A STUDY OF FEMALE ACADEMIC PERFORMANCE IN MATHEMATICS AND SCIENCE COURSES IN PUBLIC, SINGLE-GENDER SCHOOLS

by

ROBERT CHARLES KNOX

(Under the Direction of Robert Maribe Branch)

ABSTRACT

This was a non-experimental, quantitative study that used causal-comparative research design to investigate academic performance among female students attending public, single-gender schools and public, co-educational schools. Specifically, this study focused on the performance of seventh-grade students in the disciplines of mathematics and science in Georgia. The study used ex post facto data to compare the state administered standardized test scores of students in public, single-gender schools in Georgia to the test scores of students in public, co-educational schools in Georgia with similar socioeconomic status (SES). The purpose of this study was to explore whether attending a single-gender school improved female students' academic performance. This study compared the academic performance of female students in the fields of mathematics and science in the seventh-grade who attended a public, co-educational school to those who attended a public, single-gender school using Criterion-Referenced Competency Tests (CRCT) scores. The need for this study arose after the relaxation of Title IX regulations in the United States which resulted in the creation of public, single-gender schools throughout the United States. The results of this study do not provide

empirical support for the creation of public, single-gender schools in the United States in order to improve female academic performance in the disciplines of mathematics and science.

INDEX WORDS: single-gender, co-educational, Title IX

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by

ROBERT CHARLES KNOX

A.B., University of Pittsburgh, 1997

M.ED., University of Georgia, 2005

ED.S., University of Nebraska, 2008

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF EDUCATION

ATHENS, GEORGIA

2016

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by

ROBERT CHARLES KNOX

Major Professor:	Robert Maribe Branch
Committee:	Bettye Smith
	ChanMin Kim
	Michael Orey

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
December 2016

DEDICATION

This paper is dedicated to, Kelly, who has been by my side and supported me through every step of this long and demanding journey. We have faced many obstacles, and together we never gave up. It is also dedicated to my son, Preston, who is my motivation in life. Finally, I dedicate this to my late friend and mentor Matthew Roper, who always believed in me and encouraged me to reach for my dreams.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people without who this dissertation would not have been possible:

My teachers at Abington Friends Quaker High School without their belief in me and their guidance I never would have entered the education profession;

The Fenleys for making me a part of their family and for providing me with the opportunity for an education and the opportunity to succeed in life;

Dr. Blasé and Dr. Blasé who first inspired me at the University of Georgia, and who both encouraged me to pursue my dreams;

Dr. Kenneth Tanner who did everything he could to get me to the final stage of this journey before he retired from UGA;

Dr. Robert Branch who took me in as my advisor when there was no one else and who helped me through my home stretch;

To the remaining members of my committee, Dr. Bettye Smith, Dr. ChanMin Kim and Dr. Michael Orey, for giving me guidance, for believing in me and in my study and for giving of your time.

Thank you to all of you.

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CHAPTER 1:

INTRODUCTION

The debate over the appropriateness of public, single-gender education has been ongoing in the United States since the early 1960's. During the 1960's and 1970's, civil rights activists fought on behalf of African-Americans and females to end the dominance of Caucasian males in the American public, education system (Meyer, 2008). The United States Department of Education passed Title IX of the Education Amendments Act in 1972 in response to protests over gender inequality in education. Title IX prohibited sex discrimination in public schools by requiring that males and females attend, participate in and receive the same education opportunities in public institutions (Spellings, 2006). Passage of Title IX in 1972 essentially created the desegregation of public schools based on gender. The end of public, single-gender schools in the United States during the 1970's only led to the beginning of the debate about the effectiveness of co-educational schools.

Specifically, the debate over single-gender education has focused on the necessity of single-gender schools for adolescent females. The majority of both teachers and students in Georgia are female. Fifty-two percent of high school graduates in Georgia public schools are females, and over eighty percent of public, secondary school teachers in Georgia are female (Georgia Department Education, 2014). Despite the high number of females involved in the secondary education process, many educators believe that female students in the United States are not given an education equal to their male

counterparts in public, secondary schools (Sax, 2006). Studies conducted after the passage of Title IX, which have shown that even though males and females begin schooling with the same innate abilities, a gender gap in favor of males is present by the time males and females graduate high school, tend to encourage and support beliefs of inequality (Kane & Mertz, 2012). Title IX, hence, did not end the inequalities found in the American education system, because after its passage female students were still being shortchanged in public, co-educational secondary schools (American Association of University Women (AAUW), 1992). As late as the 1990's, when both all-female and all-male schools had been eliminated as a result of the implementation of Title IX, reports still showed that females were disadvantaged in the co-educational setting (Meyer, 2008). Thus, the passage of Title IX did not rectify all educational inequalities.

Females especially appear to be educationally disadvantaged in the areas of mathematics and science (AAUW, 1992 and Meyer, 2008). National data on secondary education, such as Advanced Placement Exam scores and National Assessment of Educational Progress (NEAP) tests, shows that despite the closing of the gender gap in other educational fields, males still outperform females in the fields of mathematics and science (Robelen, 2012). Further, among nations worldwide tested by the Program of International Student Assessments (PISA) the gap between the test scores of males and females in the fields of mathematics and science is the largest in the United States (Robelen, 2012). Continuous gaps in the test scores between males and females in secondary schools, especially in the fields of mathematics and science, have created a culture of educators asking for the implementation of single-gender schools (Meyer, 2008). Scholars believe that the use of single-gender schools will lessen the gender-gap in

education, because teachers can focus on the needs of the individual gender (Sax, 2005a). Sufficient evidence has been unavailable, however, to support the theory that single-gender schools would improve or prevent the discrepancies between male and female secondary students in the fields of mathematics and science due to the lack of existence of public, single-gender schools in the United States.

The purpose of this study was to compare the academic performance of seventh-grade female students in a public, single-gender school in Georgia to the test scores of seventh-grade female students in a public, co-educational school with similar socioeconomic status (SES) using state administered standardized test scores in an effort to determine if there is a difference in academic achievement between the two groups of students based on school setting. Data collected from one single-gender school and one co-educational school were used in this study, because in the State of Georgia there are only two public, single-gender middle schools. Analyzing schools outside the State of Georgia is beyond the scope of this study.

A public, co-educational school is defined as one where both males and females are educated together in the same classes, at the same time and by the same teacher. A single-gender school is defined in this study as a school where only males or only females are educated in the school; therefore, a single-gender school is either an all-female school or an all-male school. This study focused on all-female schools as the single-gender school. Schools that educate both male and female students, but that offer single-gender classes were not considered for this study. All schools that were studied are public schools, meaning they are tuition free and have no admission requirements.

The need for this study arose after the relaxation of Title IX regulations in the United States which resulted in the emergence of public, single-gender schools throughout the country. The George W. Bush administration, in response to the elements of the No Child Left Behind (NCLB) Act, allowed the relaxation of Title IX laws paving the way for public, single-gender schools to re-open across the nation and renewing the debate over single-gender education in 2006 (Nahmias, 2008). Pursuant to the 2006 amendments to Title IX, public schools in the United States can now offer single-gender opportunities as long as the school provides a rationale for the program, provides a co-education alternative option for students and conducts a review of the program every two years (Meyer, 2008). As a result of Title IX's enabling legislation, more and more single-gender schools are emerging in the United States.

The number of single-gender schools in the United States has increased exponentially during the past decade. Three public, single-gender schools existed in 1995, but that number soared to eighty-six in 2007, and continues to increase with many more public schools offering single-gender courses today (Meyer, 2008). However, in order for a public school system to conclude that single-gender schools are an educational benefit to students, more studies documenting the benefit of public, single-gender schools are needed (Bradley, 2008). The intention of this study is to provide additional answers to the continuing debate of which provides a better educational setting for female students: single-gender or co-educational schools.

Before the relaxation of Title IX regulations, it would have been impossible to conduct a study such as this on public, single-gender schools in the United States since such schools essentially did not exist. Prior to 2006 single-gender schools consisted of

either private schools, Catholic or parochial schools, or schools outside of the United States (Meyer, 2008). Therefore, if a study such as this were to have been conducted prior to 2006, then it would have had to account for more factors since, differences other than the issue of gender existed between the students enrolled in a public, co-educational school and a private, single-gender school. Modern studies on this topic such as those conducted by Bradley (2009) and Bang and Baker (2013) have provided inconclusive results. During the 2007-2008 school year, Bradley (2009) conducted a study focusing on the academic achievement of first and second grade students in single-gender classes compared to those students in co-educational classes in Georgia. Bradley found mixed results in this study having documented improvements for female students who were in single-gender reading classes, but finding no significant improvements for male students in either math or reading (Bradley, 2009). Bradley concluded that the research was inconclusive and urged further studies (2009). Bang and Baker (2013) conducted a study in South Korea, examining the academic achievements and attitudes toward science of students in three different schools including an all-male school, an all-female school and a co-educational school. Bang and Baker (2013) concluded that while the students in the co-educational school performed better, they had higher stereotypical perceptions about science and gender that could not be overcome. Therefore, more studies focusing on public, single-gender schools in the United States are needed.

The need for studies that focus on female performance at the middle school level in the fields of Science, Technology, Engineering and Math (STEM) is essential. Based on Advanced Placement testing the scores of female students in secondary schools in the United States lag behind their male counterparts in every STEM subject and the data was

found to be statistically significant (Robelen, 2012). The gender gap in math and science increases between elementary school and high school, and the declining performance of female students in mathematics and science appears to grow in the eighth grade (Robelen, 2012). This data is alarming based on the growing demand for STEM education in the global job market and needs to be further studied.

Conceptual Framework

The relaxation of the Title IX regulations in 2006 has caused the discussion over whether a public, single-gender school environment would provide an academic advantage to female students in secondary education to intensify. Nonetheless, public, single-gender schools have opened across the United States with little to no empirical data to support their necessity (Spielhagen, 2011). A main argument for the use of single-gender schools is that males and females learn best using different learning styles and in different environments (Sax, 2006). The gender differences in learning styles are present in males and females since birth (Bradway, 2013). Females in general are auditory learners and respond better to teachers who speak lower and tend to learn best in a quiet environment, while males in general are visual learners and prefer hands-on learning activities and teachers who speak in a louder tone (Bradway, 2013; Sax, 2006). Gender differences in learning styles must be addressed by school systems in order for males and females to perform to their highest potential (Gurian, 2006). Differentiated learning styles cannot be achieved in co-educational classrooms when the styles preferred by male and female students contrast with one another. Male and female students also learn best in different classroom environments. An example of this would be that the ideal ambient

temperature for females to learn in is seventy-five degrees Fahrenheit and for males it is sixty-nine degrees Fahrenheit (Sax, 2006). Proponents of single-gender schools such as Sax (2006) believe that males and females learn using different styles and under different environmental conditions that cannot be reconciled with the learning needs of their male counterparts and which has created the need for single-gender schools.

