UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

AN EXAMINATION OF THE EFFECTS OF SINGLE-GENDER CLASSES ON READING AND MATHEMATICS ACHIEVEMENT TEST SCORES OF MIDDLE SCHOOL STUDENTS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

MARILYN K. VROOMAN
Norman, Oklahoma
2009

AN EXAMINATION OF THE EFFECTS OF SINGLE-GENDER CLASSES ON READING AND MATHEMATICS ACHIEVEMENT TEST SCORES OF MIDDLE SCHOOL STUDENTS

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF EDUCATION LEADERSHIP
AND POLICY STUDIES

BY

_____
Dr. Jeffrey Maiden, Chair

_____
Dr. Jean Cate

_____
Dr. Gregg Garn

_____
Dr. Frank McQuarrie

_____
Dr. Beverley Romanin

_____
Dr. Courtney Vaughn

ACKNOWLEDGEMENTS

Education is a life-long journey and I am honored to have had the experience in the K-20 Ph.D Cohort. Dr. Maiden, I want to thank you for your willingness to chair my doctoral committee. Thank you for the hours of dedicated time you spent with me to read and edit my drafts. I especially thank you for taking the time to ensure that I understood the various concepts relating to this study. My gratitude extends to all the members of my doctoral committee. Thank you to Dr. Garn for your political insights. Special thanks to Dr. Cate for her broad vision, knowledge and direct input. Dr. McQuarrie's gift of correctness has saved many students. I rested knowing that he would catch my mistakes. Thank you to Dr. Vaughn for helping me 'dig deeper' and for your humor, laughter and vibrant personality. Your presence took the stress away.

A very special thank you goes to Dr. Beverley Romanin for the years of guidance in education. Your dedication to drive from Arkansas to Oklahoma for every committee meeting, joining my "sit in" for getting the data and all the encouragement is beyond words and comprehension. Each member of my doctoral committee has brought an integral part of oversight, compassion and perseverance.

A woman's life is never complete without the support of her soul mate. To my wonderful husband, Mr. Dick Vrooman who has stood beside me always, your nurturing encouragement, strength and love has carried me through this journey. My children, Court, Jillian and Colton are the inspiration behind this work. Three children as different as night and day challenged me to take a look at why boys and girls are so different. My vision is for all children to see that nothing is impossible.

There is a gospel song that says, “Nothing is impossible if you put your trust in God.” The words of this song sing so true, because without God I would not be where I am today. My trust and faith in His direction has been my wagon. The little red wagon has become a symbol for me through this educational journey, for some days I carry others and some days others carry me. To the precious students at Roosevelt Middle School, you have been my source of joy for the past eight years. Thank you for your times of patience challenges and love. Thank you for all the days you pushed my wagon along. May the part of me I shared with you be as inspirational as the part of you that was shared with me. Thank you to everyone that has pulled me along in my little red wagon toward success.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Educational strategies begin with student achievement in mind. Over time these strategies change to include new scientific information and sometimes change to include past practices. This quantitative research study incorporates both elements of change. As neuroscience explores the brain and its functions, a new look is given to the learning strategies that capsulate from scientific findings on how the brain works to find meaning from new information. It also encompasses the gender differences found in the functions of the brain and its overall effect on learning. This information in addition to the old practice of educating students based on gender provides a new context for educating students in a changing world.

The historical background and literature review look at changes and legislative barriers that moved education away from single-gender education. It also outlines the controversial practice as seen in the past context and as seen currently through various research studies. Research concerns on differentiated learning styles of students based on gender are discussed thoroughly and suggestions for practice are included. Due to a limited number of studies in the United States, studies from other countries have been examined

This study utilizes the brain-based learning theory to embed learning strategies into single-gender classroom settings within a co-education school and compares its findings to two other traditional co-education classroom schools. The findings are derived from analyzing six factorial analyses of covariance on three years of middle school student test scores for years 2006, 2007 and 2008, and grades six, seven and eight. Descriptive statistics are included in this study. After controlling for full academic year

(FAY) students, students that have a previous grade's post-test score, gender and grade level, there were significant findings in single-gender school (group) in mathematics for all three grades. There were no significant findings for subgroups in mathematics. There were no significant findings for any group or subgroups in reading.

Trends in student achievement were found within the schools under research and the state reporting data. These trends open another area of concern for student achievement and are recommended for future study. Future research is suggested to determine significant differences in school and classroom environments due to single-gender configurations, including discipline, teacher and student attitudes and parental involvement. A plethora of quantitative and qualitative studies can be added to the current body of knowledge based on the practice of brain-based learning and single-gender teaching.

CHAPTER 1

INTRODUCTION

Historical Influences in Single-Gender Education

History often repeats itself as is seen in the debate with single-gender education. It is imperative that we learn from past arbitrations and avoid inequalities as in the case of single-gender education and the passage of Title IX in 1972. Although single-gender education in the United States has roots dating back to the 1800s, the educational purpose had very specific objectives. Female students were educated to fulfill their social roles and the curriculum consisted of subjects such as sewing and household management; while male students were educated in the academic subjects and expected to serve a position in society (Streitmatter, 1999). During the 19th century co-education became a heated debate and resulted in needed reform. By 1900 all but two percent of the nation's public schools were co-education (Lee & Marks, 1992).

In 1972, the passage of Title IX as part of the Educational Amendment Act put the focus of education on all students having access to participation in all categories of education, disallowing discrimination based on gender in public schools (Streitmatter, 1999). The thrust for equal education came from women's rights activists claiming that the education female students were receiving was of poor quality compared to the education received by male students. According to Lee and Marks (1992) public schooling became co-education to offset the segregation of sex in the workplace. The role of education serves to prepare students for the workplace; however, there is still a lack of equality in professional roles.

Like most philosophies surrounding educational issues, single-gender schooling purports a variety of views. For centuries private and parochial schools have implemented single-gender educational forums. Despite the limitations of Title IX, some public schools continue to offer single-gender classes by balancing the opportunities for males and females (Gillis, 2005). In 1976, the United States Supreme Court allowed the Philadelphia School District, under the Equal Protection Clause, to provide two duplicate single-gender high schools in addition to their co-education high schools (*Vorcheimer v. School District of Philadelphia*, 1976). As the women's movement advanced, public schools continued to educate boys and girls together. Title IX of the Education Amendments of 1972 prohibited discrimination on the basis of gender in educational programs and activities that received federal financial assistance. The regulation stated that "…no person in the United States, on the basis of gender, can be excluded from participation under any education program or activity receiving federal financial assistance" (20 U.S.C. 1681, subpart D, §1211.400 (a), as cited in the Federal Register, 2002, p. 31098). *A Nation at Risk* was one of the first nationally recognized reports that found the educational foundations of American society were being eroded by a rising tide of mediocrity that was threatening our very future as a Nation and a people (National Commission on Excellence in Education, 1983).

Title IX has had its share of challenges in the court system. There is the notorious case of the Virginia Military Institute (VMI), a state sponsored male-only military college that was challenged for violating the Equal Protection Clause (Salomone, 2003). Despite a very debated and contentious court battle, the United States Supreme Court ruled that

the VMI and its nearby Mary Baldwin College were not comparable in their educational experiences and therefore VMI could not base admissions on gender (Streitmatter, 1999).

United States Supreme Court Justice Ruth Ginsberg wrote her statement of finding to distinguish a balance between absolute gender equality or equal treatment and the idea that women need to be accommodated for different educational needs (Salomone, 2003). In Justice Ginsberg's landmark opinion she states, "Inherent differences between men and women" are "cause for celebration, but not for the denigration of members of either gender or for artificial constraints on an individual's opportunity" (*United States v. Virginia*, 1996, p. 558). Justice Ginsberg acknowledged both the reality of difference and its potentially harmful misapplication. Officially recognized distinctions traditionally had placed women in a less advantageous position in relation to men, while inherent differences could be misapplied to artificially constrain the opportunities of either gender (Salomone, 2003). "Substantial equality," the Court maintained, was preferable to the more differential "substantial comparability" test used by the appeals court (*United States v. Virginia*, 1996, p. 559). There is a migration from equality of the Civil Rights Movement to equity in more recent decades. Chief Justice William Rehnquist voted with the majority and acknowledged that a state may have a valid interest in promoting (single-gender education) because "considerable evidence" demonstrates that it benefits students pedagogically (Salomone, 203, p. 164).

