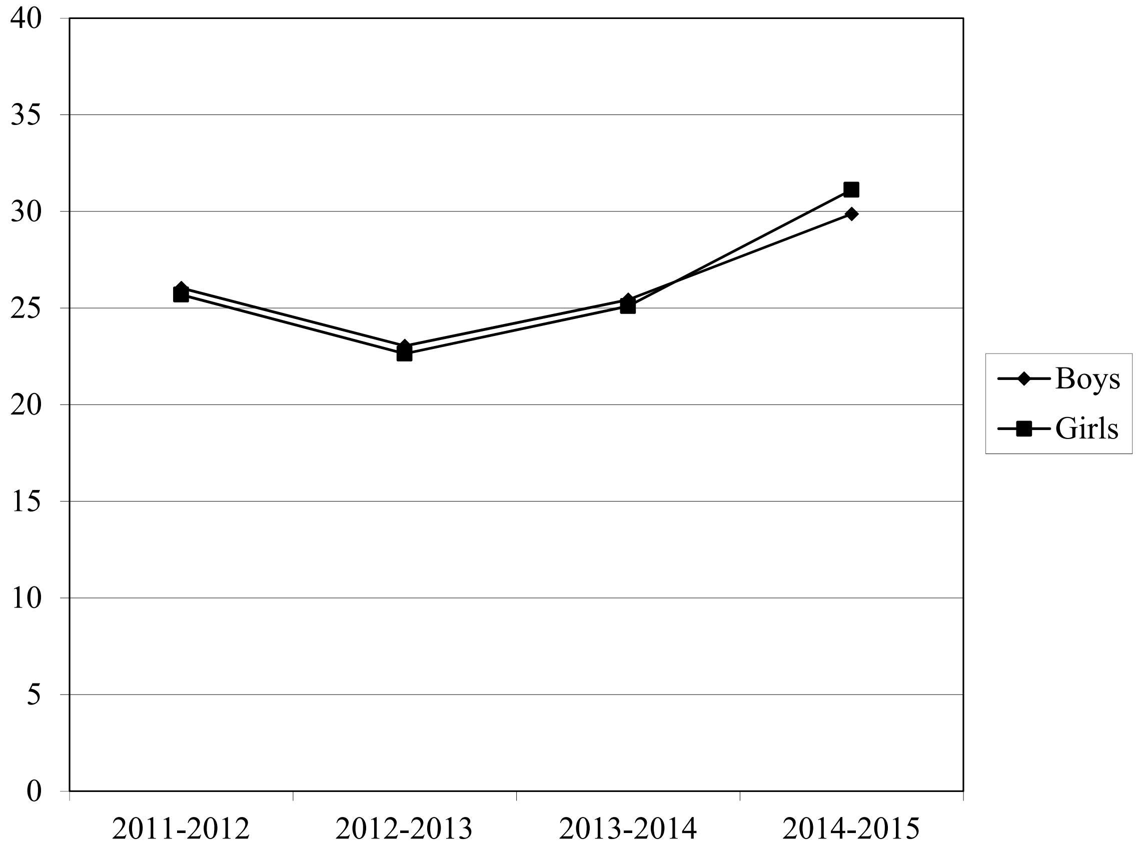

Figure 4.1. Average raw scores by gender for the Grade 8 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