The goal of single-gender schools is to accommodate the learning styles of the individual genders in order to improve academic achievement (Friend, 2007). This goal appears to be attainable because in a single-gender classroom, when females are separated from males, teachers can focus on the learning needs of females. Therefore, the notion of different learning styles for males and females conceptually frames the position that females would academically perform better in single-gender schools. This study used standardized tests scores from the Georgia Criterion-Referenced Competency Tests (CRCT) in attempt to prove or disprove this concept by comparing the tests of seventh-grade female students who attend a public, single-gender school to those who attend a public, co-educational school.

Theoretical Framework

The primary theories being used to support this study are social science theories, specifically Piaget's stage theory of cognitive development and Bandura's social learning theory. The basic reasoning for this study is that there is a significant difference for academic achievement when examining students who attend a public, single-gender school compared to students who attend a public, co-educational school in the fields of

mathematics and science. One must first understand the social theories that are the basis of this study in order to comprehend this study and the interpretation of its findings.

Piaget (1952) developed a theory to explain how it is possible for a child to develop into an adult who is capable of reasoning and thinking in the abstract. Piaget's work focused on the development of a child, not the way that a child learns (McLeod, 2012). Piaget found that children go through different stages of cognitive development, but a child's environmental experiences do influence his/her development.

Piaget (1952) theorized that all children are born with a base of knowledge called schema, and as a child grows this knowledge is either affirmed or assimilated or changed by accommodation. "A schema is a cognitive structure, a network of associations that organizes and guides an individual's perception" (Bem, 1981 p.355). Piaget further found that children go through four different stages of cognitive development, and during each stage a child is able to learn more (Wood, 2001). The sensorimotor stage is characterized from birth to two years of age. The pre-operational stage occurs from two to seven years of age. Children experience the concrete operational stage from the ages of seven to eleven and the formal operations stage usually begins at eleven years old onward although, some children never reach this final stage. A child builds on his/her knowledge from the previous stage until the child becomes an individual who can reason and think in the abstract (McLeod, 2012). The sensorimotor stage is characterized by motor activity and ends with object permanence. Egocentric thinking predominates in the pre-operational stage (Piaget, 1952). During the concrete operational stage children begin to use logic to solve problems. The final stage of formal operations is noted when a child is able to think in abstract terms.

Piaget's stage theory of cognitive development was used to establish instructional techniques in education (Huitt & Hummel, 2003). Piaget believed that if a child was of a certain age or at a certain stage of development, then certain learning styles would be most effective in teaching that child. Piaget also believed that it would be inappropriate to teach a child certain material until he/she reaches a certain age or stage of development. Piaget's stage theory of cognitive development reinforced the practice of schools having grade levels based on ages (McLeod, 2012). If it were not for scholarly work such as Piaget's, then schools may have been structured based on gender rather than age, and society could have avoided the stereotypes found in the co-educational setting. Rather, Piaget's theory neither addressed nor precludes segregation of students based on gender, however, Piaget's theory does realize the importance of individualized learning.

Piaget discovered that not all children progress through the four stages of cognitive development at the same age or at the same speed. Although Piaget's four stages occur in the same sequence and at about the same time of development for each child, there is no absolute rule of when a child completes each stage. Piaget's theory went on to form the basis of the Plowden report which stated that "[i]ndividual differences between children of the same age are so great that any class, however homogeneous it seems, must always be treated as a body of children needing individual and different attention (Plowden, 1965 pg. 25). Therefore, Piaget's theory has been influential in advocating for individual learning styles and flexibility in teaching for adolescent students (McLeod, 2012). Individualized learning is an essential factor of effective single-gender, secondary education; therefore, the stage theory of cognitive development

can be used to argue that students may need to be separated in schools based upon both age and gender in order to provide effective individualized learning.

Bandura developed a theory of social development known as social learning theory based upon the theories of Piaget. Bandura (1971) founded the social learning theory based upon the hypothesis that cognitive, personal and environmental factors act bidirectional to influence a person's learning. Specifically, Bandura theorized that students learn by observing the behavior of those around them. Bandura labelled the observance of behavior "modeling." Modeling is more than just mimicking someone. "Modeling is one of the most pervasive and powerful means of transmitting values, attitudes, and patterns of thought and behavior" (Bussey & Bandura, 1999, p. 16). In the social cognitive theory, modeling has four processes: attention, retention, production and motivation. A child does not model all behavior that he or she observes. How people respond to behavior whether through positive or negative reinforcement affects whether or not a child models that behavior (Bandura, 1971). Children are more likely to model the behavior of someone similar to them and of the same gender as them known as peer modeling (Bandura, 1971). Children first encode the observed behavior and then model the behavior if it is from a similar person and if the behavior receives a desired response (McLeod, 2011). Based upon Bandura's reasoning female students would be inclined to model the behavior of other female students only if such behavior was viewed as being rewarded.

Bandura applied social cognitive theory to gender development. Bandura integrated psychological and socio-structural factors into his theory to create a unified conceptual framework that is negotiated throughout a person's life and not just during

childhood (Bussey & Bandura, 1999). Gender development is achieved through three types of influences: modeling, enactive experience and direct tuition in Bandura's social cognitive theory (Bussey & Bandura, 1999). Bandura found that gender constancy or gender identity, as defined as the time when a child realizes that his/her gender is fixed, is a product of modeling (Bussey & Bandura, 1999). Conceivably, under the reasoning of Bandura's social cognitive theory gender identity or stereotypes are established by the person selected as a model and not those socially accepted norms dictated by society at large.

Bandura also focused his attention to the study of self-efficacy. Bandura found that children who set personal goals have higher self-efficacy (Bandura & Schunk, 1981). Through a course of studies Bandura discovered that children's self-efficacy based on academic goals had an impact on their academic achievement (Zimmerman, Bandura, & Martinez-Pons, 1992). Bandura dedicated a portion of his works studying the school environment and students' academic achievements.

Bandura recognized the important role that schools have in gender development and how education can affect a child's self-efficacy. Both the behavior of teachers and the modeling of students affects a child's academic achievement. Bandura acknowledged that teachers foster gender differentiations through behavior such as favoring male students which in turn improves the self-efficacy of male students while undermining the self-efficacy of female students and which creates a male dominate environment (Bussey & Bandura, 1999). Traditionally, in a co-educational setting female students are not rewarded for performing well in mathematics and science whether this is intentional behavior by teachers or not (Sadker & Sadker, 1994). Bandura reasoned that even if a

teacher is not gender biased he/she still contributes to the lower self-efficacy of female students unless the teacher overcompensates for male dominance in certain fields (Bussey & Bandura, 1999). An example of this would be that computers and mathematics tend to be masculinized in society, so females tend to have lower mathematical and computer efficacy; and therefore, females tend to show less interest in acquiring these skills (Bussey & Bandura, 1999). According to Bandura children also tend to mimic or model the same behaviors of those who are of the same gender. Therefore, based on Bandura's theory female students in a co-educational environment would not be inclined to model behavior that promotes success in these academic fields such as mathematics and science since the male students and not the other female students are being rewarded by teachers for dominance in these classes. Modeling behavior leads to an efficacy in the area that is modelled; therefore, a cycle of gender stereotypes is created (Bandura, 1971). Based on Bandura's findings of gender development, Bandura believed that schools must have a "concerted effort to counteract the personal effects of stereotypic gender-role socialization and the social perpetuation of them" (Bussey & Bandura, 1999 p. 39). Hence, although Bandura did not advocate for single-gender schools, his research could be used to make an argument for single-gender schools so that preference cannot be given to a dominate gender.

Preventing gender stereotypes is a primary factor for studying single-gender education. Scholars such as Bandura realize that gender stereotypes are based upon socialization and not the natural characteristics of the genders (Hanson, 2001). Problems that relate to gender gaps in education such as math anxiety for females have been shown through research to be learned behaviors (Hanson, 2001). Bandura believes that a child's

lowered sense of efficacy can be changed with guided mastery experiences (Bussey & Bandura, 1999). Therefore, if children were educated in a single-gender setting then female students would have a strong presence in mathematics and science classrooms. Single-gender schools would allow female students to receive positive reinforcement for behavior that is traditionally considered masculine such as mathematics and computer use in the absence of male students. Female students would also dominate instructional time in a single-gender school. Therefore, an argument could be made that in a single-gender school female students could have the ability to reach his or her full potential and establish better self-efficacy.

Although Piaget's stage theory of cognitive development and the social learning theory developed by Bandura both theorize means of cognitive development, the theories of both Piaget and Bandura are important to consider together when evaluating single-gender education. Both theories can co-exist. Both theories discussed can be used to support single-gender schools. Both theories realize the importance of environment on a child's development and reasoned that a person only models a behavior or adopts a schema if a positive reaction is associated with the behavior or schema. Thus, the nexus of the theories of stage theory of cognitive development and social cognitive development frame this study.

Significance of the Study

The results of this study could immediately be used to support or reject the development of public, single-gender schools. Specifically, results from this study could help influence whether more public, single-gender schools are developed in the United

States and could also contribute to an understanding of the correlation between single-gender education and academic achievement. Few studies, to date, have focused on the educational effects in mathematics courses of female students who attend a single-gender middle school compared to female students who attend co-educational middle schools (Gilson, 1999). Although the data used for this study was archival, this study is significant because, it developed new research which compared students enrolled in public, single-gender schools to students enrolled in public, co-educational schools which schools had similar socio-economics and similar geographic locations.

Research Questions

This study compared public school students to other public school students; therefore, factors such as school day length, class size, mandated curriculum and testing within each targeted school are equivalent. The following questions were used to guide the implementation of this study.

1. Do seventh-grade female students who attend a public, single-gender school in Georgia outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of mathematics?
2. Do seventh-grade female students who attend a public, single-gender school in Georgia outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of science?

CHAPTER 2:

REVIEW OF RELATED LITERATURE

Despite the fact that the theoretical framework and scientific research to support single-gender schools was not developed until the twentieth century, public, single-gender schools have existed throughout the majority of American history. This chapter reviews the turbulent history of public, single-gender schools in the United States and examines the differing studies which have provided evidence of a gap between the academic performance of males and females in the disciplines of mathematics and science.

Single-Gender Schools in the United States

The roles of males and females in early American society were viewed as being different, and the educational needs and opportunities presented to males and females mimicked their societal roles. Originally, in American history and through the mid-nineteen hundreds, the majority of American public school classrooms consisted of single-sex classes (Gilbert, 2007). Colonial America did not have compulsory education. Males attended schools in town referred to as town schools (Riordan, 1990). While, at this time only wealthy females received an education, and it was usually conducted in their home (Riordan, 1990). As historical events occurred such as the Industrial Revolution and the Civil War, it became necessary for females to assist with commerce. The emergence of females into commerce meant that females needed to receive some

form of education. Co-educational high schools began to develop in the mid-1800's, however, co-educational at this time did not mean together as female students were still taught separate from their male counterparts (Riordan, 1990). Colonial schools were the beginning of single-gender classes.