During the 1990s, private independent schools began to implement single-gender schooling and parental groups began to open charter schools. According to Lewin (1999) enrollment in these schools jumped 69%; consequently something was convincing parents with adequate resources that single-gender education was a good investment in

their daughters' futures. Several weeks after the Supreme Court ruled on *United States v. Virginia*, New York City announces the opening of a Young Women's Leadership School, an all-girl's middle school serving inner-city minority students sparing a national debate (Salomone, 2003). The National Organization for Women (NOW) and the American Civil Liberties Union (ACLU) vocalized accusations: single-gender schools smack of benevolent genderism, deny young women and men the interpersonal skills needed to function in the real world, reinforces persistent stereotypes, and serves merely as a short-term political fix that ignores pervasive inequities in the schools (Salomone, 2003). According to Streitmatter (1999)

> Philadelphia High School for Girls and Baltimore's Western High School has remained single-gender since their founding in the 1940's. Although they have been through difficult debates, media attention and criticism, they have maintained a rigorous academic program. The school's supporters maintain that the schools have something no other school can replicate in a co-education setting. Both schools are "first-generation" all girls' schools with history, tradition, and gradual accommodation over a period spanning more than a century and a half. These schools show how ethnicity and class intersect in the lives of inner-city adolescent girls. Because these schools are completely voluntary and not publicly supported, they have an advantage on the negative debate around single-gender schooling. These schools differ from each other in a variety of ways that are not quantifiable, from their curriculum to the instructional materials and approaches used, to their educational philosophy, academic expectations, teacher experience, and overall climate. (p. 20)

A similar phenomenon started taking place among boys' schools, where enrollments have risen 16.6 % over the past decade (NAIS, 2002). Salomone states that "Families, and particularly inner-city minority parents, not unlike their more affluent urban and suburban neighbors, are more than ever looking to exercise greater voice in the education of their children. So far small, but increasing numbers of consumers are choosing single-gender programs for their children" (2003, p. 112). Until recent legislation, private sectors have utilized single-gender schools and some have served as stepping stones to prestigious colleges and universities.

Consequently, there is much more woven into the educational process than just dividing schools by gender. The single-gender configuration of schools is not incidental; however, it is a key ingredient that makes these schools "work" especially, but not exclusively for a specific population of girls, many of whom come burdened with social problems that in other settings too often translate into academic deficits and failure (Streitmatter, 1999, p. 105).

On January 8, 2002 President Bush signed into law the No Child Left Behind Act of 2001 (NCLB), which reauthorized the Elementary and Secondary Act of 1965. Following was Senate Amendment 540 as a subsection of NCLB which provided public schools more options in the education programs that could offer to parents who could not afford private or parochial schools (NCLB, S.540, 2001). From the one room school house to the halls of justice, some parts of education's history have been controversial.

Problem Statement

Generally, student performance and academic achievement in the United States are not reaching the expectation levels as set forth by the federal government under No

Child Left Behind (NCLB) legislation (2001). Furthermore, male students have been falling behind female students academically in reading, while female students continue to lag behind male students in mathematics and science. The achievement gap between males and females has been increasing in recent years (Gambell & Hunter, 1999; Sax, 2005; Tinklin, Croxford, Ducklin & Frame, 2001; Warrington, Younger & Williams, 2000). To inspire schools to close the achievement gaps, policymakers have mandated annual standardized testing and definitive achievement goals (Symonds, 2004). According to Tinklin, Croxford, Ducklin and Frame, "the average levels of academic achievement have increased for both males and females over the past three decades, but the gain in achievement by males has not kept up with that of females" (2001, p. 4). There is evidence of gender differences at all levels of school education. Girls tend to outperform boys throughout primary school in reading (Gurian, 2001).

According to Gambell and Hunter (1999) males seem to do better when they read for information, whereas females perform better on overall reading tasks, especially when they read for personal interest. Middle school students are at the turning point in their lives and it is important that both our girls and our boys have the opportunities to develop fully as individuals (Gurian, 2003). Burke (1989) found that there were general differences in academic performances between boys and girls but suggested more research is needed to understand the reasons for these differences.

This study is founded on the theoretical framework of brain-based education. Jensen (2007) defines brain-based learning as "the understanding and teaching based on what we have learned directly from studying the brain. Brain-based teaching is the application of principles and strategies that appear to be compatible with what we know

about the brain" (p. 5). As the federal government increases high stakes testing, it is imperative that educators take into account all variables that factor into the cause and effect of student achievement outcomes. Therefore, this study will take an inside look into the educational outcomes of single-gender classrooms compared to student outcomes in co-education classrooms.

Statement of Purpose

The purpose of this study is to determine if any significant differences exist in student achievement by implementing single-gender classes in a co-education institution. Effective use of every resource and strategy educators have available is needed to expand the learning opportunities that are offered to students and parents. The intent of this study is to explore the relative effectiveness of single-gender classrooms and add to the current body of knowledge available. A thorough analysis of this research will allow educators at all levels, board members, community, staff and students to review the research findings of a school using single-gender classes and schools using traditional co-education classrooms.

Research Questions

1. Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

2. Are the differences in question 1 related to the gender of the students?

3. Are there statistically significant differences in mathematics test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

4. Are the differences in question 3 related to the gender of the students?

Significance of the study

Educators from all over the United States are looking at options for educational programs that will enhance student achievement and "leave no child behind." There is little evidence from studies in American public schools, either to verify outcomes or to substantiate the need for and public tolerance of single-gender education (Gillis, 2005). Much of the research in the United States was performed in the 1980s and 1990s, as discussed thoroughly in the literature review; however there is a considerable gap in research until 2004. There are currently no studies available that describe teachers that are trained for single-gender classes. A large portion of the more recent research regarding single-gender classes has been done in countries outside the United States.

Limitations of the study

This research is limited to three middle schools within an urban school district. Therefore, the demographic make-up of the students and the population could limit its effectiveness in suburban or rural districts. The gender of the teacher in reference to the gender of students in any specific class is not a factor in this study. Because teachers are often reassigned to teach different grades and subjects from year to year, the relationship

of the teacher's gender to student performance outcomes could not be measured. The results of this study are dependent upon the test score data reported from the State Department of Education (SDE) for each student in the single-gender school; as well as each student in the two co-education schools used in this study. The final results were calculated using six factorial analyses of covariance (ANCOVA), based on the annual Core Curriculum Test (CCT) scores for years 2006, 2007, and 2008; disseminated by the State Department of Education (SDE) and administered by trained test administrators at each school to full academic year (FAY) students and did not include non-full academic year students (NFAY) that had been enrolled less than one full year in the single-gender school or the co-education schools. Due to the high percentage of low socio-economic status (SES) students at the three middle schools used in this study, SES was not identified as a variable being analyzed. The ethnicity make-up of the student population includes a majority of Hispanic students; thus ethnicity was not chosen as a separate variable to be included in the ANCOVAs. This study has been controlled for SES and ethnicity.

Definitions

Co-education classrooms (COC) – are traditional classrooms where boys and girls are given educational instruction together in the same room at the same school (AAUW, 1998; Medin & Medin, 2005; Salomone, 2003).

Sex – the condition of being male or female; gender (Dictionary.com, 2009).

Gender – refers to the biological make-up of an individual person (Gill, 2004; Gurian, 2003; Sax, 2005).

Single-gender classrooms (SGC) – are classrooms that educate only one specific gender at a time. Males are educated with other male students and females are educated with other female students (AAUW, 1998; Medin & Medin, 2005; Salomone, 2003).