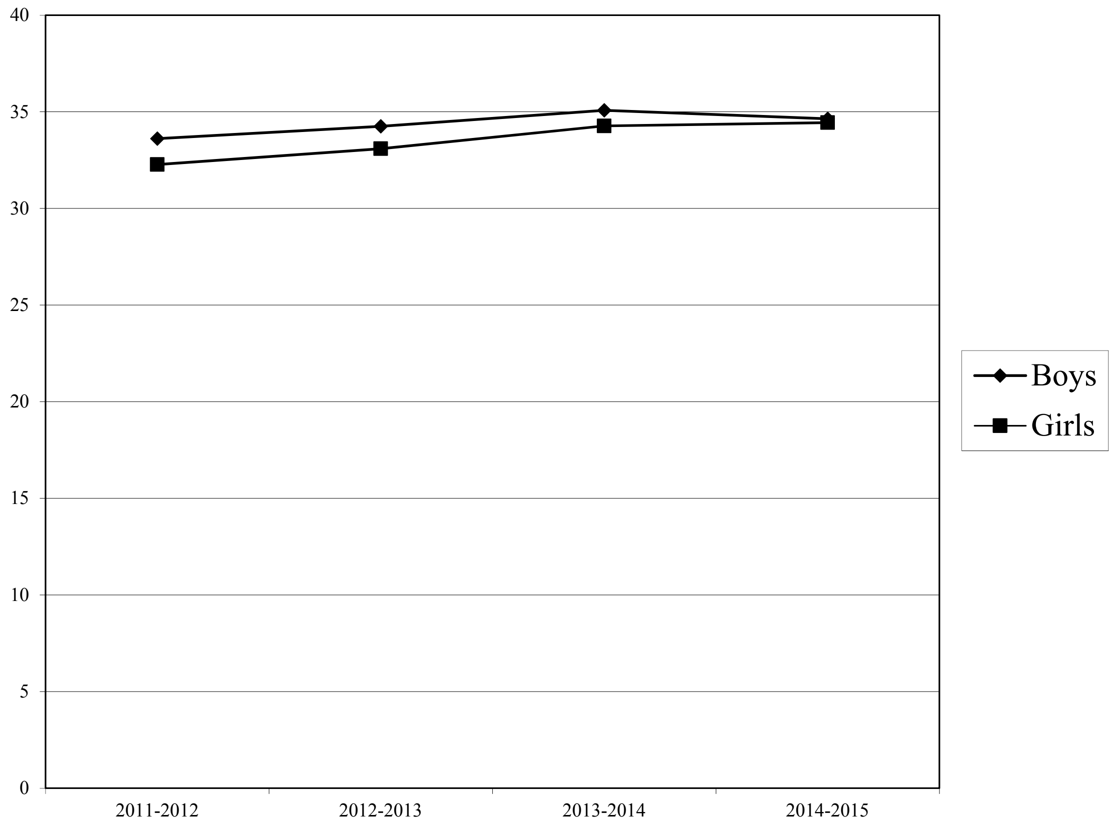

Figure 4.2. Average raw scores by gender for the Grade 8 State of Texas Assessment of Academic Readiness Science test for the 2011-2012 through the 2014-2015 school years.