During the early 1900's two tracks of education were created, which are still followed today: college preparatory and vocational. Unfortunately, during the early 1900's the two tracks of education were determined based on race and gender not academic ability. Female and African-American students were traditionally placed in the vocational track, while the college preparatory track was often reserved for white males. Female students were required to take courses in home economics and were steered towards careers in nursing, teaching, or motherhood (Sadker & Sadker, 1994). Therefore, even though schools were given the title co-education, in the mid-1900's public, secondary schools were segregated based upon gender due to the courses males and females were encouraged to take.

As the attitudes toward women and minorities in the United States changed, so did the rights and opportunities afforded to them. The Civil Rights Act of 1964 called for the desegregation of public schools. Unfortunately, the Civil Rights Act of 1964 was implemented through the United States Supreme Court Case of *Brown v. Board of Education* (1954) which only focused on ending segregation based on race in the school systems. It was not until the United States Department of Education passed Title IX of the Education Amendments in 1972 that sex discrimination was prohibited in public schools (Spellings, 2006). Title IX required that males and females attend, participate in and receive the same education opportunities (Spellings, 2006). Specifically, 20 USC

§1681 states “no person in the United States shall on the basis of sex, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any education program or activity receiving federal financial assistance” (U.S. Department of Labor, 1972). Title IX was most popularly used in many school systems to provide females with equal access to sport programs; however, Title IX also applied to single-gender schools. As a result of Title IX, in 1983 the last all-boys public school in the United States went co-educational.

The United States Supreme Court, reinforced the strength of Title IX and added a constitutional element in the landmark decision of *United States v. Virginia* (1996). This case involved the Virginia Military Institute (VMI), a public, higher learning institute exclusively for men. The State of Virginia and VMI were sued based upon VMI’s male-only admission policy. As a compromise, VMI offered to develop the Virginia Women's Institute for Leadership as an equivalent school for female students. The United States Supreme Court rejected this compromise finding that a new institution would not offer the same prestigious reputation and opportunities as VMI, and hence would not meet the heightened scrutiny requirements of the equal protection clause of the 14th Amendment to the United States Constitution (United States v. Virginia, 1996). Effectively, the passage of Title IX and the ruling in *United States v. Virginia* created the desegregation of public schools based on gender. Both secondary and post-secondary public, single-gender schools ceased to exist in the United States.

Women had fought for equal opportunities in education for decades, but after the passage of Title IX the question became does co-education really mean equal? The United States Department of Education commissioned a task force in the early 1980’s to

examine why schools in America were failing. The commission reported its results in a report titled *A Nation at Risk*, but when the commission outlined its findings many such as the American Association of University Women (AAUW) felt as if the report omitted a female perspective (AAUW, 1992). The AAUW released its own report in 1992, claiming that public, co-educational schools shortchanged female students (AAUW, 1992). The AAUW report was based upon an analysis of over 1300 previous studies of single-gender education. The AAUW report concluded that a student's gender in the school setting affected academic performance and public, co-educational schools were not meeting the needs of female students; therefore, female students were being placed at a disadvantage (AAUW, 1992). The AAUW (1992) discovered that female students ages nine to fifteen were experiencing lower self-esteem than their male counterparts and lower interest in the subject areas of mathematics and science. The AAUW (1992) discovered that schools and teachers were encouraging male but not female students to take courses in mathematics and science, and therefore the United States job market was losing over one-half of its potential human capital. The 1992 report cited several reasons for the inequality shown to females including the fact that teachers called on female students less, female students were sexually harassed by male students, and teaching methods that favored learning styles used by males were often utilized in classes (AAUW). The AAUW report concluded that based on all factors: achievement scores, curriculum design, and teacher-student interaction, the evidence was clear that gender affects the nation's public elementary and secondary schools (1992). The AAUW report in 1992 instigated a national debate over the effectiveness of co-educational schools. Educators and lawmakers were forced to reconsider the advantages of single-gender

classes and single-gender schools in order to end the inequality between education for males and females.

Bolstering the argument for public, single-gender schools was a report published by Sadker and Sadker (1994). Sadker and Sadker, worked as professors at America University and conducted a three-year study of over 100 secondary schools in the Northeast (Sadker & Sadker, 1994). Ninety-five percent of all teachers in the United States are female (United States Department of Education, 2004). Still, the Sadkers observed that teachers, even if unintentionally, discriminate against female students in the classroom (Sadker & Sadker, 1994). Throughout their study the Sadkers observed teacher behavior that favored male students such as increased praise for male students, lack of criticism or prevention of bad behavior by male students and extra attention given to male students, while female students were encouraged to be quieter, to focus more on their appearance and to seek help more often (Sadker & Sadker, 1994). Teacher behavior such as that observed in the Sadker study that favors male students in the classroom can unintentionally produce gender-bias which can result in male dominance, is a prime example of how stereotypes could be prevented through use of a single-gender classroom, and therefore is the basis for one of many arguments for the use of single-gender schools.

Support to return to single-gender education in the United States was reaching a high in the mid-1990's, but then the AAUW released a new report. Despite the fact that no significant new studies had been presented, the AAUW in 1998 released a new report on female educational performance whereby the AAUW retracted its conclusions from the 1992 report that females were not receiving equal opportunities in co-educational

classes (AAUW, 1998). The AAUW (1998) now reasoned that the overall evidence revealed that single-gender schools were no better for females than co-educational schools. The basis for the retraction was a belief that the differences in academic performance between male and female students shown in previously reviewed studies could be attributed to socio-economic factors and not gender (AAUW, 1998). The AAUW researchers concluded that comparisons between single-gender and co-educational institutions are difficult to make because so few schools offer single-gender courses, the students who attend single-gender schools do so for a variety of reasons and represent a wide spectrum of demographics which may attribute to the performance differences and study results are often the subjective interpretation of the researcher (AAUW, 1998). The AAUW now concluded that the key to successful education was good education regardless of whether it occurs in a co-education or single-gender school (AAUW, 1998). Good education defined as small classes, equitable teaching practices and focused curriculum became the focus of the AAUW (Sharpe, 2000). However, there was practically no new research to support the conclusions of the second AAUW report which, was in contradiction to earlier reports, and thus the 1998 report of the AAUW is subject to criticism. The 1998 report released by the AAUW did not end the debate of co-education verses single-gender schools, but rather added to the discussion.

Regardless of the conflicting views over single-gender education, it was evident that after four years of public schooling an achievement gap existed with minority students (United States Department of Education, 2004). One answer to this achievement gap was the passage of the federal No Child Left Behind (NCLB) legislation in 2002. Under the NCLB legislation every state was required to create accountability standards

for each school, and if a school failed to meet those standards for two consecutive years, then the school faced the potential of losing federal funding. Schools now had difficulty in meeting the higher demands of what NCLB termed adequate yearly progress. The United States Department of Education responded in 2006 with amendments to Title IX regulations which allowed public school systems to form public, single-gender classes and schools if such programs were deemed to be in the best interest of the child under the standards of the NCLB Act. Parents were demanding more options from public schools for their children's education; therefore, American public schools responded by offering single-gender options (Hartman, 2010). Thirty years after its passage, Title IX was reinterpreted and relaxed in order to allow public schools to comply with the contradicting elements of NCLB. The new interpretation of Title IX provides the opportunity for public school systems to create single-gender classes and single-gender schools (Friend, 2007). With the new educational amendments federal law permits public, single-gender schools as long as student's decision to enroll in a single-gender school is voluntary and a co-educational alternative is offered and available (Spellings, 2006). As a result of the enabling legislation, more and more single-gender schools began emerging in the United States. Three public, single-gender schools existed in 1995, but that number soared to eighty-six in 2007 and continued to increase with many other public schools offering single-sex courses (Meyer, 2008). The question of the superiority of single-gender schools has intensified over the last decade as more public, single-gender schools have opened across the United States.

Single-Gender Schools for Females

Despite the fact that segregated schools are referred to as single-gender schools, in reality the development of single-gender schools has been focused on creating all-female schools. Despite gains made in academic achievement for females over the past several decades, scholars still question if school systems are meeting the academic needs of female students and have not been as concerned with the needs of male students (Spielhagen, 2011). Academic research continues to support the rationale for all-female schools since it shows that female students underperform male students in the fields of mathematics and science at all education levels (Reid & Ross, 2006). Therefore, the debate to support all-female schools continues and is more divided than ever.

On one side of the debate there are educators such as Leonard Sax, the Executive Director of the National Association for Single Sex Public Education, who believe that public, single-gender education options should be provided in the United States (Sax, 2005a). Members of female-friendly organizations such as the National Coalition for Women (NCW), who argue that single-gender schools and classes are unnecessary and in fact produce adverse effects, are on the other side of the debate (Green, 2006). Over the past decade and a half the debate over the effectiveness of single-gender education has heightened not just in the United States but also across the world.

There are several arguments that support separate education for males and females. The first theory is one of biology. The brains of males and females are different; therefore, they learn differently (Kommer, 2006). Scientists have found that both the chemistry and the structure of the male and female brains are different (Kommer, 2006). The areas of the brain associated with language skills mature faster in females while the

areas of the brain associated with spatial skills mature faster in males (Sax, 2005a). The biological differences between males and females are real and tangible, and based on these biological differences males and females need to be raised, disciplined and educated differently (Sax, 2005b). Teachers in co-educational classrooms typically do not use teaching methods that are conducive to learning for both genders. Teachers in a single-gender school would be able to tailor their teaching methods and curriculum in a manner to complement the brain development of males or females. However, merely placing male and female students in separate classrooms will not accomplish improvements in academic performances unless teachers are educated as to how male and female students are biologically different and therefore learn differently (Sax, 2006). If single-gender schools are to succeed then teachers must be trained on the biological differences of the male and female brain.

The second reason proponents advocate for public, single-gender education is dissuade stereotypes. A belief exists that men and women have different social experiences and therefore different social needs (Weil, 2008). “Many educators and theorists believe that single-sex education is beneficial for students, not simply because males and females learn differently, but because it does not enforce any type of gender based stereotype or adolescent subculture” (Foster, 2012). Teachers in co-educational schools are often unaware of the unintentional biased behavior they exhibit towards a specific gender through their verbal interactions, eye contact, and body language with students and therefore do not know to correct or change their actions (Sanders, 1997). By removing the opposite sex from the educational setting, single-gender schools are able to prevent the stereotypes associated with that gender from being reinforced through the

lesson plans. Teachers in all female middle schools do not have any male students in their classes; therefore, in a single-gender school these teachers cannot unconsciously favor male students or encourage male students over female students to strive in disciplines such as mathematics and science.

Finally, some scholars advocate for single-gender education so that males and females can focus on their studies and not be distracted by the opposite sex. By middle school most students are experiencing puberty. Whether it is hormones or just plain curiosity during the secondary school years, students are interested in learning more about the opposite sex (Hopkins, 2001). Once again, by removing the opposite sex from classes, single-gender schools are able to remove distractions during the school day.