Assumptions

1. It is assumed that the returned postcards surveying the parent's opinion of single-gender education were marked and signed by the legal parent or guardian of each postcard referenced.

2. It is assumed that all student data reflect that students were taught using the Priority Academic Student Skills (PASS) curriculum as outlined by the State Department of Education.

3. The test scores collected from the district's data base are accurately computed and correctly reflect the academic achievement of the students.

4. The teachers at the three urban middle schools used in this study are all highly qualified and certified according to the guidelines set forth by the State Department of Education.

5. All students with scores reflected in this research were enrolled in the sixth, seventh, or eighth grade in years 2006, 2007 and 2008.

Overview of Method

This study is a quantitative reflection of ex-post facto data from one urban middle school with students enrolled in single-gender classes in a co-education institution and students from two urban middle schools where students were enrolled in traditional co-education classes. These data were analyzed using specific independent variables and one

dependent variable. Six ANCOVAs were used to determine if there were any significant difference in reading and mathematics achievement for boys and girls educated in single-gender classes and boys and girls educated in co-education classes. These analyses were supplemented with descriptive statistics, including means and standard deviations. The following chapter is a summation of literature characterizing past and current studies surrounding the controversial use of single-gender classes to improve academic achievement.

CHAPTER 2

REVIEW OF THE LITERATURE

Much of the historical awareness of single-gender education surrounds the debated issue of equality. Current research looks for erudition that focuses on the child and the way that each child learns. Although schools are not staffed for one-on-one instruction, there are characteristics based on gender of the student that give us an insight into differentiated instructional strategies for individualized learning. In order to better identify these characteristics, researchers look at how the brain processes information, stores that information and then retrieves it.

Brain-based research has indirectly begun to affect the way teachers conduct their classrooms. Educators are reviewing the new research and applying it to learning processes. These reviewers of research have been studying how the brain processes, stores and retrieves information for many years. This review of literature will address the main structures of the brain and how information is processed and stored. This review of literature will also address the characteristics and research findings that support single-gender education. This review looks at the concerns that advocacy groups, parents and educators have regarding single-gender education and the boundaries set forth by current legislation.

High-stakes testing and accountability outlined in No Child Left Behind (NCLB) is sending educators throughout the United States scrambling for answers to address the achievement gaps between boys and girls. There is a growing frontier around brain-based learning. The findings of scientific researchers are allowing educators to expand teaching and learning strategies into the classroom based on brain differences. It is important to

note that the learning strategies sought to employ in single-gender classrooms or traditional co-education classrooms are not strategies directly from neuroscientists, but strategies identified by educators from the neuroscience research as naturally designed for learning (Jensen, 2008). The differences in the male and female brain could be the answer to the puzzling questions surrounding academic achievement gaps in student learning.

Brain-based Research

Research around brain-based learning is being produced quickly. “The U.S. scientific community declared the 1990’s ‘the decade of the brain’” (Sousa, 1995, p. xiii). Nineteen years later, the brain is still a strong component in education theory and strategy. The theory that brain-based learning is built on is the structure and its function related to learning. Jensen describes brain-based learning in three words: “engagement, strategies and principles. Brain-based education is the engagement of strategies based on principles derived from an understanding of the brain” (2008, p.4). The developers believe as long as the brain is not prohibited from fulfilling its normal processes, learning will occur (On Purpose Associates, 2009).

As technology advances, scientists and researchers have more tools available to study the brain and its functions. Computerized axial tomography (CAT) scanners, positron-emission tomography (PET) scans and magnetic resonance imaging (MRI) are devices in technology that provide different images of the brain and detect different functions. Through the use of these tools scientists are able to see the intensity of brain activity during the learning process. According to Little, Klein, Shobat, McClure and

Thulborn (2004) “the rate of learning can be manipulated by changing task difficulty and by including or excluding feedback” (p. 84).

The effort to maximize a person’s learning potential includes understanding how and where learning takes place. The brain is working constantly even when we are asleep. The images available through modern technology are able to capture this and determine the intensity of a person’s brain activity (Amen, 2005). Scientists in neurobiology and cognitive neuroscience have produced research that helps educators understand how the brain learns. To better understand the concept of brain-based learning one needs to understand the physical characteristics of the brain itself.

The human brain weighs approximately three pounds and consumes about 20 percent of our daily caloric intake (Amen, 2005; Gurian, 2003; Jensen, 1998; Sousa, 1995). Early researchers divided the brain into two hemispheres, right and left. According to James (2007) the brain works the same for both genders with just a few areas of exception. Five different parts of the brain are responsible for specific functions.

The cerebrum is the largest of these sections and controls thinking, speech, memory and muscular movement. This pale gray wrinkled area can be divided into two halves known as the cerebral hemispheres. These two hemispheres are connected by the corpus callosum which houses millions of nerve fibers that bridge communication from one hemisphere to the other (Sousa, 1995). It has often been communicated that left-brained people are predominantly verbal and analytical and right-brained people are associated with artistic and emotional characteristics (Wolfe, 2001).

The left hemisphere processes situations that include spatial and positive emotions. This portion of the brain functions analytically and solves problems by

breaking them apart. The left side of the brain controls the right side of the body and processes auditory and visual stimuli. Individuals with left brain dominance prefers to write and talk, talks to think and learn, looks for differences and is willing to take few risks. Based on these differences, students with left brain dominance respond better to spoken instructions (Amen, 2005).

The right hemisphere is where students that are spatially oriented become creative and responsible. The right side of the brain controls the left side of the body. The kinesthetic learner is often right brain dominant and they solve problems by looking at the whole and by handling objects. Right brain dominance is often spontaneous and individuals let go of their feelings easier. In the classroom, these students prefer to draw and they picture things to think. They look for likenesses in what they are learning and follow written directions best (Wolfe, 2001).

Although there is truth to the right-brain, left-brain dominance, newer research in neuroscience does not apply these labels. “The term scientists now used is ‘relative lateralization’ meaning the brain is designed to process spatially from left to right hemisphere, but it processes time from front to back” (Jensen, 2008, p. 19). In the middle of the brain is the hippocampus, amygdala, thalamus and the hypothalamus. The hippocampus is quite small and plays a major role in converting memory into long term storage. The hippocampus is essential for meaning to occur. Different parts of the brain mature at different times depending on the gender of the individual. It is believed that the hippocampus in females increase in size faster than the males. As the left side of the hippocampus increases, researchers associated this with academic strengths in spelling,

reading and verbal intelligence. An increase in the right side of the hippocampus is associated with academic strength in mathematical calculations (James, 2007).

Rocha, Rocha, Massad and Menezes (2005) performed a study to determine how human mathematic cognitive abilities evolve. In this study, the researchers found that mathematical calculations do not come from one particular place in a person's brain, but from a combination of many parts of the brain working together to solve the problem. This cerebral process involves different types of neurons distributed throughout the brain. Educators can take this information and construct a learning strategy that utilizes the various parts of the brain for mathematical reasoning.

The almond shaped structure attached to the end of the hippocampus called the amygdala is the major contributor to emotions. Educators are finding that student emotions have an important role in cognitive learning (Sousa, 1995). Students that are stressed or their brains are in distress have a hard time using higher order thinking skills and lose their ability to index, store and retrieve information. According to Jensen (2008) "high levels of distress can cause the death of brain cells in the hippocampus – an area critical to specific memory formation. And chronic stress impairs students' ability to sort out what is important and what is not" (p. 45). A study by Yurgelun-Todd, Killgore, and Cintron (2003) found that the increases in the amygdala had connections to strengths in the areas of vocabulary, basic arithmetic and reading single words. As teachers design lessons for classroom learning, consideration can be given to the emotional affect that a lesson can have on its students. Males and females deal with emotional stimuli differently, thus presentation can take this opportunity into the context.

The cerebellum also known as the little brain coordinates all physical movement. The brain stem is the center of the sensory reception and where the heartbeat, digestion, body temperature and respiration are controlled and regulated (Gurian, 2003; James, 2007; Jensen, 1998). Of the 12 body nerves that go to the brain, 11 of them end in the brain stem (Sousa, 1995). Each of these areas have an important function that works together to enhance learning.