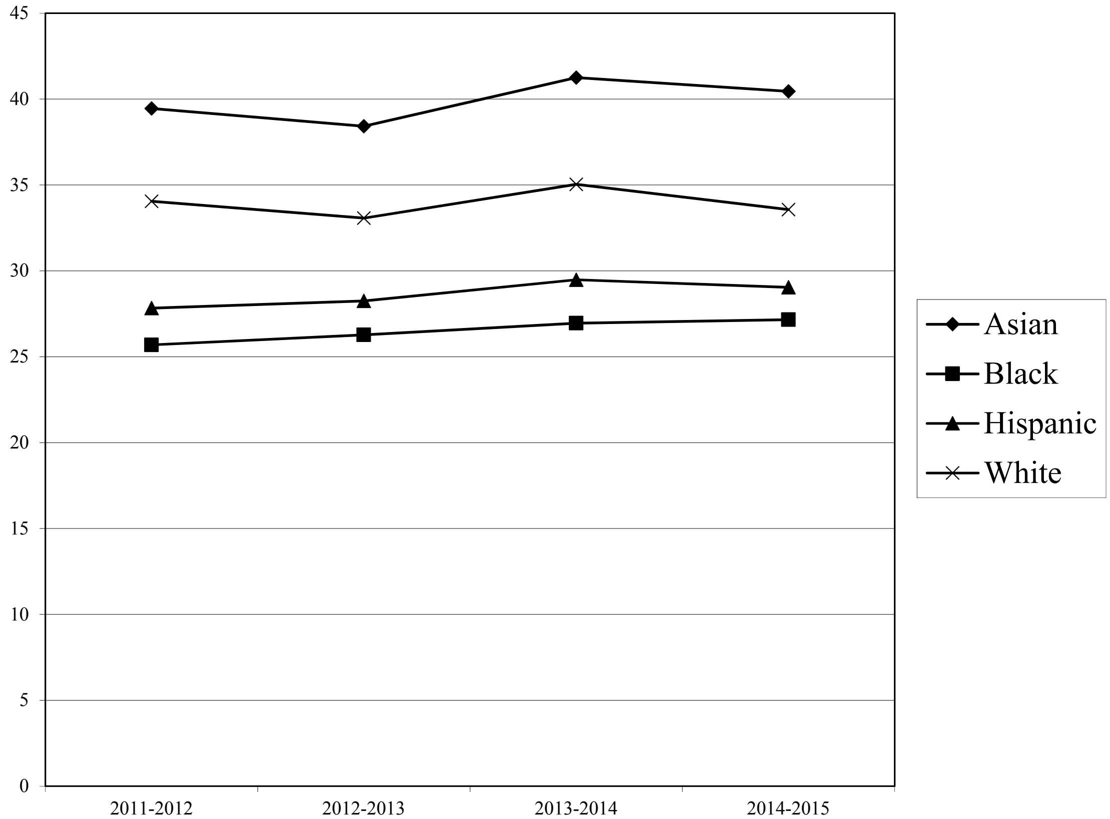

Figure 4.3. Average raw scores by ethnicity/race for the Grade 8 State of Texas Assessment of Academic Readiness Mathematics test for the 2011-2012 through the 2014-2015 school years.