On the other side of the debate, opponents of single-gender schools contend that efforts focused on the academic achievements of female students are unnecessary and unfair. Some researchers have concluded that the margin between male and female students' academic performances has narrowed, and is no longer an issue (Sharpe, 2000). Other scholars argue that the priority to assist female students in secondary education has had a negative effect on male students, so that public school systems are now failing to educate male students properly (Meyer, 2008). Research, however, has disproven this second argument by documenting that while female academic performances have improved, male academic performances are remaining static and not getting worse (Mead, 2006). Researchers such as Mead (2006) rather, oppose single-gender schools based on the reasoning that the real inequalities in education are based on race and socioeconomics not gender. Based on the differences of opinion over the validity of

single-gender schools more conclusive research is needed, thus creating the purpose for this study.

Despite the continuing debate about the effectiveness of single-gender schools, the usage of single-gender schools skyrocketed in the United States in the early 2000's. Single-gender schools in the United States rose to approximately 540 schools in 37 states between the years 2006 to 2008 (McNeil, 2008). Those numbers, however, are now declining as states have begun to cease the operation of their single-gender programs (National Association for Single Sex Public Education, n.d.). The reason for the decline in single-gender schools has been two-fold. First, there is insufficient research to support funding for single-gender programs, and second many programs do not want to be exposed to lawsuits, challenging the constitutionality of the new Title IX regulations, which have been threatened by the American Civil Liberties Union (National Association for Single Sex Public Education, n.d. and Meder, 2012). If public, single-gender schools are going to continue to operate in the United States, then it is essential to develop future research to support their need.

Gender Differences Based on Mathematics and Science Performances

Due in part to the history of American education, males have historically academically outperformed females. Sadker and Sadker (1994) concluded that although female students may begin school academically performing ahead of their male counterparts, by the time that female students graduate from high school female students are academically behind the performance of male students. This is especially true in the

disciplines of science, technology, engineering and mathematics, known as the STEM fields.

Focus on the gender gap in the STEM fields is essential, because today's job market is rooted in these disciplines. Over the past ten years, jobs in the STEM fields has grown three times faster than jobs in non-STEM fields, and for the next several years STEM jobs are calculated to grow by at least two times as fast as non-STEM jobs (U.S. Department of Commerce, 2011). This is important news for female students and employers. The AAUW (1992) discovered that schools and teachers were encouraging male, but not female students to take courses in mathematics and science, and therefore as a nation our job market was losing over one-half of our potential human capital (Organization for Economic Co-operation and Development (OECD), 2012). While more females are now seeking higher degrees and account for a higher percentage of the workforce than in previous years, female wages and degrees of study still greatly differ from those of males (Stoet & Geary, 2013). Substantially lower female wages are thought to be directly influenced by the lack of females in technical fields which may be a trickling effect from their inadequacies in mathematics and science starting in secondary school (Ellison & Swanson, 2010). Therefore, the gender gap in academic performance is also creating a socioeconomic gap amongst the genders.

The cause of the gender gap in academic performance in the STEM fields is unknown. Some scholars believe that males and females have equal intrinsic aptitude for mathematics and science, and that male and female babies are born with the same cognitive abilities to develop skills in mathematics and science (Spelke, 2005). However, the AAUW (1992) discovered that females age nine to fifteen were experiencing lower

self-esteem than their male counterparts and lower interest in the subject areas of mathematics and science. Ninety-one percent of female students have an interest in mathematic courses in the fourth grade, but that number drops to fifty percent by the time a female student reaches the twelfth grade (Amelink, 2012). Gender stereotypes that support mathematics and science being a male dominated field are reiterated in public school curriculums, potentially discouraging female students from pursuing degrees and jobs in the areas of science and engineering. Researchers believe that female students' disinterest in mathematics is related to gender based stereotypes promulgated by parents and teachers such as careers in mathematics and science are masculine careers (Amelink, 2012). The gender stereotypes discouraging female students from prevailing in mathematics are reinforced by female teachers who themselves suffer from math anxiety (Amelink, 2012). Lack of interest in mathematic courses during secondary school can have a correlation to female students' lack of interest in pursuing other STEM fields that require a strong mathematic background (Amelink, 2012). Therefore, a lack of interest in mathematics by female students may have created a domino effect which has led to increasing the equality gap between genders.

Female students may have less interest in mathematics and science courses, but do they lack the ability to perform as well as males in these courses? Although the gap between male and female students' performance in mathematics has narrowed, it does still exist (Ellison & Swanson, 2010). Female students' test scores in the areas of mathematics and science are consistently lower than those of their male counterparts, and surprisingly this gap becomes much greater amongst higher achieving students, especially those in percentages beyond 99% (Ellison & Swanson, 2010 and Stoet &

Geary, 2013). Ellison & Swanson (2010) studied the Scholastic Aptitude Test (SAT) scores used for college admissions and found that as reported SAT scores for math reached 800, the gap between the number of males to females scoring that high increased from a marginal gap to a difference of a 2.1:1 male to female ratio. These findings led Ellison & Swanson (2010) to also examine scores from the American Mathematics Competition (AMC), a competition meant for high mathematic achievers that leads to the Math Olympiad. Ellison & Swanson (2010) found that of the students who scored one hundred or higher out of one hundred and fifty points on the AMC 12, there was a 4.2-1 male to female ratio, despite the fact that forty-four percent of AMC test-takers were female. Additionally, the performance gap between genders on the AMC test was consistent with all high school students who competed across the United States (Ellison & Swanson, 2010). The fact that gaps between males and females in mathematics and science increase amongst high achieving students diminishes the argument that low socio-economic factors are the main contributor to the gender gap in academic performances (Stoet & Geary, 2013). Ellison & Swanson (2010) concluded that American girls with high mathematical ability are not developing or pursuing their full potential. If American female students are in fact failing to reach their full mathematical potential, then the American education system must be failing somewhere.

The gender gap in academic performance in mathematics is not isolated to the United States. Stoet & Geary (2013) conducted a review of data from the Programme for International Student Assessment (PISA) over a ten year period from seventy-five countries. Stoet & Geary (2013) concluded that male students scored higher than female students in mathematics worldwide, however, the degree of variation differed by country.

Contrary to what was expected, those countries known more for gender equality had higher differences between the mathematic scores of male and female students (Stoet & Geary, 2013). Stoet & Geary (2013) also found that the performance gap in mathematics was greatest among high achieving male and female students with the largest gap having a 13:1 male to female ratio with males performing at an optimal level. Existence of worldwide evidence in support of a gender gap in the academic performance of male and female students in the fields of mathematics and science can be used to rebut the arguments that socioeconomic factors and teaching methods are the root cause of any such gaps, and add validity to an argument in support of single-gender schools based on biological differences in learning.

New studies with fresh data have been released since the opening of public, single-gender schools across the United States and internationally focusing on female achievement in the STEM fields in single-gender schools. During the 2007-2008 school year, Katherine Bradley conducted a dissertation study focusing on the academic achievement of first and second grade students in Georgia single-gender classes to those students in co-educational classes (Bradley, 2009). The instrument used in that study was the measures of academic progress (MAP) for mathematics and reading tests given by teachers at the beginning and end of the school year. Bradley's (2009) study produced mixed results. The study showed improvements for female students who attended the single-gender classes for both mathematics and reading, but the study showed no significant improvements for the male students who attended a single-gender class on either mathematics or reading tests (Bradley, 2009). Due to the inconsistent results Bradley's study cannot be used to resolve the debate about public, single-gender schools.

Tully and Jacobs (2010) conducted a study for their thesis at Harvard University which focused on female engineering students enrolled at the University of Technology in Sydney, Australia. This survey study reviewed the effect that attending a single-gender high school had on female students' perception of their mathematical abilities and the influence of a single-gender school on a female choosing an engineering major (Tully & Jacobs, 2010). Tully and Jacob (2010) discovered that single-gender schools may have had an indirect impact on a female student's choice to pursue engineering, but Tully & Jacob's student interviews failed to discover any direct impact. The same was true for the impact of single-gender schools on a female's performance in mathematics. "Research on single-gender education and the impact on mathematics achievement is contradictory and inconclusive" (Tully & Jacobs, 2010, p.2). Based on the research of Tully and Jacob more studies would be needed to justify public, single-gender schools in the United States.

Bang and Baker (2013) conducted a study in South Korea examining the academic achievement and attitudes towards science of students in three different schools including an all-male school, an all-female school and a co-educational school. The study concluded that while the students in the co-educational school performed better, they had higher stereotypical perceptions about science that could not be overcome (Bang &Baker, 2013). "The study shows that all the principals and science teachers had stereotypic perceptions regarding female students learning science, but only students from the co-educational school held more non-stereotypic perceptions about science than the single-sex schools" (Bang & Baker, 2013, p. 37). Therefore, even with the additions of this latest research more studies are needed.

Scholars agree that there is a gender gap for academic performance in the fields of mathematics and science. The lack of female achievement in the STEM fields directly influences career choices and earning potential. However, there are mixed results as to whether single-gender schools are viable solutions to the concern of female success and achievement in the fields of mathematics and science.

Single-Gender Middle Schools

A typical middle school student ranges from the ages of eleven to fourteen. This age range is a crucial time period in a child's life for both personal and academic development (Reid & Roberts, 2006). During this period of adolescence, female middle school students generally experience a decline in the confidence of their academic abilities (Kommer, 2006). A study of the effects of single-gender schools on a female's academic performance in mathematics is important to be conducted at the middle school level, because one of the largest gaps between female and male students in mathematics is found in female students transitioning from middle to high school (Fennema & Hart, 1994 and Reid & Roberts, 2006). Additionally, the majority of single-gender schools that have opened are at the middle school level due to female students' lagging academic achievements in middle school grades (Spielhagen, 2011). Between the 2007 to 2009 school years, three hundred and four public, single-gender middle schools were reported in operation in the United States, compared to two hundred and thirty-six elementary schools and one hundred and six high schools (Klein, Lee, McKinsey, & Archer, 2014). Therefore, it is essential that new studies on the effectiveness of public, single-gender schools focus on middle school students since the majority of data that is available is for

the middle grade levels, and because middle school is a critical point for a student's academic success.

Chapter 2 Summary

Title IX was enacted over thirty years ago, yet the discussion over what is equal for males and females in the field of education continues. In the field of education equal seems to refer to equal treatment not equal outcomes (Sanders, 1997). The debate to support the emergence of single-gender schools is more divided than ever. Over the past decade and a half, the effectiveness of single-gender education has been questioned not just in the United States, but also across the world. Today, there is an argument for the re-segregation of public schools based on gender. However, more research is necessary if public school systems are going to expend the money and resources necessary to create single-gender schools as the new normal in the United States.

CHAPTER 3:

RESEARCH DESIGN

The purpose of this study was to investigate academic performance between female students attending single-gender schools and co-educational schools. This was a non-experimental, quantitative study that used causal-comparative research. Specifically, this study focused on the performance of seventh-grade female students in the disciplines of mathematics and science in Georgia. The study compared the state administered standardized test scores of female students in public, single-gender schools in Georgia to the test scores of students in public, co-educational schools in Georgia. This chapter describes the study participants, the context and method in which data were collected, review of the pilot study and the processes that were used for data analysis. Figure 1 below shows the logic model of this study.