Trillions of cells are located in the brain, and these cells are in two types; glial and nerve. The nerve cells or neurons connect to each other as learning occurs. This connection known as synapses continues to make more connections when new learning takes place. The rate that neuron connections occur can vary based on socio-economic status, ethnicity, genetics and environment. The richer the environments the more interconnections can be made which helps learning take place faster and with greater meaning (Sousa, 1995).

However, Gurian (2007) found that the lack of bonding and attachment decreases the number of synapses in key areas of a baby's brain, primarily in the frontal and prefrontal cortex where in later development the control for behavior, ability to learn, aggressiveness, emotional literacy and social success take place. According to James (2005) past research has found that the male brain is larger than the female brain and one explanation is that the male brain contains more brain cells. In another study, Witelson, Glezer, and Kigar (1995) found that females have more brain cells in the area of the brain where language occurs.

Gurian (2007) suggest that it is important to notice differences and understand the inner development of each child. It includes understanding how boys and girls are

‘hardwired’ to problem solve whether they are at home, in the community or at school. Differences also include sensory strengths and weaknesses. In studies of the auditory system, research shows that girls hear two to four times better than boys. One reason for this is that the cochlea in boys is longer which causes the response time to be longer (Don, Ponton, Eggermont, & Masuda, 1993; James, 2007). Ironically, in many classrooms male students are found sitting in the back of the room where sound delivery is at a greater distance.

The sensory system involving vision is another area that boys and girls differ. The retina is thicker in men than women, allowing males to have better vision than females (James, 2007). By adjusting the lighting in the classroom, teachers are able to differentiate the learning environment to accentuate student learning in single-gender classrooms. In general, male students prefer half as much light as female students. The physical feelings involved in the sensory system of touch conclude that males have a higher tolerance for pain and cold (James, 2007; Slocumb, 2004). All of these sensory differences and many more are registered in the brain.

Through the use of PET scans, scientists have discovered the differences in brain activity between males and females. Amen (2005) found that in PET scans the female brain shows more blood flow and activity in a resting state than the male brain in an active state. When the patients are asked to think of different objects or thoughts, different areas of the brain light up during the scan. This gives researchers the opportunity to observe what parts of the brain are associated with various types of learning.

Amen (2005) explains brain development is especially rapid during the first year of life. Brain scans show that by 12 months a baby's brain resembles that of a normal young adult. By age three a baby's brain has formed about one thousand trillion connections – about twice as many as adult brains have. Shucard and Shucard (1990) found that girl babies, three months and six months had a higher response to stimuli on the left hemisphere of the brain, whereas boy babies of the same ages had higher responses to stimuli on the right hemisphere of the brain. Table 1 shows the differences found in boys and girls sensory perception.

Much of the research about brain-based learning indicates male students are already two years behind females in reading and writing when they enter the first grade. By the time they reach the fourth grade, girls score higher on reading test nationally than their male counterparts (Salomone, 2003). According to Sax (2005) after review of report card grades, on average girls outperform boys in school in most subjects in all age groups. However, on academic tests such as the SAT and ACT, males generally outscore the females on these exams (Gurian, 2003).

In order to make a significant impact on student learning, educators are looking at the research knowledge about the human brain and how it works and learns and aligning learning strategies for academic achievement. According to Sousa (2003),

> Brain-compatible curriculum must be based on the way today's student learns best. It should offer variety, challenge, and choices for students, and alternative ways of assessing academic progress. Some of the curriculum methods are authentic problems, simulations, projects, scenarios, service options, concept building, case studies, and performance. (p. 89)

The differences in how boys and girls learn have given some educators new perspectives into single-gender education. As researchers and scientists explore more depth into how the brain processes it provides more knowledge that can be applied to classroom learning. Whether teaching boys and girls separately or teaching them together, new knowledge in brain research supports a variety of new ways to learn.

Learning Styles Based on Gender

"Something scary is happening to boys today" says Sax (2007, cover). As teachers struggle to find ways to motivate students to learn, they are finding a lack of intrinsic motivation. The underachievement of male students is not just isolated to one country, but a mystery around the world (Francis, 1999). In a 12 year longitudinal study by Younger and Warrington (2002) "qualitative analysis of classroom interaction found that boys were more passive and made fewer contributions to the lesson, consequently the teacher had lower expectations of the boys, responding to their responses with occasional surprise and gentle humor" (p. 365).

Many educators are puzzled by the trend in lower achievements and have started looking at brain-based learning strategies to correct this dilemma. Brain-based learning has identified a plethora of ways that boys and girls learn differently (Gurian, 2001). Research on brain-based studies indicates that the male and female brain process information differently (Sousa, 2006). According to Slocumb (2004) "That guy thing is really a brain thing. The male brain is figured completely different from the female brain and that is rarely taken into account in personal relationships, parenting, or in the classroom" (p. 13). According to Sax (2005), "there are fundamental, hard-wired,

Table 1

Differences in Sensory Perception

Sensory	Girls	Boys
Auditory	Hear 2-4 times better than boys Girls hear softer sounds and higher pitches Girls hearing is sharper	Often sit in the back of the classroom Have a better tolerance for noise Can locate sound better Lose their hearing earlier and it is more profound
Visual	Like bright lighting	See better than girls and like the room to be darker Color blindness is more common The retina is thicker in males
Touch	Associated with emotions	Higher tolerance to pain Higher tolerance to hot and cold
Taste and Smell	More sensitive to taste and smell More accurate in identifying tastes and smells	
Brain Activity	Female brain at rest is more active than the male brain at optimal performance.	Male brain goes into a rest state after 10 minutes of lecture.
Verbal Skills	Talk sooner Speech is clearer sooner Better in spelling Better neural connectivity	More direct neural connectivity Suffer more cases of dyslexia
Spatial	Equal to boys in spatial visualization Better at perceptual speed	Clearer in mental rotation of objects Slightly better at spatial perception Better at spatiotemporal tasks
Special Education	23%	77%
Developmental Differences	Talk earlier Develop fine motor earlier First to develop their hippocampi Cognitively more ready to start school Under stress, they use social support	Under stress, they stand and defend Develop gross motor skills before fine motor skills Better at remembering facts Utilize fight or flight response from an increase in testosterone

(Adapted from *Teaching the Male Brain*, James, 2007)

genetically programmed differences in how boys and girls learn" (as cited by Downs, 2007, p. 20).

Hormones create a big difference in the learning patterns of males and females (Smith, 2002). The different levels of various hormones affect the ways in which males and females approach learning (Gurian, 2001). During conception males and females are determined by their chromosome structure; males receive one X and one Y chromosome and females receive two X chromosomes. Research has also shown that the male brain material is coded by the Y chromosome and the female brain is coded by the X chromosome; thus the brain material is genetically programmed (Sax, 2005). Because of these physiological factors as well as others, educators are exploring their options in the brain differences of males and females and to identify what learning strategies students would benefit from most.

Sousa (2006) indicates that in overall cognitive performance there is no significant difference between the male and female brain. However, when specific skills are identified significant differences can be found. Spatial skills are the strongest male advantage, where language use is the strongest female advantage (James, 2007). Developmental time tables are different for males and females. According to Sax (2005) the area of the brain that involves language and fine motor skills develops as much as six years earlier in females than males, but the area of the brain that involves targeting and spatial memory matures about four years earlier in males than females. Despite these broad differences in development we continue to educate boys and girls together according to birthdates.

As educators look at the navigational strategies males and females use, males look toward geometric cues where females rely most on landmarks. When stress is present, the males go toward the fight or flight response (assertiveness) and females often tend and befriend (nurturing). As a society, changes in nature have given way to individual survival and directly and indirectly nurturing the lives of others (Sylwester, 2007). Although according to Smith (2002) "Education must change from relying mostly on social and behavioral science to being based more on biology" (p.18).