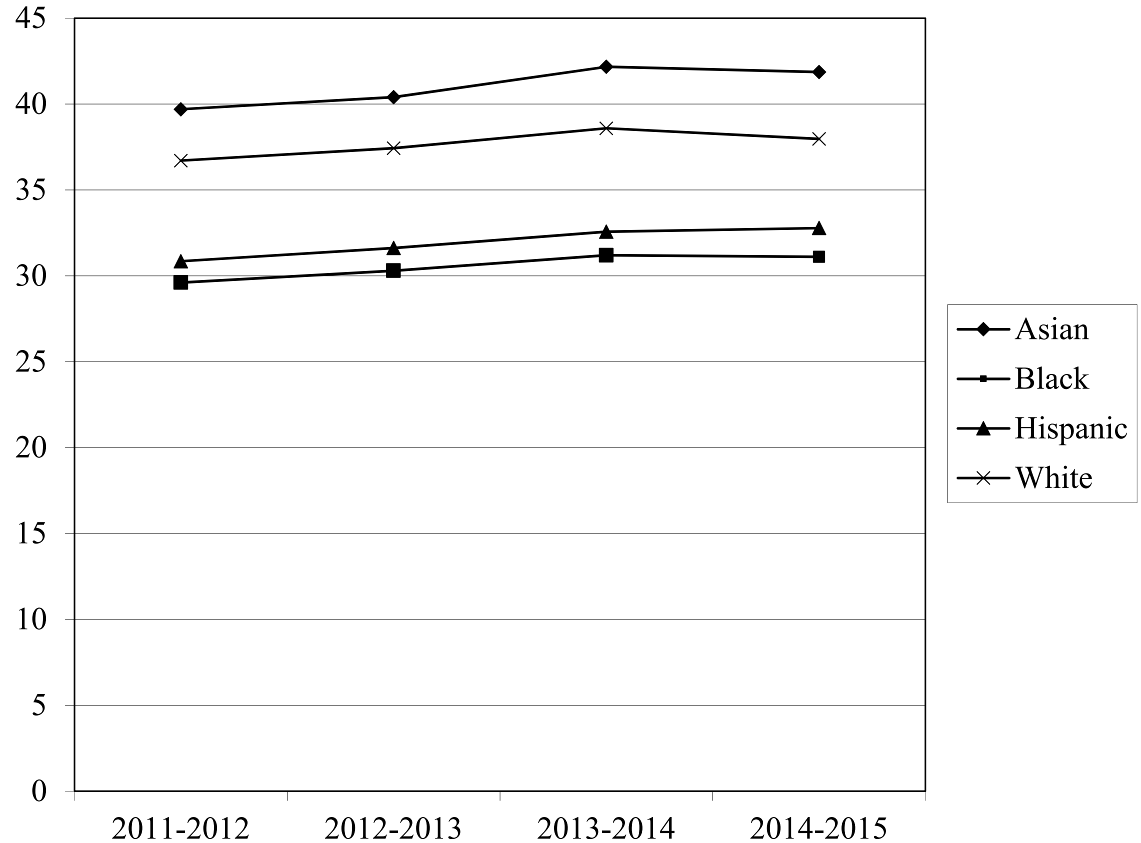

Figure 4.4. Average raw scores by ethnicity/race for the Grade 8 State of Texas Assessment of Academic Readiness Science for the 2011-2012 through the 2014-2015 school years.

CHAPTER V

IMPLICATIONS AND RECOMMENDATIONS

The purpose of the first study was to ascertain the extent to which differences were present in the STAAR Mathematics and Science test scores by Grade 5 and Grade 8 student economic status. The purpose of the second study was to examine differences in Grade 5 STAAR Mathematics and Science test performance by gender and by ethnicity/race (i.e., Asian, Black, Hispanic, and White). Finally, with respect to the third study in this journal-ready dissertation, the purpose was to investigate the STAAR Mathematics and Science test scores of Grade 8 student by gender and by ethnicity/race (i.e., Asian, Black, Hispanic, and White).

Regarding the first study in this journal-ready dissertation the STAAR Mathematics Scores for Grade 5 students, students who were economically disadvantaged had average scores that were between 5.88 and 6.69 points lower than students who were not economically disadvantaged during all four years of the study (i.e., the 2011-2012 school year through the 2014-2015 school year). For each year the differences between the Grade 5 Mathematics test scores by student economic status represented moderate effect sizes. In each year, students who were not economically disadvantaged had higher average test scores than did the group of students in poverty. For the STAAR 8 Mathematics exam, a moderate effect size was present for each school year, and Grade 8 students who were not economically disadvantaged had higher average test scores than did Grade 8 students who were economically disadvantaged on the STAAR Mathematics exam. A summary of effect sizes for the Grade 5 and Grade 8 Mathematics score differences is revealed in Table 5.1

Table 5.1

Summary of Effect Sizes for Grade 5 and Grade 8 STAAR Mathematics Score Differences by Student Poverty for the 2011-2012 through the 2014-2015 School Years

School Year and Grade Level STAAR Exam	Statistically Significant	Effect Size	Higher Performing Group
2011-2012			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2012-2013			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2013-2014			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2014-2015			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged

For each year of the study, the differences between the Grade 5 and Grade 8 Science test scores by student economic status represented moderate effect sizes. Students in Grade 5 who were economically disadvantaged had lower average scores than students who were not economically disadvantaged on the STAAR Science Scores during all four years of the study. The average scores of Grade 8 students for the STAAR Science Scores were lower for students in poverty than for students who were not economically disadvantaged in all four years of the study. Readers are directed to Table 5.2 for a summary of effect sizes for the STAAR Grade 5 and Grade 8 Science score differences.