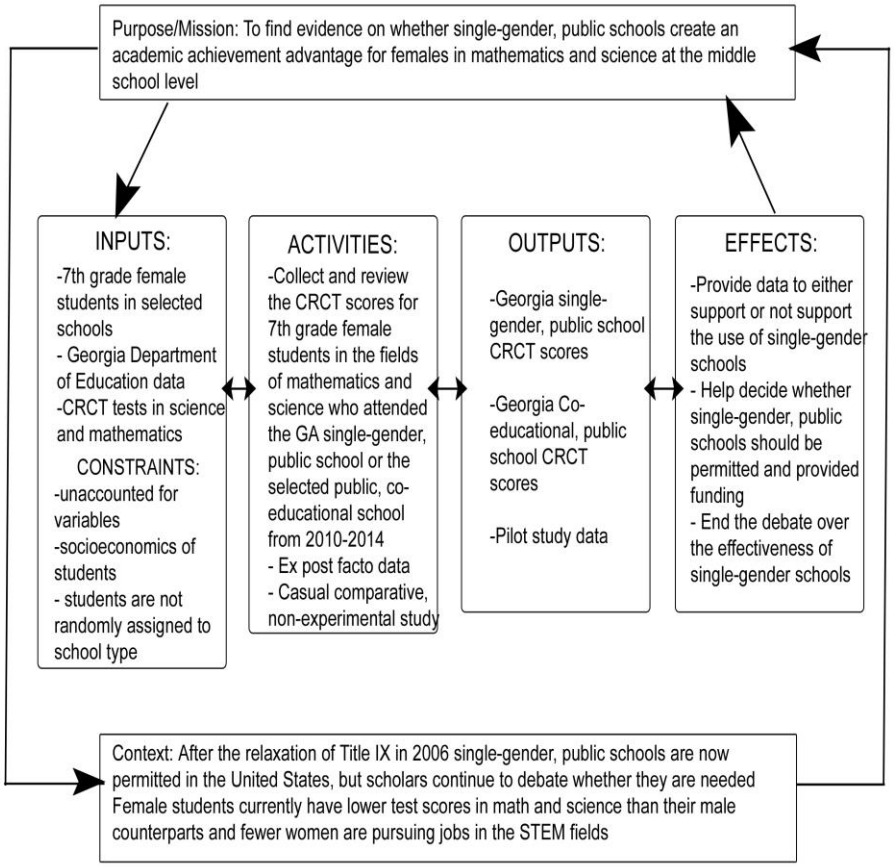

Figure 1. Logic model.

Participants

Participants for this study were female students who were enrolled in the seventh-grade at either the selected public, single-gender middle school or the selected public, co-educational middle school between the 2009-2010 school year to the 2013-2014 school year. Specifically, this study focused on seventh-grade female students who were enrolled at CE Middle School or SG Middle School in Georgia and who completed the

Georgia Criterion-Referenced Competency Tests (CRCT) in the fields of mathematics or science during the applicable school years.

The tests scores of over 2,000 seventh-grade female students were reviewed for this study. Seventh-grade students were selected to use in this study, because seventh-grade students receive a statewide common core curriculum in the disciplines of mathematics and science. Seventh-grade students on average range in age from twelve to thirteen. SG Middle School was selected for use in this study since it was the first public, single-gender school in Georgia. It is significant that SG Middle School is a public school. Being a public school means that SG Middle School must teach students the same core curriculum used statewide, that the class size, the length of the school day and the length of instruction time must be equivalent to other public schools in the state, that all teachers must be certified by the state and that attendance is tuition-free. SG Middle School was also selected because it is a single-gender school, meaning that it teaches only female students; it does not merely provide single-gender classrooms.

Several schools across the State of Georgia were considered to represent the traditional, public co-educational school in this study. Ultimately, CE Middle School was selected due to its geographical proximately to SG Middle School. Both schools are located within the same county. Maintaining similar socio-economic and demographic characteristics of the participants is important, because differences in these characteristics can be used to explain variations in standardized test scores (Toutkoushian & Curtis, 2005). The spatial proximity of the schools is important to establish a student population with similar socio-economic factors. Based on the spatial proximity of the schools, then the students observed in this study presumably live in similar types of neighborhoods.

Both participating schools are located in suburban settings. Additional socioeconomic factors including low-income levels and limited English proficiency are also similar among the participants in this study and are illustrated in Figure 2. Based on the similarities of the schools, the differences in the studied participants due to extraneous variables should be reduced.

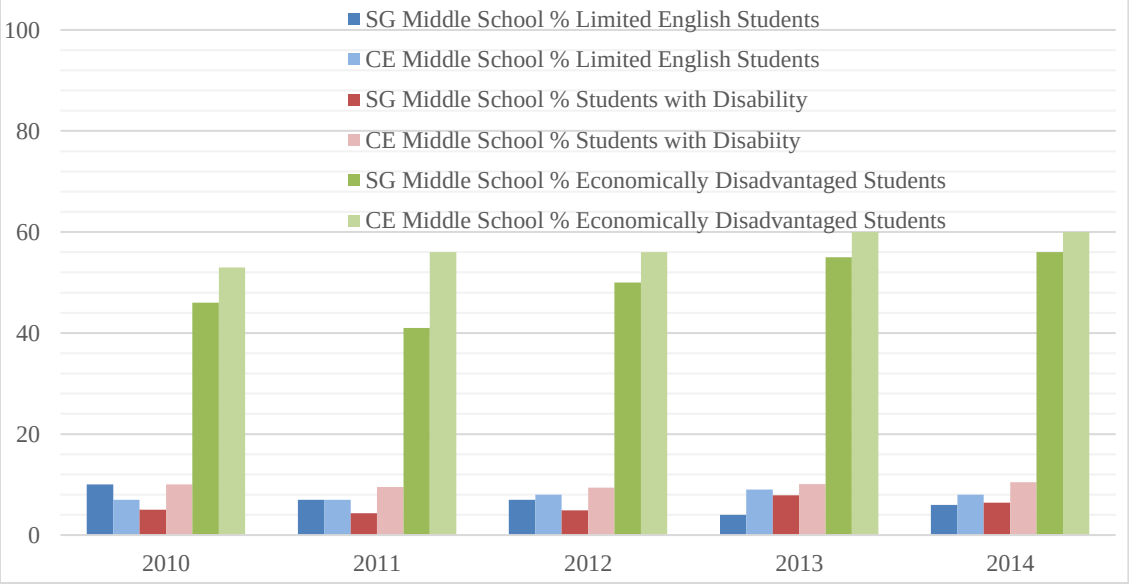

Figure 2. Socio-economics factors at each school.

Figure 2 illustrates the percentage of female students enrolled in each participating school that were classified as limited English speakers, students with a disability and students who were economically disadvantaged for each year of the study. This information was collected and provided by the Georgia Department of Education.

Individual students' and teachers' identities were not reported or known for this study. Therefore, this study qualified for exemption from Institutional Review Board (IRB) approval. A copy of the IRB exemption letter is attached as Appendix "A."

Context

This was an ex post facto study. The study used archival data that was available from the Georgia Department of Education. Therefore, the majority of this study occurred through the use of the computer in order to retrieve the necessary data.

The CRCT tests were administered in an educational setting. All tests were administered in the spring semester of each school year. All students completed the test in their regular classrooms at their own school during normal school hours. All tests were monitored by either the student's classroom teacher or another teacher trained in the administration of standardized tests.

Data Collection Procedures

This study used ex post facto data since the test scores being evaluated were from 2010 to 2014. The Georgia Department of Education compiles the CRCT test results for each school at the end of each year, however, while these reports are broken down by school, the Georgia Department of Education does not report the scores by gender. The Georgia Department of Education provided a scaled score for each student who completed the CRCT based on randomly assigned student numbers used for identification. Separate scores were reported for each discipline of mathematics, science, reading, writing and social studies for both male and female students. The data in the score reports had to be reviewed for this study in order to obtain the CRCT scores in the desired disciplines and to eliminate the scores for male students. Score codes for each year were also provided by the Georgia Department of Education which showed which

range of scaled scores were considered to meet standards (PRO), Did Not Meet Standards (DNM) and exceeded standards (ADV).

Data Collection Tools

Academic achievement is defined as the performance outcomes that indicate the extent to which a person has accomplished specific goals in an educational setting (Steinmayr, Meißner, Weidinger & Wirthwein, 2014). Academic achievement can be measured using a variety of instruments such as authentic assessments, Advanced Placement scores, student enrollment in post-secondary programs and chosen fields of study and job placements. These instruments were all considered for this study, however, the Georgia CRCT was the instrument that was finally selected to be used in this study.

The Georgia CRCT was selected to be used in this study for several reasons. First, the tests were standardized across the state. The Georgia CRCTs were state created instruments given in response to federal and state legislation, were written by professional content specialists and were based on common core curriculum. These state standardized tests were given annually to all seventh-grade public school students in Georgia in the spring of each school year to measure a student's knowledge on the state's core curriculum. According to the Georgia Department of Education testing department the CRCT tests were "designed to measure how well students acquire, learn, and accomplish the knowledge and skills set forth in a specific curriculum or unit of instruction" (2014). Therefore, the Georgia CRCT provides an authentic evaluation of a student's skill set in each discipline tested.

The second reason the Georgia CRCT was selected for use in this study is because this test measures student achievement in each of the academic fields relevant to this study: mathematics and science. The Georgia CRCT scores for mathematics and science have been found to be very reliable. The Georgia CRCT was evaluated and was found to be a reliable measurement of student knowledge in the range of 0.87 to 0.91 for mathematics and 0.89 to 0.90 for science (Georgia Department of Education, 2014). Students were given separate tests in the disciplines of mathematics and science and received individual scores for each of the subject areas. Because test scores are reported for each academic discipline the results can be isolated and studied for each subject area.

Finally, the Georgia CRCT was selected as the measurement of academic performance, because the tests were administered under tightly-controlled conditions. Proctors had to complete state training before they could administer the tests. Tests were administered statewide at the same time, on the same day in the spring of each school year and in the same manner. All answer sheets were secured upon their collection and graded by the state; therefore, there was little room for error. Students who completed the Georgia CRCT received a scaled score in each subject area showing that he/she exceeds standards (ADV), meets standards (PRO) or does not meet standards (DNM). A student's scaled score was considered to exceed the standards if it was 850 or higher, students with scaled scores from 800 to 849 were considered to have met the standard, and students with scaled scores of lower than 800 were considered to be below the state's minimum level of proficiency (Georgia Department of Education, 2014). The score guide was the same for each of the observed testing years of this study and for both disciplines of mathematics and science.

Data Analysis

The analysis examined the relationship between the scores for mathematics and science of females who attended a public, co-educational school and the scores for mathematics and science of females who attended a public, single-gender school. The scores of the female students at CE Middle School were compared to the scores of the female students at SG Middle School for both of the subjects of mathematics and science for each of the years from 2010 to 2014. The independent variable (IV) was the type of school, single-gender or co-education and the dependent variables (DV) were the seventh- grade female students' subtest scores as measured by the Georgia CRCT in mathematics and science. The independent variable was categorical which made this study a causal-comparative study rather than correlational (Johnson & Christensen, 2012). Each analysis had two dependent variables, mathematics and science test scores, and one independent variable with two levels, single-gender or co-educational school settings. Figure 3 summarizes the analysis for this study.