Theorists have disagreed on how students learn before the variable of gender ever takes place. "Vygotsky's (1978) notion of the 'zone of proximal development' implies that literacy development is not an individualist, biological maturation phenomenon, but a constructivist and social one, where a student's development depends on his or her interaction with others in different learning environments" (as cited in Gambell & Hunter, 1995, p. 7). Vygotsky's zone of proximal development involves finding the right learning 'zone.' Students should be impelled to have high expectations, but not so high they get discouraged. Social interaction is a vehicle to keep students in the zone (Romanin, 2009).

Many of the previous research studies used socialization as the theoretical framework for single-gender and co-education studies. Socialization is one of the strongest arguments used by opponents of single-gender education. They contend that by separating the genders at school, educators are depriving the students of the ability to learn socialization in preparation for the real world (AAUW, 1992). Although social skills are important to the development of children, the social theory is not a part of this study's framework.

In low socio-economic school communities with high rates of minority students, the achievement gap becomes even wider. Ruby Payne (2003) explains:

> Growing up in an environment that is concrete, emotional, and sensory-based, boys in poverty aren't exposed to language in the same way as middle-class boys. With limited language, a person doesn't have the tools necessary to manipulate and negotiate his/her position in the world. To develop that ability, an abstract structure must be built in the mind. Language and experience builds that structure. (p. 42)

Educators have obstacles to overcome with male students that are already behind in language, compounded by low socio-economic conditions and growing rapidly, are students that qualify as English language learners.

Research has also identified physiological differences in male and female hearing. According to the findings, girls hear two to four times better than boys (Gurian, 2001; James, 2007; Sax, 2005). According to James (2007) hearing is a significant aspect that affects student learning. In the classroom, girls learn better in a quieter environment due to their sharper hearing; while boys work better under the umbrella using louder volume (NASSPE, 2004). To address the auditory issue with students, some schools are investing in surround-sound systems for the classroom. Through a microphone worn by the teacher, the sound is amplified through four speakers strategically placed in the classroom. The lack of words, along with the driving need to compete, the need to be moving around and the inability to articulate feelings, put boys in a difficult situation academically, socially and emotionally. Often, the internal conflicts that arise from these situations cause boys to withdraw and retreat to their rooms (Slocumb, 2004). Based on Slocumb's belief, boys

have a slower processing time, as much as five hours to process emotive data which girls process immediately (2004).

One of the obscurities disturbing educators is why the achievement gap in reading between the boys and girls is increasing. Gambell and Hunter (1999) write that it is in the attitude and purpose for which students read. Male students read for a specific purpose and find very little value in reading. Female students read more for pleasure and enjoy reading. This reference to the various purposes for reading is seen in the choices of reading materials in many classrooms. Dam and Volman (1991) have gone so far as to suggest that based on learning theories, girls learn in an environment where the teacher is predominantly someone they can identify with, their mother. Whereas boys often learn in an environment where the primary figure with whom they identify, their father is absent.

As research continues to enlighten educators as to the importance of various factors that influence a student's intellect, educational institutions can construct learning environments conducive to higher achievement. The knowledge we glean from research on brain-based learning serves to be a great responsibility for educators to manage school factors that will maximize learning achievement for all students (Jenson, 2006). Through extended professional development teachers can learn specific strategies that relate to how boys learn best and girls learn best. These opportunities for students can build self-esteem, confidence in learning and ultimately increase academic achievement.

Differences between Single-gender and Co-education Schooling

"Too many schools are creating an environment that is 'toxic' to boys, turning them off learning and leaving them quite unprepared for adult life" according to Sax (as

cited by Frean, 2008, p.30). Special education referrals and discipline referrals for males are growing in disproportionate numbers (Gurian, 2003). Jimenez and Lockheed (1989) acknowledged in previous studies they have had difficulty in confining the differences between attitudes and cognitive abilities of students in single-gender and co-education schools based on school characteristics only; many outside influences have an impact on student achievement. Dam and Volman (1991) allude to some research findings that inequality is the result of schools ignoring the differences found between boys and girls, but significantly in the differences of attitudes.

Studies of research show that boys are less motivated about school than girls and their attitudes are not as positive as the girls (Francis, 2000; Van Houtte, 2004). In a study by Warrington, Younger and Williams, they conclude the following:

> In general, it is recorded that girls spend more time doing homework, display less disturbing behavior in the classroom and play truant less often. Girls have higher expectations of them and are more enthusiastic about continuing their studies.
>
> Boys take it easier, work less hard and are distracted more quickly. (2000, p. 397)

Peer relationships are influential in academic achievement. Boys are concerned about the perception of groups, while girls tend to develop relationships that are close and personal (Francis, 2000; Gurian, 2003; Sax, 2005; Van Houtte, 2004; Warrington, Younger & Williams, 2000). One study concludes that statistically the effect on academic achievement can be identified by gender-specific study cultures (Tinklin, Croxford, Ducklin & Frame, 2000).

Advocates that argue for single-gender education look at three areas of benefit: the claim that single-gender education benefits all students, the claim that single-gender

education benefits females and the claim of benefit to males. In striving to reach the ideal education educators looks for equity; however when equity is not achieved it reflects bias (Davis, 2000). Feminist groups have claimed bias for years in education and often referring it to "power" in education (Unterhalter, 2007, p. 94).

According to Mael (1998) co-education advocates do not normally contend that co-education is pedagogically superior to single-gender education. However, they do believe that co-education settings mirror the real-world social community. Advocates believe that students are better prepared for society when boys and girls have had the social experiences in school that will sustain them in the future. Some proponents for co-education fear that without male classmates, females will not have the motivation to continue in education and end up in stereotypical careers.

The American Association of University Women (AAUW, 1992) reports a study that shows from pre-school to college, females are neither as supported nor given equal attention like their male counterparts when educated in mixed classrooms. However, Dam and Volman contend "that girls are often forced to adapt to masculine thought patterns because it is the masculine way of learning that is used in education" (1991, p. 317). If this is true, why are boys falling so far behind?

One of the strongest arguments for boys in single-gender classrooms is that co-education settings do not allow for the differences in male maturation, language development and structured discipline. Brain-based research identifies the strengths that male students have in spatial learning. Middle school boys prefer to read periodicals that feature mountain biking, adventure, computer games and outdoor activities (Gambell & Hunter, 1999); however, curriculum writers rarely take this into consideration. Ding and

Harscamp (2006) found a difference in how males and females communicate during problem solving in physics class. Male students would express their opinions directly and the female students would circumvent. Although the female students were more likely to initiate conversation by asking questions, the males began presenting explanations for their portion of discussion.

In 2005, the American Institutes for Research (AIR) for the U.S. Department of Education (USDE) reviewed over 2000 quantitative research studies on single-gender education. AIR narrowed the studies down to 33 studies in which they felt viable information could be relied on. The AIR found some support for the premise that single-gender education is beneficial and only limited findings that single-gender classrooms could be detrimental or that co-education classrooms are more beneficial. The AIR concluded that there was not enough evidence of benefit or harm. Mael (1998) found that advocates of co-education do not claim that it is better for children, their concern surrounds the opportunity for social interaction to occur which better prepares students for the "real world" (p. 103).

Research Studies on Single-Gender Education

Cohen (1998) concludes that boys' low academic achievement is the result of external faults; including the teacher, school, instructional strategies used and how learning is accessed. However, he believes that low academic achievement for females is alleged to be the result of internal inadequacies. According to Francis (1999) boys "laddish" behavior in the classroom is the result of natural innate differences between boys and girls. In her research study, she found that "laddish" behavior is not true in all boys (pp. 358-359).

Jimenez and Lockheed (1998) reveal three reasons that single-gender configuration is more effective than co-education: (1) differences in resources available within the schools; (2) differences in governance and organizational characteristics; and (3) differences in classroom climate for girls. During their study, much of the single-gender schools were private, thus accommodating students from higher socio-economic status which attributed to the difference in resources. Relating learning environment to the success of single-gender configuration for females incorporates classroom interaction and participation. Results indicate that females in single-gender classrooms have more opportunities to learn (p. 118).