Table 5.2

Summary of Effect Sizes for Grade 5 and Grade 8 STAAR Science Score Differences by Student Poverty for the 2011-2012 through the 2014-2015 School Years

School Year and Grade Level STAAR Exam	Statistically Significant	Effect Size	Higher Performing Group
2011-2012			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2012-2013			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2013-2014			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged
2014-2015			
Grade 5	Yes	Moderate	Not Disadvantaged
Grade 8	Yes	Moderate	Not Disadvantaged

With regard to the second study, the STAAR Mathematics and Science test scores of Grade 5 students were obtained and analyzed. The degree to which differences were present in the STAAR Mathematics and Science test scores for Grade 5 students by their gender and by their ethnicity/race (i.e., Asian, Black, Hispanic, and White) were determined. Through analyzing four school years of Texas statewide data, any trends that might be present by student gender or by student ethnicity/race were identified.

Regarding Grade 5 STAAR Mathematics and Science exams by gender, statistically significant differences were present, albeit with trivial effect sizes. The average scores of girls on the Grade 5 Mathematics Scores were consistently higher than the average scores of boys in all four years of the study (i.e., 2001-2012 through 2014-2015 school years). In contrast to the mathematics results, the average test scores of

Grade 5 boys on the STAAR Science Scores were consistently higher than for girls in all four years of the study. Presented in Table 5.3 is a summary of the effect sizes for STAAR Mathematics and Science score differences by gender.

Table 5.3

Summary of Effect Sizes for Grade 5 STAAR Mathematics and Science Score Differences by Student Gender for the 2011-2012 through the 2014-2015 School Years

School Year and Subject STAAR Exam	Statistically Significant	Effect Size	Higher Performing Group
2011-2012			
Mathematics	Yes	Trivial	Girls
Science	Yes	Trivial	Boys
2012-2013			
Mathematics	Yes	Trivial	Girls
Science	Yes	Trivial	Boys
2013-2014			
Mathematics	Yes	Trivial	Girls
Science	Yes	Trivial	Boys
2014-2015			
Mathematics	Yes	Trivial	Girls
Science	Yes	Trivial	Boys

With respect to student ethnicity/race for Grade 5 STAAR Mathematics, statistically significant differences were present with moderate effect sizes for each of the four years of this investigation. The average differences among the four ethnic/racial groups were reflective of the largest achievement gaps that were present. In each school year, Asian students had the highest average test scores, followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter, Ramirez, & Severn, 2006) was clearly evident.

Regarding the Grade 5 STAAR Science exams for the2011-2012 through the 2014-2015 school years, a stair-step achievement gap (Carpenter et al., 2006) was also clearly evident, although the gap was not as wide as for the Grade 5 STAAR Mathematics Scores results. A moderate effect size was present for each of the four years of data analyzed herein. Asian students consistently had the highest average test scores, followed by White, Hispanic, and Black students, respectively. Represented in Table 5.4 are the effect sizes and highest performing ethnic/racial group with regard to the Grade 5 STAAR Mathematics and Science score differences.

Table 5.4

Summary of Effect Sizes for Grade 5 STAAR Mathematics and Science Score Differences by Student Ethnicity/Race for the 2011-2012 through the 2014-2015 School Years

School Year and Subject STAAR Exam	Statistically Significant	Effect Size	Highest Performing Group
2011-2012			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2012-2013			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2013-2014			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2014-2015			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian

Reported in the third study of the journal ready dissertation the Grade 8 STAAR Mathematics exam, boys had a slightly higher average test score than girls in the first three years of data (i.e., the 2011-2012 through 2013-2014 school years). In the 2014-2015 school year, however, girls had a slightly higher average score than boys. With respect to the Grade 8 STAAR Science exam, boys had higher average test scores than girls in each of the four years. However, the gender gap closed each year. These statistically significant results for both the STAAR Mathematics and STAAR Science tests between boys and girls were indicative of trivial effect sizes. Presented in Table 5.5 is a summary of the effect sizes with respect to STAAR Mathematics and Science score differences by gender.