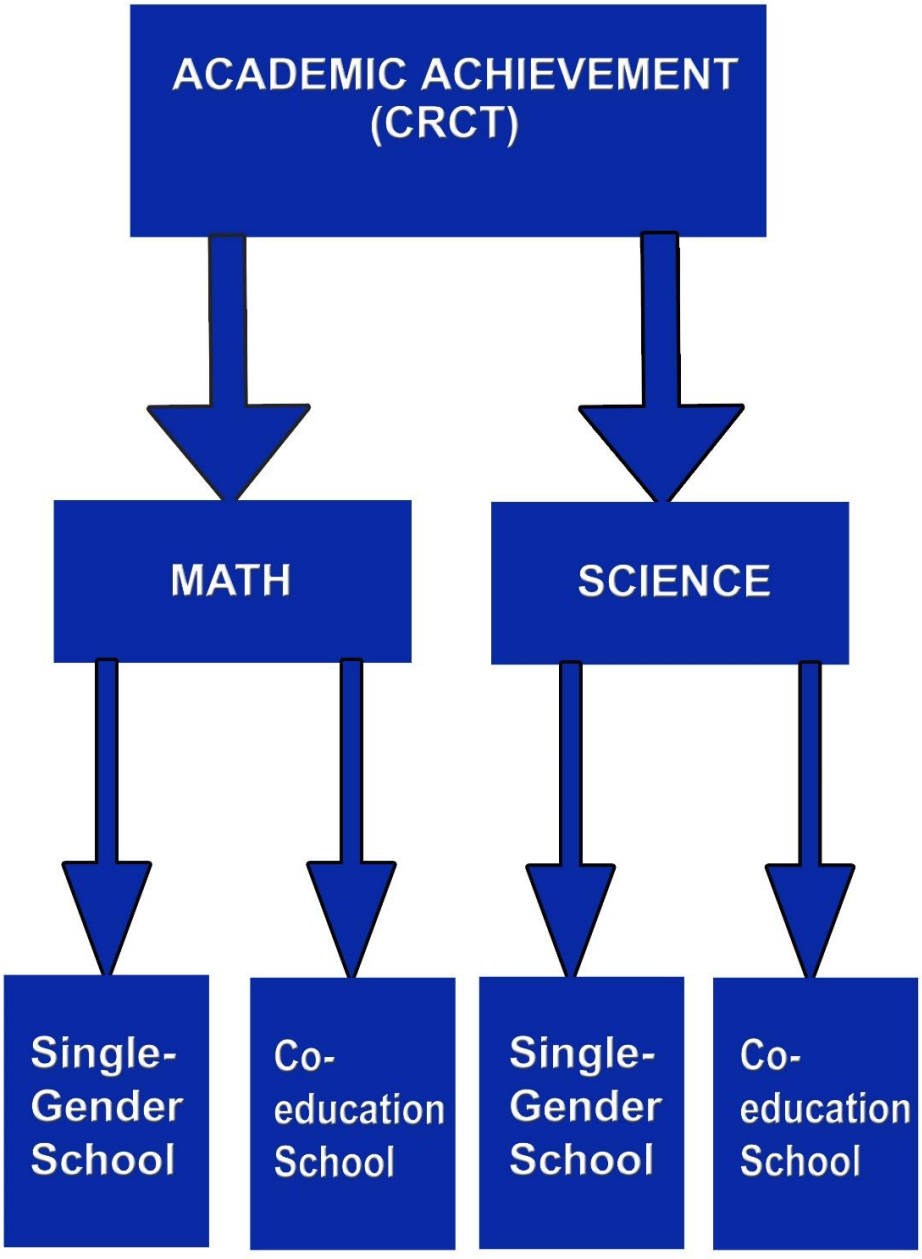

Figure 3. Data analysis summary.

Prior to any statistical calculations being performed, a preliminary review of the data was conducted to determine the percentage of female students who did not meet, met

and exceeded the standard state score each year for each subject and at each school. Descriptive statistics were then used to examine the test scores. The mean score and standard deviation of the scores for each school in each year and for each subtest were calculated and compared statistically. A test of significance was performed to determine if academic setting affected a student's academic performance. A t-test was selected as the test of significance since only two groups were studied (Gay, Mills & Airasian, 2012). An alpha = 0.05 was used as this is the acceptable level of probability for educational research (Gay, Mills & Airasian, 2012). A two-tail test of significance was conducted to determine if any difference existed in the performance levels. Specifically, t-tests were conducted to determine if there was a significant difference in female students' scores in mathematics and science between CE Middle School and SG Middle School. An effect size test using Cohen's d was also conducted to determine if a practical as well as a statistically significant difference existed between the performance levels on the CRCT. An effect size of d = 0.2 is considered small, of d = 0.5 is considered medium and of d = 0.8 is considered large (Cohen, 1988). All statistical calculations were made using computer software.

Pilot Study

A pilot study was conducted prior to the collection of the data for the study. The pilot study involved two middle schools located in the State of Georgia. Middle School A represented a public, single-gender school similar to SG Middle School that teaches only female students, and Middle School B represented a public, co-educational school similar

to CE Middle School. Both schools involved in the pilot study were in close spatial proximity and taught students with similar socio-economic statuses.

The focus of the pilot study was the Georgia CRCT test scores for seventh-grade female students in the disciplines of mathematics and science. The pilot study was an ex post facto study. The data used was archival data from the school years covering 2010-2014. The data were collected from the Georgia Department of Education. In collecting the data for the pilot study, a potential problem for the study was found. The Georgia Department of Education routinely reports the CRCT scores for each school in Georgia using percentages. The Georgia Department of Education calculates the percent of students in each school that does not meet the standards, that meets the standards and that exceeds the standards by gender for each grade level and in each assessment level on the Georgia Criterion-Referenced Competency Test. These percentages cannot be used to complete a data analysis; therefore, the raw score data had to be requested and collected.

As reflected in the tables below, a preliminary review of the data for the pilot study reveals that during the examined years females at a co-educational school outperformed their counterparts at a single-gender school. Seventh-grade female students who attended a co-educational school had a higher mean score for both mathematics and science for each year reviewed. The Department of Education also records the percentage of students who passed or exceeded the expectations of the Georgia CRCT standard score for each subject. Again, for each year reviewed the co-educational school had a higher percent of female students exceed or meet the Georgia CRCT standard score than the single-gender school. Based upon the preliminary study there is not empirical data to

support an argument that, single-gender schools deliver increased academic performance for female students in mathematics and science.

Table 1

Pilot Study CRCT Scores for Mathematics

	School	# Students	Mean Score	% DNM	%PRO	%ADV
2010	Middle School A	127	830	14.8	69.5	15.6
	Middle School B	144	834	9.3	65.6	25.1
2011	Middle School A	172	817	28.5	57.6	14
	Middle School B	115	837	5.5	56.4	38.1
2012	Middle School A	145	825	20.7	56.6	22.8
	Middle School B	181	839	5.5	56.4	38.1
2013	Middle School A	114	820	14.0	72.8	13.2
	Middle School B	178	831	4.5	64.4	31.1
2014	Middle School A	95	818	25.3	63.2	11.6
	Middle School B	213	829	10.3	68.1	21.6

Table 2

Pilot Study CRCT Scores for Science

	School	# Students	Mean Score	% DNM	%PRO	%ADV
2010	Middle School A	127	829	23.4	55.5	21.1
	Middle School B	142	831	14.8	56.6	28.6
2011	Middle School A	172	824	30.1	53.8	16.2
	Middle School B	115	837	8.3	50.3	41.4
2012	Middle School A	147	815	37.4	44.2	18.4
	Middle School B	181	837	9.4	53.6	37.0
2013	Middle School A	119	810	33.6	58.8	7.6
	Middle School B	179	839	10.1	50.8	39.1
2014	Middle School A	97	808	44.3	41.2	14.4
	Middle School B	212	828	17.5	58.5	24.1

The preceding tables show the mean score for the seventh-grade female students enrolled in each school that was a part of the pilot study in each of the observed school years. The tables also report the number of seventh-grade female students that were tested

at each school in each discipline in each year and the percentage of those students who exceeded, met and did not meet the state scaled score expectations for each discipline in each year.

CHAPTER 4:

RESULTS

This chapter provides the results of the data analysis outlined in Chapter 3. The results are presented in relation to the two research questions guiding this study which attempted to ascertain whether attendance in a public, single-gender school affected a female student's performance in the disciplines of mathematics and science. This chapter also provides a more detailed description of the participants used in the study.

Description of Participants

Participants for this study chose whether to attend a public, single-gender school or a public, co-educational school; there was no random assignment of the participants due to the fact that this study was ex post facto. The identities of the participants are unknown; however, each participant was enrolled in the seventh-grade either at CE Middle School or SG Middle School at some time from the 2009-2010 to the 2013-2014 school years. Both schools are located in the same county and are within two miles of one another.

CE Middle School routinely had more students enrolled than SG Middle School. On average between the observed school years, CE Middle School had a seventh-grade class with 211 female students. The largest number of female students in a seventh-grade class at CE Middle School was during the 2009-2010 school year when 215 females were

tested. On average the seventh-grade female students at CE Middle School accounted for one-half of the seventh-grade class.

SG Middle School in contrast had an average seventh-grade class size of 129 female students during the observed school years. The largest class of seventh graders at SG Middle School was during the 2010-2011 school year when there were 153 seventh-grade students enrolled. Figure 4 summarizes the number of female students enrolled in the seventh-grade for each year and at each participating school during the course of this study.

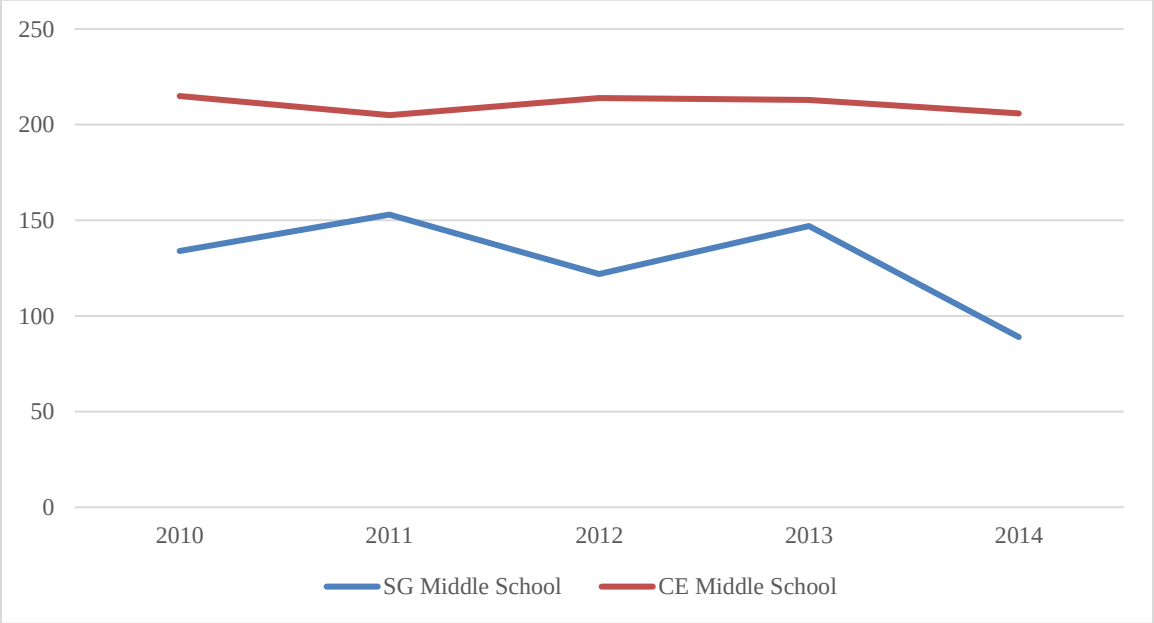

Figure 4. Enrollment numbers.