The American Association of University Women (1992) found that teachers called on girls less often in the classroom than boys and that the teachers encouraged boys more often than the girls (Gill, 2004). When the U.S. Congress enacted the No Child Left Behind (2001) legislation, all states were required to have a method of accountability by which schools are measured by student performance. The focus of the NCLB reform is reading and mathematics (NCLB, 2001). Accountability for student achievement has created the need for educators at all levels to look at a variety of educational strategies to increase student learning. Much of the arguments for single-gender education are to address the apparent imbalance in subject achievements.

In a pilot study by Gillis (2005), students in a fifth grade elementary school were separated by gender in mathematics class. The purpose of this study was to analyze the impact of student achievement after implementing gender-based instruction in a suburban public elementary school. The measurements included student performance in academic achievement, student attendance and classroom behavior. Gillis (2005) speculates that by

examining the impact of single-gender classrooms on the performance of the fifth-grade students, both school and district-level administrators were able to evaluate the effectiveness of single-gender classrooms and make decisions about the future of the program. In order to answer the two research questions, a mixed methods study was used. A qualitative case study was used to examine the perceptions of the stakeholders involved in the single-gender classroom experience. In an effort to integrate the attitudes and perceptions of teachers, administrators, parents, and students, interviews and observations were collected throughout the year in an investigative case study. A quantitative analysis was used to determine the impact of single-gender classrooms on the performance of the fifth grade mathematics' students. Using a pretest-posttest design, the researcher used the outcome scores from the control group (fourth-grade co-education classes) and outcomes from the treatment group (fifth-grade single-gender classes) and used descriptive statistics to organize and simplify the data, a paired samples *t* test was used to test for statistical significance between fourth and fifth grade scores and male/female discipline referrals.

The findings of this study indicate that students maintained a daily average attendance rate of 96.7% during the fifth grade, which exceeded the districts average by 1.1%. The most significant findings in the study came from the behavior portion of the study. The students in the pilot program were better behaved than all the other schools in the district, based on district discipline data. However, the study found that there was no significant difference in academic achievement from fourth-grade co-education classes to fifth-grade single-gender classes when measured by the students' final averages in five major subject areas. Although the academic achievement data were not significant, the

other areas of study did provide enough evidence that the school's administration decided to continue with the program.

Benjamin Wright, former principal of Thurgood Marshall Elementary School in Seattle, found his students improved significantly when he began offering single-gender classrooms in 2001. The average boys' score in reading went from the 10th percentile to the 6sixth percentile after single-gender education was implemented. Discipline referrals were dramatically reduced from an average of 30 per day to fewer than two per day. Wright also reported an improvement in student morale, the doubling of the number of students wanting to go to college, and a reduction in teen pregnancies (Wright, 2007).

The Moten Elementary School in Washington, D.C., began offering single-gender programs in 2001. Before the implementation of this new program, the performance of the students on the standardized tests at Moten was near the bottom of the district's achievement list. When the results of the Stanford 9 mathematics test came back, the students went from 49% to 88% passing. The reading scores went from 59% to over 92% passing. Disruptive behavior was dramatically reduced. Moten which is located in one of Washington, D.C.'s poorest neighborhoods, ranked with some of the top public and private schools in the district (Gillis, 2005; Single-Gender Education, 2003).

The two research studies from Moten Elementary and Thurgood Marshall do not identify specific strategies used in the classrooms other than separating the students by gender in the classrooms. The literature fails to give depth into the specific ways the teachers address classrooms full of boys or classrooms full of girls. The literature supporting single-gender education includes other factors of consideration that effect

student achievement as in attitude, motivation, teacher gender, student socio-economic status and student ethnicity.

Riordan (1994) claims, single-gender classes provide a better learning environment for "at-risk," urban, African American students, especially male students. In addition they believe that single-gender schooling decreases behavior problems among black students, while enhancing academic motivation. Educators in the United States, especially urban districts have been looking at single-gender classes for African American male students for some time. More than other ethnicities, African American male students have been channeled into special education programs, therefore disallowing these students to take more challenging courses (Murrell, 1992; Singh, Vaught & Mitchell, 1998).

Singh, Vaught and Mitchell's (1998) study involved two classes of single-gender and two co-education classes of fifth-graders. These students were African American, with low socio-economic background and who lived in inner-city. The researchers found that students' grades in the single-gender classes were higher than the students in the co-education classes; however they were not statistically significant. On standardized test there was no difference found. When scores were disaggregated, their study supported other well documented findings that single-gender classes were beneficial for girls-only classes and for African American girls. For African American boys, there was only limited evidence of positive effect for all Black male classes. Although there were no noted harmful effects of the single-gender classes on either, they did have findings that the single-gender configuration of the students had a positive effect on attendance, attitude of the students and their behavior in the classroom.

Critics of single-gender education believe that by separating the genders in class reinforce stereotyping and concentrate more on differences than similarities (Medin & Medin, 2005). When teachers are relating new material to previous experiences, many of student experiences are limited. According to research on classroom environments and interaction, in the co-education classrooms girls have been viewed as having to "act like boys" in order to achieve academic success (AAUW, 1998).

The scholarly literature does not reflect the opinion that girls should act like boys in order to achieve an equitable education. However, the literature does address the facts that boys lag behind girls in language arts areas and girls fall short in the areas of science and mathematics. It is for these reasons that this study is looking at single-gender classrooms to rectify these differences and allow both genders to learn in an environment that is conducive to their needs and learning styles.

Some believe that the academic achievement gap begins in middle school, and widens as students get older (Walkerdine, 1998). Middle school is a tumultuous time in a student's physiological and social development. Gurian (2001) writes that these young people have a natural desire to be with individuals of the same gender as well as individuals from the opposite gender. For these reasons, educators are looking at single-gender education as one possible means of maximizing academic potential.

Although historical research is limited due to legislation, advocacy groups and economics, new research is emerging that shows academic improvement for girls in all-girl classes, especially surrounding the subjects of mathematics and science. Much of the research regarding boys has been mixed in the past, but recent research is showing the same advancements for boys in reading and writing, and in behavior and discipline

(Gurian, 2001). These findings are encouraging to many educators looking for alternative ways of educating students.

Summary

In most of the literature regarding brain differences, use of language, growth and maturation the authors delineate between the male and female brains and the distinction in their functions. With this information in hand, it would be novel to assume that males and females would benefit from individualized instruction based on the differences in learning styles and maturation continuums. However, for years education has combined boys and girls together in the classroom and taught them as if they all learned in the same way.

As educators become alarmed at the low achievement levels of boys and the academic gaps in test scores, an old strategy in educating students is emerging in the public schools. Single-gender classrooms and single-gender schools are emerging all over the United States as well as other countries in an effort to increase academic achievement and narrow the achievement gaps in test scores between boys and girls. Many of the studies reviewed in this chapter are the result of studies done abroad since in the United States public schools were limited by Title IX legislation.

Many issues in education are debated by advocacy groups and single-gender schooling is one of those issues. Many of the quantitative studies done on single-gender classrooms compared to co-education classrooms have not shown any significant difference in the outcomes for boys and girls achievement scores. However, qualitative studies have shown a variety of advantages for girls. Many studies show that boys perform better when girls are present in the classrooms. Part of this is attributed to the

female presence keeping the male students calmer (Younger & Warrington, 2002). But should one gender be responsible for the education of another gender?

The research has shown that the benefits of single-gender classrooms can be associated with the student's ethnicity and social economic status (Sax, 2007). The low socio-economic students as well as the Hispanic and Black youths show more benefit from single-gender education than does the middle- and upper-class students (Gillis, 2005; Sax, 2007). This study encompasses low socio-economic students the majority whom are of color. There has been much controversy in the past regarding the studies done on single-gender education compared to co-educational learning. This study should give additional insight into the significance of single-gender schooling and add to the current literature.