Table 5.5

Summary of Effect Sizes for Grade 8 STAAR Mathematics and Science Score Differences by Student Gender for the 2011-2012 through the 2014-2015 School Years

School Year and Subject STAAR Exam	Statistically Significant	Effect Size	Higher Performing Group
2011-2012			
Mathematics	Yes	Trivial	Boys
Science	Yes	Trivial	Boys
2012-2013			
Mathematics	Yes	Trivial	Boys
Science	Yes	Trivial	Boys
2013-2014			
Mathematics	Yes	Trivial	Boys
Science	Yes	Trivial	Boys
2014-2015			
Mathematics	Yes	Trivial	Girls
Science	Yes	Trivial	Boys

Statistical analyses on the Grade 8 STAAR Mathematics exams and STAAR Science exams by ethnicity/race yielded statistically significant differences with moderate effect sizes for all four school years of data analyzed. A stair-step achievement gap (Carpenter et al., 2006) was clearly evident for each year of the study regarding ethnicity/race. Asian students consistently outscored White, Hispanic, and Black students respectfully. Represented in Table 5.6 are the effect sizes for each year of the study.

Table 5.6

Summary of Effect Sizes for Grade 8 STAAR Mathematics and Science Score Differences by Student Ethnicity/Race for the 2011-2012 through the 2014-2015 School Years

School Year and Subject STAAR Exam	Statistically Significant	Effect Size	Highest Performing Group
2011-2012			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2012-2013			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2013-2014			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian
2014-2015			
Mathematics	Yes	Moderate	Asian
Science	Yes	Moderate	Asian

Connections to Existing Literature

Findings obtained in the first study regarding Grade 5 and Grade 8 STAAR Mathematics and Science scores by economic status (i.e., economically disadvantaged and not economically disadvantaged) were congruent with the existing research on student poverty (Beatty, 2013; Farmbry, 2014; Gotfried & Williams, 2013). The average test scores of students who were economically disadvantaged were always lower than the average test scores of their more affluent counterparts on the Grade 5 Mathematics and Science exams, and for Grade 8 Science Exams.

Results from the second empirical investigation conducted herein were commensurate with the existing achievement gap research (Bolkan, 2015; Nikischer, 2013; PCAST, 2010) regarding Black and Hispanic students. Indeed, achievement gaps were present between Asian, White, Hispanic, and Black students every year of the study (i.e., the 2011-2012 through the 2014-2015 school years). On the STAAR Mathematics exam, Grade 8 White students had an average point difference ranging from 6.41 to 8.35 points from Black students. White students had average score differences ranging from 4.53 to 6.23 points higher than Hispanic students.

Researchers (e.g., Beasley & Fischer, 2012; Gaughan & Bozeman, 2015; PCAST, 2010) have noted the underrepresentation of women in STEM fields of employment. Interestingly, in the third study of this journal-ready dissertation, results were mixed on whether boys had higher test scores than girls. As noted previously, in some cases girls had slightly higher average test scores and in other instances boys had slightly higher average test scores.

Implications for Policy and Practice

In this journal-ready dissertation, the Grade 5 and Grade 8 STAAR Mathematics and Science scores were analyzed to determine whether differences were present by student economic status, gender, and ethnicity/race. Students who were economically disadvantaged outscored students who were not economically disadvantaged by several points on almost every exam. In the empirical investigation regarding ethnicity/race, Black and Hispanic students consistently scored lower on all tests than Asian and White students. Only minimal differences were revealed in the average test scores of boys and girls. As such, it is a concern that women are not more represented in STEM employment fields.