SG Middle School is a predominately African-American school. During the course of the study each seventh-grade class was comprised of more than fifty percent of African-Americans. CE Middle School is also a majority-minority school; however, no one minority created the majority during the studied time period. On average CE Middle School during the observed time frame was comprised of approximately thirty percent each of Hispanic, African-American and Caucasian students. Both schools had an

insignificant number, less than ten percent, of students who had limited English language proficiently. The graphs in Figure 5 and Figure 6 summarize the ethnicity of the females enrolled in the seventh-grade at the participating schools during the study period.

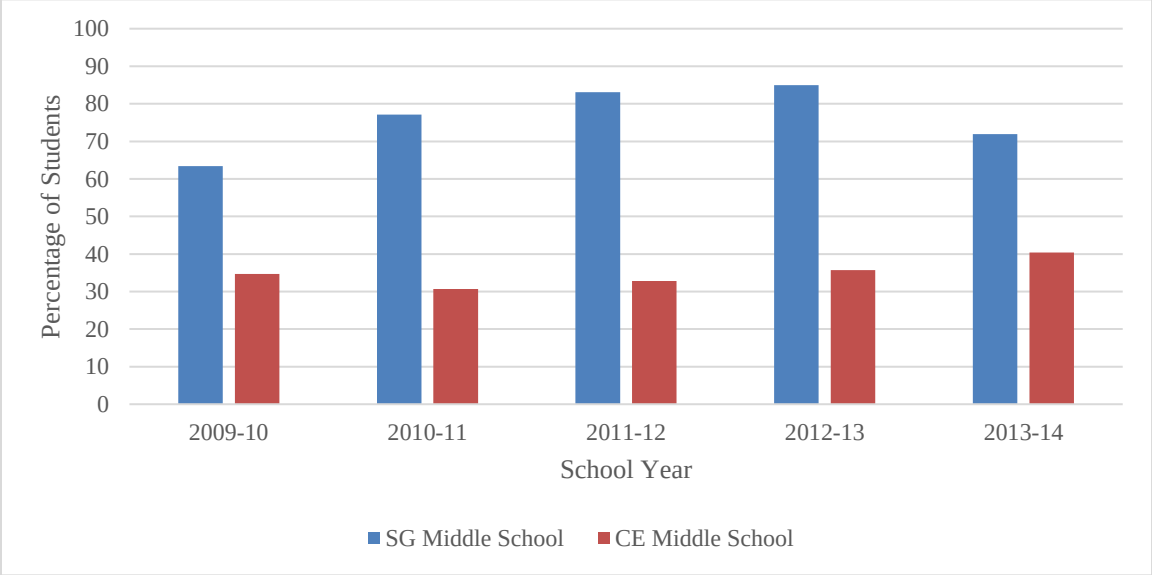

Figure 5. Percentage of African-American seventh-grade female students.

This figure illustrates the percentage of female students enrolled in the seventh-grade that were classified as African-American at each of the subject schools for each year of the study. The count was taken in March of each school year.

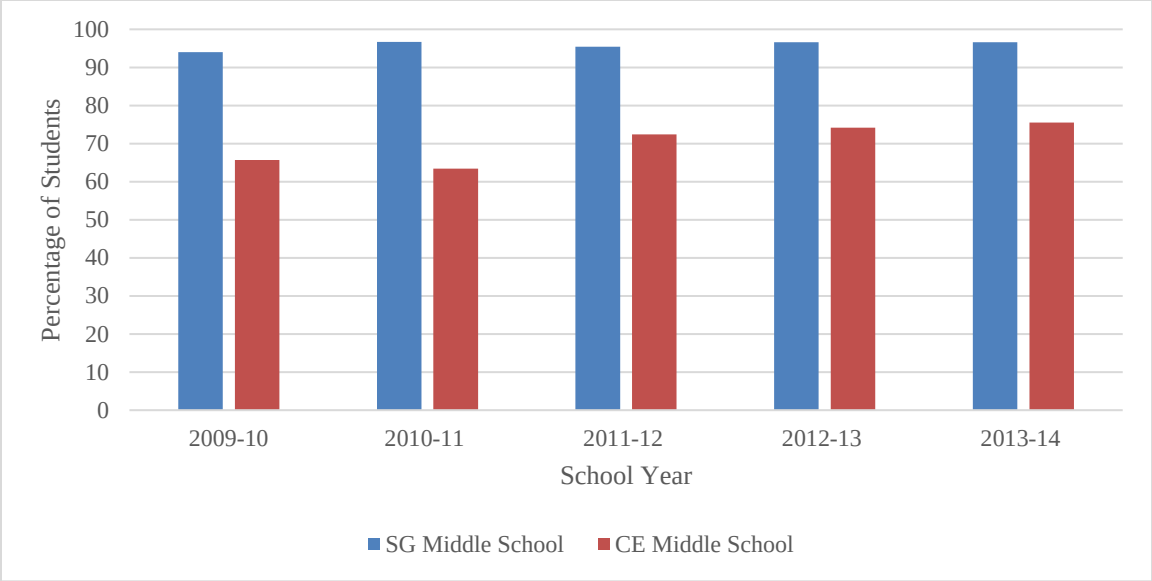

Figure 6. Percentage of minority seventh-grade female students.

This figure illustrates the percentage of female students that were classified as a minority at each of the subject schools for each year of the study. Minorities included African-American, Asian, Hispanic, American Indian and Pacific Islander.

Research Question 1

Do seventh-grade female students who attend a public, single-gender school in Georgia outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of mathematics?

The results for the study in the discipline of mathematics are inconclusive. The data collected cannot be used to prove or disprove that seventh-grade female students who attended a public, single-gender school outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of mathematics. The data in this study in regards to mathematics are inconclusive, because the results are mixed.

Table 3 reports the means of the scaled Georgia CRCT scores for the seventh-grade female students in the discipline of mathematics including the number of female students tested and the percentage of female students who did not meet, met and exceeded the state standards at both SG Middle School and CE Middle School. Overall, seventh-grade female students at SG Middle School, the public, single-gender school studied, performed better than the seventh-grade female students who attended CE Middle School on the Georgia CRCT mathematics tests in 2010, 2012 and 2013. During these testing years, the seventh-grade female students at SG Middle School had both a higher mean score and a lower percentage of students who did not meet the state standards than the seventh-grade female students at CE Middle School, the public, co-educational school in the study; however, in 2011 and 2014 the female seventh-grade students at CE Middle School performed better on the mathematics portion of the Georgia Criterion-Referenced Competency Test.

Table 3

Mean and Passage Rates for CRCT Scores for Mathematics

	School	# Students	Mean Score	% DNM	%PRO	%ADV
2010	SG Middle School	134	862	3.0	33.6	63.4
	CE Middle School	215	847	8.4	44.7	47.0
2011	SG Middle School	150	853	1.3	46.7	52.0
	CE Middle School	205	860	2.9	34.6	62.4
2012	SG Middle School	121	862	1.7	35.5	62.8
	CE Middle School	205	851	2.0	45.4	52.7
2013	SG Middle School	143	855	3.5	39.2	57.3
	CE Middle School	210	850	6.7	45.2	48.0
2014	SG Middle School	86	846	10.5	41.9	46.5
	CE Middle School	204	852	4.0	48.0	48.0

Table 4

Statistical Results for CRCT Scores in Mathematics

	SG Middle School		CE Middle School					
	M	SD	M	SD	t	df	p	Cohen's d
2010	862	34.8	847	33.9	3.93	277	.00*	.44
2011	853	32.5	860	35.1	-2.18	334	.03*	.21
2012	862	33.4	851	33.6	2.68	253	.01*	.03
2013	855	32.7	850	36.0	1.13	323	.26	.15
2014	846	36.9	852	39.0	-1.32	168	.19	.16

* delineates statistically significant

A statistical data analysis was performed, and the results are summarized n Table 4 above. As part of the statistical data analysis, two-tailed, two-sample t-tests were conducted on the data as the test of significance. Results for the t-tests indicate a statistically significant mean difference, at the .05 level of significance, between female students attending a public, single-gender school and female students attending a public, co-educational school on the CRCT mathematics scores in the years of 2010, 2011 and 2012. Using the scaled scores for mathematics t (277) = 3.93 and p = .00 for the 2010 Georgia CRCT, t (334) = -2.18 and p = .03 for the 2011 Georgia CRCT, t (253) = 2.68 and p = .01 for the 2012 Georgia CRCT, t (323) = 1.13 and p = .26 for the 2013 Georgia CRCT and for the 2014 Georgia CRCT t (168) = -1.32 and p = .19.

Based on the results in Table 4 in the years 2010, 2011 and 2012 the differences between the mean scores of seventh-grade female students who attended a public, single-gender school and female students who attended a public, co-educational school were significant and were not the differences expected by chance on the mathematics portion of the CRCT. It cannot be concluded that there are statistically significant differences between the mean scores of seventh-grade female students who attended a public, single-

gender school and female students who attended a public, co-educational school on the mathematics portion of the CRCT during the years of 2013 and 2014; therefore, any difference in the mean scores during these years may be caused by chance.

The effect size was calculated using Cohen's d with d = .02 to be considered small and d = .05 to be considered medium. Using the means and standard deviations calculated in Table 4 for mathematic scores on the Georgia CRCT d = .44 for 2010, d = .21 for 2011, d = .03 for 2012, d = .15 for 2013 and d = .16 for 2014; therefore, all of the calculated effect sizes fall within the small to medium range.

Research Question 2

Do seventh-grade female students who attend a public, single-gender school in Georgia outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of science?

The data collected during the study do not support the conclusion that seventh-grade female students who attend a public, single-gender school in Georgia outperform seventh-grade female students who attend a public, co-educational school in Georgia in the discipline of science. The data collected show that on the science portion of the Georgia CRCT the opposite was true based on performance.