CHAPTER 3

DESIGN

Introduction

Education has often been straddled with the responsibilities of child rearing that once were provided by the family unit. In some schools, school personnel are involved in educating, parenting, counseling, providing nutrition and moral instruction. Education is perceived as a place where children can develop their own unique needs and potential. Despite the challenges of socio-economic status and ethnicity, the school has a strong relationship to the formation of student identity. The framework and subjective theories which underpin the focus of this study begins with brain-based learning.

The review of literature has explored the brain and its functions, the differences in how the brain learns and its relationship to gender differences and the possible affects to academic achievement for students enrolled in single-gender classes and students enrolled in co-education classes. An effort has been made through the implementation of brain-based learning to promote a positive environment for academic success. It is important that the education provided to students be sustainable for future development. The teachers and students depend on a cooperative culture to provide a learning environment that incorporates hands-on learning and student discourse that allows them to experience inquiry.

The evidence found in previous studies has limitations due to past legislation, lack of research in public schools, and limited longitudinal studies. The majority of current research comes from studies of private schools and schools in other countries. In order to understand how gender specific education is sustainable, the outcomes of this study will

depict through quantitative analysis the statistically significant differences in the dependant and independent variables as set forth in this research design. The goal of this study was to glean information to answer four research questions.

1. Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?
    - sixth grade
    - seventh grade
    - eighth grade
2. Are the differences in question 1 related to gender of the students?
3. Are there statistically significant differences in mathematics test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?
    - sixth grade
    - seventh grade
    - eighth grade
4. Are the differences in question 3 related to gender of the students?

This chapter also describes the methods used in this study, a description of the participants, a description of the instrumentation used, the procedures followed in collecting the data, and the statistical methods used in analyzing the data.

Population

The population this study is designed to address is students enrolled in middle school grades. The population sample used in this study is middle school, sixth, seventh

and eighth grade students enrolled in three middle schools within one urban school district. On October 1, 2008 the total middle school enrollment for the district was 6,548. The average class size in the district was 19.4 students. The average population of all students enrolled in this district was 36,318 (District Profile, 2008). The demographic characteristics of this population include students from 59 elementary schools, 10 middle schools, 10 high schools and 6 alternative schools. All of these schools are divided into six feeder regions which are identified by the high schools. The student ethnicity in this urban school district reflects white, 22.5%; Hispanic, 39.1%; African-American, 30.4%; American Indian, 5.3%; and Asian 2.7%. The district's discipline is divided into four categories and the percentage of discipline referrals for each: Elementary schools, 26.6%; Middle schools, 40.4%; High schools, 32%; and Alternative schools, < 1%. Full academic year (FAY) students from three middle schools are encompassed in this study and reflected in the demographics stated above. The average middle school student attendance is 92.2%.

Student Group from Single-Gender Classes

The student group of single-gender classes (SGC) consists of full academic year (FAY) middle school students enrolled in one particular middle school in an urban district. The students at this school create a demographic structure of 70% Hispanic, 14% white, 9% African American, 7% Native American, and 0% Asian. On October 1, 2008, this middle school had an enrollment of 820 students. The mobility rate of the student population was 56%. The school division included 49.8% female students and 50.2% male students. The federal Free Lunch Program was provided for 100 % of the student population. The average attendance rate for these students is 92.0%. English language

learners account for 42.3% of the population and special education supports 17.9% of its students, while gifted and talented equals 6.6%. See Table 4 for demographic comparison.

The professional staff at this urban middle school has one principal, three assistant principals, three counselors, ten special education teachers, five English language learner (ELL) teachers, 12 elective teachers and one national certified technology education teacher, six language arts teachers, six mathematics teachers, six social studies teachers and six science teachers. Two remedial language arts teachers, two remedial mathematics teachers and one national certified media specialist work together as a team to reinforce instruction within the school. The ethnic diversity of this staff includes: 72% white, 10% African American, and 18% Hispanic. There are 41 female teachers and 21 male teachers with a 12 year average length of service. Twenty-six percent of the staff holds degrees above a bachelor's degree.

The core subjects (language arts, mathematics, social studies and science) are taught to boys and girls in single-gender classrooms. Each classroom at this urban middle school is equipped with a surround-sound system. As previously cited in the literature review, boys hear two to four times less than girls (James, 2007; Sax, 2005). Surround-sound systems were installed to eliminate this barrier to learning. Vocational technology education provides instruction for females during first semester classes and males during second semester classes. Students are in mixed-gender classes for physical education, dance, drama, band, vocal music, foreign language, computers, and art and home economics classes. Their lunch time and passing from class to class is in mixed company.

During the spring of 2002, a language arts teacher shared with the principal researcher information from an educational article on testing; that article suggested students should be divided by gender during high stakes testing. The student results inferred that if students were separated by gender in different rooms there was a probability that test scores would increase. It was believed that by separating the genders during testing the students would be able to focus on the tests without distraction from the opposite gender.

In April 2003, counselors at this urban middle school proposed a schedule to test the eighth grade students in separate classrooms and segregated by boys and girls. Students were randomly assigned by gender to their testing sites for the Core Curriculum Test (CCT) reading and mathematics exams. In April 2004, the counselors and teachers working together created a testing schedule that provided students to test separately by gender and also in groupings based on previous benchmark scores. Their objective was to create a testing environment without distractions from the opposite gender and also have students grouped where students would be more willing to take their time. The staff felt that a testing conflict occurs when students watch each other take the test and students who are slower test takers see their peers finish early, the slower students had a propensity to quickly answer without reading the questions.

After general conversations with teachers, counselors and students there was an overwhelming response concurring that students were able to concentrate better and put more effort into the individual tests. The same testing procedure was used in April 2007, when the state began requiring students in grades six, seven and eight to take CCT tests in reading and mathematics. However, it was during the summer of 2004 when the results

of the 2004 spring CCT scores published by the State Department of Education (SDE) were delivered to the individual school districts. Scores were then disseminated among individual school sites.

At this urban middle school, the spring 2004 test scores indicated that eighth grade boys had scored 17% lower in reading achievement than the girls in the same grade. The findings provided an indication that boys taught in the same class as girls at this urban middle school were not achieving the same level of academic success as the girls. The administrators and faculty began looking for identifiable reasons that the boys' reading scores would have a 17% gap compared to the girls' scores in the same grade at the same school. During a search for strategies that would focus on the manner in which boys learn, the disclosure of information in Michael Gurian's book, *Boys and Girls Learn Differently,* suggested that boys and girls should be taught separately because they do not learn in the same way (2001). An effort to find more research that supported the differences in how boys and girls learn produced very few researched findings to support this claim.

In an attempt to make the gains needed to bridge the educational gaps, instructional change needed to take place. In July 2004, a letter was mailed to the 900 parents whose students were pre-enrolled and planned to attend this urban middle school the 2004-2005 school year (Appendix A). The letter outlined concerns with student achievement and requested parental input about having students taught in reading and mathematics classes using a single-gender classroom approach. Included with the letter was a postcard which gave the parent the option to check "yes" or "no" as to their opinion of the single-gender class option (Appendix B). There were 171 postcards

returned and 150 parents marked “yes” and 21 parents marked “no.” According to the central office administration of this urban school district there was enough parental support to forward this project proposal to the school district’s board members (Appendix C). A packet of information, including the parent letter, postcard, articles concerning single-gender education and cover letter (Appendix D) were included. After review by the board members, there was no dissent to the program.

In September 2004, students were randomly assigned by gender to grade level reading, mathematics and vocational technology education classes. Technology education classes are not a part of this study; however, there is considerable concern regarding the limited number of women entering the career area of technology (technology education is not a part of this study because of insufficient measurable data). There are two academic teams of teachers at each of the three grade levels in this urban middle school. One language arts teacher per grade had three classes of boys and two classes of girls, where the other language arts teacher in that same grade had three classes of girls and two classes of boys. The same procedure was used with the mathematics classes. It was important to randomly assign the students by teams so that in the event of a student-teacher conflict, the student could be transferred to the other team of teachers.