Educational policymakers could ensure that STEM-related programs are available that give these underrepresented groups (i.e., girls, Black, and Hispanic students) multiple opportunities to learn and practice math and science inside and outside of school. Currently, test results from assessments such as the STAAR Mathematics and STAAR Science exams are referenced by researchers as if they are a true reflection of what is learned in the science and mathematics classroom. In reality, the STAAR exams measure merely a small portion of what is taught. Moreover, the multiple choice format is too restrictive to give a more accurate reflection of the critical thinking skills required of students today. Consideration should be given to authentic assessments that measure skills that standardized tests cannot measure such as creativity, problem-solving, collaboration, and other skills not measured by current state and national assessments.

Recommendations for Educational Leaders

Policymakers are encouraged to write and fund a state level STEM curriculum that includes project-based, hands-on learning which simulates real world experiences. School and district leaders are encouraged to advocate for multidisciplinary lessons that include many opportunities for students to engage in real-life problem solving skills for all students. Similarly, educational leaders should consider assessments that measure critical thinking skills, rather than rote memorization. Additionally, school leaders should encourage students who are economically disadvantaged to participate in challenging STEM programs both during school, and outside of normal school hours.

Although gender differences on the Grade 5 and Grade 8 Mathematics and Science scores were minimally present, women continue to remain underrepresented in STEM education (Neuhauser, 2015). Maltese and Tai (2010) reported that students in Grade 8 who considered science to be relevant to their future were more likely to pursue a STEM degree. School district and educational leaders are encouraged to work with mathematics and science teachers to give multiple opportunities for middle school girls and underrepresented minority students (i.e., Black and Hispanic) to make a personal connection to STEM subjects during the impressionable middle school years. Mathematics and science teachers could participate in meaningful professional development in which problem solving and project-based learning are emphasized. In addition to overseeing quality STEM programs, school administrators and teachers should consider alternative assessments that allow students to exercise their creativity, collaboration, and problem solving skills.

Recommendations for Future Research

In this journal-ready dissertation, the STAAR Mathematics and STAAR Science test scores were examined for Grade 5 students and Grade 8 students by their economic status, gender, and ethnicity/race for the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 school years. Regarding economic status, results were consistent throughout each year of study. Students who were not economically disadvantaged had higher average mathematics and science test scores than did students who were economically disadvantaged. Researchers are encouraged to continue monitoring student test scores based on student economic status. Researchers are specifically encouraged to examine the issue of poverty in more depth than currently occurs. That is, students may quality for the reduced lunch program but not quality for the free lunch program. This determination is made, at least in Texas, based upon family income. As such, degrees of poverty exist. Researchers are encouraged to analyze achievement gaps for students who are not poor, students who are moderately poor, and for students who are extremely poor. Researchers are also urged to analyze student mathematics and science performance by gender within ethnic/racial groups. That is, in the second study of this journal-ready dissertation, gender was analyzed by itself and ethnicity/race was also analyzed by itself. Accordingly, the degree to which Black boys differed from Black girls, Hispanic boys differed from Hispanic girls, and so on in their mathematics and science skills was not determined. Future research in this area is clearly warranted. In the second and third study, differences in Grade 5 and Grade 8 STAAR Mathematics and Science scores were analyzed by gender and ethnicity/race. Additionally, future research might include longitudinal studies that follow scores of students as they progress through the educational system to examine any trends.

Conclusion

The purpose of this journal-ready dissertation was to examine the extent to which differences existed in STAAR Mathematics and Science scores for Grade 5 and Grade 8 students by their economic status, gender, and ethnicity/race. Data were analyzed for four years of data (i.e., the 2011-2012, 2012-2013, 2013-2014, and 2014-2015 school years). Statistically significant differences were present for all research questions for all four years of data. During each of the four school years, students who were economically disadvantaged consistently had lower average test scores than students who were not economically disadvantaged. With regard to gender, the statistically significant differences in test scores represented trivial effect sizes. Statistically analyses of the STAAR Mathematics and Science scores by ethnicity/race revealed the presence of achievement gaps. The average mathematics and science test scores of Asian students were consistently the highest followed by White, Hispanic, and Black students, respectively. Thus, a stair-step achievement gap (Carpenter et al., 2006) was clearly evident for each year of the study regarding ethnicity/race.