Table 5 reports the means of the scaled Georgia CRCT scores for the seventh-grade female students in the discipline of science including the number of female students tested and the percentage of female students who did not meet, met and exceeded the state standards at both SG Middle School and CE Middle School. The seventh-grade female students who attended CE Middle School had a higher mean score

on the science portion of the Georgia CRCT in every testing year from 2010 until 2014, and in addition fewer seventh-grade female students failed to meet state standards (DMV) at CE Middle School than at SG Middle School in each year studied except for 2012.

Table 5

Mean and Passage Rates for CRCT Scores for Science

	School	# Students	Mean Score	% DNM	%PRO	%ADV
2010	SG Middle School	134	833	11.2	59.0	29.9
	CE Middle School	215	850	9.8	38.1	52.1
2011	SG Middle School	150	843	8.0	46.7	45.3
	CE Middle School	205	861	4.4	35.6	60.0
2012	SG Middle School	122	848	8.2	36.1	55.7
	CE Middle School	214	852	9.8	36.4	53.7
2013	SG Middle School	145	848	9.0	40.7	50.3
	CE Middle School	213	855	6.1	35.7	58.2
2014	SG Middle School	89	845	10.1	41.6	48.3
	CE Middle School	206	857	5.8	33.0	61.1

Table 6

Statistical Results for CRCT Scores in Science

	SG Middle School		CE Middle School					
	M	SD	M	SD	t	df	p	Cohen's d
2010	833	29.5	850	39.2	-4.54	335	.00*	.49
2011	843	34.4	861	40.9	-4.45	346	.00*	.48
2012	848	32.3	852	39.8	-.86	296	.39	.11
2013	848	32.5	855	40.5	-1.92	346	.06	.19
2014	845	36.8	857	39.0	-2.47	176	.01*	.31

* delineates statistically significant

A statistical data analysis was performed, and the results are summarized n Table 6 above. As part of the statistical data analysis, two-tailed, two-sample t-tests were conducted on the data as the test of significance. Results for the t-tests indicate a statistically significant mean difference, at the .05 level of significance, between female students attending a public, single-gender school and female students attending a public, co-educational school on the CRCT mathematics scores in the years of 2010, 2011 and 2014. Using the scaled scores for science t (335) = -4.54 and p = .00* for the 2010 Georgia CRCT, t (346) = -4.45 and p = .00* for the 2011 Georgia CRCT, t (296) = -0.86 and p = .39 for the 2012 Georgia CRCT, t (346) = -1.92 and p = .06 for the 2013 Georgia CRCT and for the 2014 Georgia CRCT t (176) = -2.47 and p = .01*.

Based on the results in Table 4 in the years 2010, 2011 and 2014 the differences between the mean scores of seventh-grade female students who attended a public, single-gender school and female students who attended a public, co-educational school were significant and were not the differences expected by chance on the science portion of the

CRCT. It cannot be concluded that there are statistically significant differences between the mean scores of seventh-grade female students who attended a public, single-gender school and female students who attended a public, co-educational school on the science portion of the CRCT during the years of 2012 and 2013; therefore, any difference in the mean scores during these years may be caused by chance.

The effect size was calculated using Cohen's d with d = .02 to be considered small and d = .05 to be considered medium. Using the means and standard deviations calculated in Table 6 for science scores on the Georgia CRCT d = .49 for 2010, d = .48 for 2011, d = .11 for 2012, d = .19 for 2013 and d = .31 for 2014; therefore, all of the calculated effect sizes fall within the small to medium range.

CHAPTER 5:

DISCUSSION

Discussion of the Results

Based upon the literature review and the theoretical framework of this study, it was anticipated that female students who attended a single-gender school would outperform female students who attended a co-educational school on the seventh-grade Georgia CRCT in mathematics and science. Therefore, the results of this study on the science portion of the Georgia CRCT scores were surprising. Increased academic performance of students in single-gender classes has previously been documented in other programs (Sax, 2005). However, some single-gender education programs have been abandoned due to a lack of improvement in academic performance (Sax, 2005), and some studies have provided inconclusive results (Bradley, 2009). The results of this study were inconclusive. This study found that female students who attended a public, co-educational school clearly outscored female students who attended a public, single-gender school on the CRCT in science based on the mean score and passage rate data. When conducting the data analysis the difference between the mean scores of seventh-grade female students attending a public, single-gender school and seventh-grade female students attending a public, co-educational school were found to be statistically significant for three out of the five years: 2010, 2011 and 2014. During each of the years with a mean difference that was statistically significant the seventh-grade female students at the public, co-educational school outperformed the female students who attended the

public, single-gender school on the science portion of the CRCT; therefore, the data from the science portion of this study cannot be used to support an argument that single-gender schools improve female students' academic performance in science.

The same analysis cannot be made for the data on the mathematics portion of the Georgia CRCT. On the mathematics portion of the CRCT the female students who attended a public, single-gender school outscored the female students who attended a public, co-educational school in three out of the five years studied based on the mean scores. When conducting the data analysis the difference between the mean scores of seventh-grade female students attending a public, single-gender school and seventh-grade female students attending a public, co-educational school were found to be statistically significant for three out of the five years: 2010, 2011 and 2012. Only two out of the five years studied, 2010 and 2012, had a mean difference that was statistically significant and that was a year in which seventh-grade female students at the public, single-gender school had a higher mean score on the mathematics portion of the CRCT. The third year in which statistical significance was recorded, 2011, seventh-grade female students at the public, co-educational school had a higher mean score on the mathematics portion of the CRCT. Both possible outcomes failed to be supported by data in a majority of the years studied. Based on the inconclusive data results it cannot be concluded that female students who attend a public, single-gender school outperform female students who attend a public, co-educational school in the discipline of mathematics. The mixed results of this study fail to provide support for the argument that single-gender schools help improve female students' academic performance in mathematics and science.

The results of this study could be attributed to a variety of factors. First, the majority of successful single-gender classrooms in the United States since the relaxation of Title IX regulations have been in programs that were failing as co-educational schools (Sax, 2005). These schools converted from co-educational schools to schools that offered single-gender options and were able to report that the students who attended a single-gender class had improved academic performance compared to the school's previously failing performance; however, no comparison was done between the students at these schools to students in a co-educational school. It is feasible that single-gender schools may provide a viable alternative for students who do not perform well in a co-educational setting, but since these students are already low performers they may not outperform the students who attend a co-educational school. However, this theory would not explain why female students who attended a public, single-gender school outscored female students who attended a public, co-educational school on the mathematics CRCT for over half of the study period.

The second factor that may have affected the results of this study is the teachers. Simply creating a single-gender school will not improve students' academic performance, teachers must be trained in teaching methods that are beneficial to the gender they teach (Sax, 2006). Teachers in a co-educational school can be educated in teaching methods to help improve the academic performance of students in their classes as well. This study used testing data starting with the year 2010. This was four years after the relaxation of Title IX regulations and after the emergence of public, single-gender schools in the United States. It is feasible that in light of the growth of public, single-gender schools, teachers in public, co-educational schools adapted their teaching methods to be more

attentive to female students. If true, then this could explain the reason that female students in public, co-educational schools outscored female students who attended public, single-gender schools on the science portion of the test. This would not, however, account for the increased scores on the mathematics portion of the CRCT in three out of the five years studied for female students who attended a public, single-gender school. Also, although not a part of this study's data analysis, a cursory review of the mean scores for the male students who attended the public, co-educational school was conducted. The male students who attended the public, co-educational school used in this study had a higher mean score than the female students in both mathematics and science for each year studied, however, the male students who attended the public, co-educational school used in the pilot study had a lower mean score than the female students in both mathematics and science for each year of the study. Based upon the data of the male students, teaching methods altered to benefit female students could not explain why female students at a public, co-educational school outscored female students who attended a public, single-gender school on the Georgia CRCT in mathematics and science.

Finally, school environment may be a factor that contributed to the data. Different schools commonly have different standards and different resources that are acquired over time and that lead to a better caliber of students. Although the schools studied were located within close geographic proximity to one another, it is possible that the public, co-educational schools had better resources and hence better students since the public, single-gender schools are fairly new schools.

Despite the mixed results of this study, it is still sufficient. Modern studies on the effectiveness of single-gender education, including this current study, have yielded inconclusive or mixed results. If all modern studies are coming up with inconclusive data, then it could be argued that there is no evidence to support the continuation of public, single-gender schools at least for the use of mainstream education. Public, single-gender schools may still be effective due to personal preference or to address issues aside from improved academic achievement for female students, however, at some point inconclusive or mixed data must be interpreted to mean that there is not empirical support for the growth of public, single-gender schools.

Limitations of the Study

This study had several limitations attributable to extraneous variables which could not be controlled. Whenever a researcher works with groups of human subjects especially in a study of academia, it is impossible to make the participants of each group identical. Each human subject brings his or her own unique characteristics to the group which cannot be mimicked. Some students, for example, naturally have a higher or lower intelligence, some may suffer from learning disabilities and some students simply do not perform well on standardized tests. Because the identity of the test subjects is unknown it is impossible to identify with certainty if any of these extraneous variables existed. Extraneous variables which could not be controlled existed within the school environment as well such as the experience of the teachers, the teaching methods used in the classroom and the general resources available in differing school systems. This study, also, was not be able to account for the fact that the students chose to enroll in a public,

single-gender school. There is no random assignment of the students. The limitations of this study are not unique to this study, but rather similar limitations exist in all of the modern day studies over single-gender education (Bradley, 2009). Regardless of its limitations, this study was significant, because it created new research to be used in the debate over the use of federal funding under the new Title IX regulations.

Recommendations for Further Study

Despite the ability to add this study to the growing list of studies that have reviewed the effectiveness of single-gender schools worldwide, more studies on this issue are needed especially if scholars continue to advocate for single-gender schools as the standard of mainstream education. Although there has been an emergence of new data supporting the biological differences between male and female students, empirical data supporting the effectiveness of single-gender schools are still lacking. Ideally, future studies would be commissioned by local school systems so that students could be randomly assigned to either a single-gender or co-educational school. Random assignment of students to a single-gender school in the United States would be in violation of the Title IX requirement that single-gender education options be voluntary; therefore, the same extraneous variables that limited this study will continue to limit future studies.

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Appendix A

The University of Georgia

Phone 706-542-3199

Office of the Vice President for Research
Human Subjects Office

Fax 706-542-3660

NOT HUMAN RESEARCH DETERMINATION

August 21, 2015

Dear Robert Branch:

The University of Georgia Institutional Review Board (IRB) reviewed the following protocol on 8/21/2015:

Type of Review:	Initial Study
Title of Study:	A Study of Female Academic Performance in Mathematics and Sciences Courses in Single-Gender Public Schools
Investigator:	ROBERT Branch
IRB ID:	STUDY00002435
Funding:	None
Grant ID:	None

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations because it is limited to the analysis of existing publicly available data that are not individually identifiable and were not collected specifically for the currently proposed project.

University of Georgia (UGA) IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human subjects, please submit a new request to the IRB for a determination.

Sincerely,

Larry Nackerud, PhD
University of Georgia
Institutional Review Board Chairperson

629 Boyd Graduate Studies Research Center • Athens, Georgia 30602-7411
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