These studies are important to STEM learning because it has been 50 years since President Lyndon Johnson declared a War on Poverty, and the achievement gap remains between students who are economically disadvantaged and students who are not economically disadvantaged. The passage of the No Child Left Behind Act of 2001 was responsible for an increased awareness among educators of racial imbalances in school systems; however, the achievement gaps among certain minority groups persist. These educational disparities, as well as the underrepresented presence in STEM jobs of people who are poor, women, or minorities (i.e., Black and Hispanic) should warrant attention to curriculum, instruction, and assessment designed to promote higher achievement and interest in STEM areas for all students.

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APPENDIX

Institutional Review Board
Office of Research and Sponsored Programs
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Sam Houston
STATE UNIVERSITY
A Member of The Texas State University System

DATE:	July 20, 2016
TO:	Pamela Anderson [Faculty Sponsor: Dr. George Moore]
FROM:	Sam Houston State University (SHSU) IRB
PROJECT TITLE:	*Differences in Mathematics and Science Performance by Gender, Ethnicity/Race, and Economic Status: A Multiyear Texas Statewide Study [T/D]*
PROTOCOL #:	2016-06-30206
SUBMISSION TYPE:	INITIAL REVIEW
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	July 20, 2016
REVIEW CATEGORY:	Category 4—research involving existing, publicly available data usually has little, if any, associated risk, particularly if subject identifiers are removed from the data or specimens.

Thank you for your submission of Initial Review materials for this project. The Sam Houston State University (SHSU) IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

*** What should investigators do when considering changes to an exempt study that could make it nonexempt?**

It is the PI's responsibility to consult with the IRB whenever questions arise about whether planned changes to an exempt study might make that study nonexempt human subjects research. In this case, please make available sufficient information to the IRB so it can make a correct determination.

If you have any questions, please contact the IRB Office at 936-294-4875 or irb@shsu.edu. Please include your project title and protocol number in all correspondence with this committee.

Sincerely,

Donna Desforges
IRB Chair, PHSC
PHSC-IRB

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Sam Houston State University IRB's records

VITA

Pamela Bennett Anderson

EDUCATIONAL HISTORY

Doctorate of Education–Educational Leadership, December 2016
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Master of Education in Administration, EC-12, May 2011
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PROFESSIONAL EXPERIENCE

Technology Specialist, Roberts Elementary (Houston ISD)

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Academic Trainer, IT, Professional Development Services (Houston ISD)

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Campus Educational Technologist, Tinsley Elementary (Houston ISD)

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Reading Specialist, Argyle Elementary and Valley West Elementary (Houston ISD),

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Second Grade Teacher, Argyle Elementary, *1998–1999*

RECOGNITIONS

Book Creator Ambassador, 2015
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SCHOLARLY RESEARCH ACTIVITY

PUBLICATIONS

Wehde-Roddiger, C., Trevino, R., Anderson, P., Arrambide, T., O'Conor, J., & Onwuegbuzie, A. (2012). The influence of advanced placement enrollment on high school GPA and class rank: Implications for school administrators. *International Journal of Educational Leadership Preparation, 7*(3).

PRESENTATIONS

Anderson, P. B. (2014, June). *Making eBooks weird.* Paper presentation at the iPadPalooza Conference, Austin, TX.

Anderson, P. B. (2014, June). *Creating eBooks with.* Paper presentation at the iPadPalooza Conference, Austin, TX.

Wehde-Roddiger, C., Trevino, R., Anderson, P., Arrambide, T., O'Conor, J., & Onwuegbuzie, A. (2011, February). *Advanced Placement and its influence on GPA and class rank.* Paper presented at Southwest Educational Research Association Annual Conference, New Orleans, LA.

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