Although articles concerning single-gender classrooms had been shared with the teachers, it was not enough to prepare them for the school changes that would occur when the boys and girls were separated in classrooms. In October 2004, the Gurian Institute was contracted to provide the teachers at this urban middle school strategies for teaching boys and girls differently. Two intense days were spent with professional trainers in discussion and practical applications that teachers could use in the classroom to maximize

student achievement based on the differences in how boys and girls learn. When classes resumed, teachers adapted these new learning practices in their classrooms. Positive results ensued to benefit student learning and student behavior. At the end of the 2004-2005 academic years, the results on the 2005 Core Curriculum Test (CCT) showed that the eighth grade boys had narrowed the achievement gap in reading within 9% of the girls and the scores for both boys and girls increased in reading and mathematics.

In preparation for the following academic school year, the faculty decided to offer single-gender classes in all core subjects: language arts, mathematics, science and social studies for sixth, seventh, and eighth grades. Ironically, during the 2004-2005 school year it was noted that the students in co-education classes for social studies and science would separate themselves by gender inside the classroom. The teachers believed that the students at this age felt more comfortable with their same gender peers. The experience from the mathematics and reading classes allowed the students to see and feel the comfort of being together, because the students sat together by gender in other classes.

Although single-gender education has been seen by some researchers as a positive educational strategy in improving student achievement for all students, it does not stand alone. Professional development has been a very important part of educating the students at this urban middle school. Through book studies, contracted professional trainers, horizontal and vertical planning by the teachers, learning specific strategies for how to educate students to address gender differences is an on-going process. At the time of this study, teachers and administrators are still dedicated to professional development as scientists and researchers discover more knowledge pertaining to boys and girls, brain-based learning and other educational strategies that give teachers the advantage of

diversifying their instruction. It is also important to note that in the past five years, no parent or guardian has requested their student be educated in a co-education classroom.

Six years of CCT results for this urban middle school are listed in Table 2. Each year the SDE, using a national testing company, revises the test questions. Although the test questions are similar and apply to the state curriculum standards, the tests are not the same. The number of questions asked on each test has remained the same every year.

Table 2

CCT results for the school with single-gender classrooms

	Grade 6		Grade 7		Grade 8		Total	
School Year	Math	Reading	Math	Reading	Math	Reading	Math	Reading
2002-03	--	--	--	--	35%	32%	35%	32%
2003-04	--	--	--	--	44%	51%	44%	51%
2004-05	--	--	--	--	56%	44%	56%	44%
2005-06	--	--	--	--	67%	56%	67%	56%
2006-07	55%	53%	52%	45%	51%	48%	53%	49%
2007-08	57%	54%	53%	51%	55%	39%	55%	48%

-- denotes that the CCT test was not given to the students during those school years.

Student Group from Co-education classes

The student scores from co-education classes (COC) consist of full academic year (FAY) students from two other middle schools in the same urban school district. For the purpose of identification the schools involved in the study will be known as School A and School B. The demographic make-up of this urban school district includes students from 59 elementary schools, 10 middle schools, 10 high schools and six alternative schools.

All of these schools are divided into six feeder regions which are identified by the high schools they feed into. The student ethnicity in this urban school district reflects white, 22.5%; Hispanic, 39.1%; African-American, 30.4%; American Indian, 5.3%; and Asian 2.7%. Full academic year (FAY) students from three of the 10 middle schools are encompassed in this study and are included in the demographics stated above.
All statistical information was accumulated from the published 2007-2008 Statistical Profile of this urban school district.

Co-education School A (COC-A)

School A is located in the same part of the city as the single-gender school (SGC). This school had an enrollment of 904 students as of October 1, 2008. The average daily attendance rate for these students is 92.1%. The demographic make-up of the student population is 55% Hispanic, 25% white, 12% African American, 7% Native American and 1% Asian. The male students encumber 51.7% of the school's enrollment and the females make up the remaining 48.3%. Students that qualify for free lunch at school A is 96.3%. English language learners enrolled are 25.3% of the population and 19.8% of the population is enrolled in special education. Table 3 represents co-education School A's (COC-A) CCT scores for the past six years.

The professional staff at this urban middle school has one principal, three assistant principals, three counselors, ten special education teachers, two English language learner (ELL) teachers, 12 elective teachers and one national certified teacher, six language arts teachers, six mathematics teachers, six social studies teachers and six science teachers. The ethnic diversity of this staff includes: 22.4% minority. This staff

has an average tenure of 13.3 years and 36.2% of the faculty has a master's degree or above (District Profile, 2008).

Table 3

CCT results for Co-education School A

	Grade 6		Grade 7		Grade 8		Total	
School Year	Math	Reading	Math	Reading	Math	Reading	Math	Reading
2002-03	--	--	--	--	42%	42%	42%	42%
2003-04	--	--	--	--	61%	54%	61%	54%
2004-05	--	--	--	--	61%	54%	61%	54%
2005-06	--	--	--	--	68%	58%	68%	58%
2006-07	63%	55%	52%	58%	63%	59%	60%	57%
2007-08	56%	60%	56%	62%	76%	60%	66%	61%

-- denotes that the CCT test was not given to the students during those years.

Co-education School B (COC-B)

School B is located in the same part of the city as COC-A and the single-gender (SGC) school. School B had an enrollment of 498 students as of October 1, 2008. The average daily attendance rate for these students is 92%. The demographic make-up of the student population is 71% Hispanic, 14% white, 8% African American, 7% Native American and 0% Asian. The school's female population is 45.4% and male population is 54.6%. Students that qualify for free lunch at school B is 99.8%. English language learner population enrolled is 45% of the population and 17.3% of the population is enrolled in special education. Table 4 represents COC-B's CCT scores for the past six years.

The professional staff at this urban middle school has one principal, two assistant principals, two counselors, seven special education teachers, four English language learner (ELL) teachers, 7 elective teachers and one national certified teacher, six language arts teachers, six mathematics teachers, six social studies teachers and six science teachers. The ethnic diversity of this staff includes 30% minority. The average tenure at this urban middle school is 15.8 years and 37.5% of the faculty hold a master's degree or higher.

Table 4

CCT results from Co-education School B

	Grade 6		Grade 7		Grade 8		Total	
School Year	Math	Reading	Math	Reading	Math	Reading	Math	Reading
2002-03	--	--	--	--	33%	32%	33%	32%
2003-04	--	--	--	--	58%	43%	58%	43%
2004-05	--	--	--	--	50%	37%	50%	37%
2005-06	--	--	--	--	51%	37%	51%	37%
2006-07	56%	55%	43%	37%	51%	48%	49%	45%
2007-08	53%	55%	51%	55%	72%	47%	60%	52%

-- denotes that the CCT test was not given to the students during those years.

Table 5

Demographic Comparison Table for District and Three Middle Schools

School Year: 2007-2008

	# of students	White	Hispanic	African American	Native American	Asian	Free Lunch	Male	Female
District	36,318	22.5%	39.1%	30.4%	5.3%	2.7%	85.8%	--	--
SGC	820	14%	70%	9%	7%	0%	100%	50.2%	49.8%
COC-A	904	25.3%	55%	12%	7%	1%	96.3%	51.7%	48.3%
COC-B	498	14%	71%	8%	7%	0%	99.8%	54.6%	45.4%

--unavailable on district profile

Research Design

This is a quantitative study using ex-post facto data from the school district's central office student data base. Six factorial analyses of covariance (ANCOVA) were used to determine if there is any significant difference in achievement for boys and girls educated in single-gender classes and students, boys and girls educated in co-education classes.

Instrumentation

The Core Curriculum Test (CCT) is given to all of the State's students' grades 3-8 and End of Year Instruction (EOI) exams are given for specific subject courses at the high school level each year in April. The purpose of these tests is to evaluate the progress of each student, the school, the district and the state for reporting requirements to the federal government. Regulations from the federal government NCLB requires that all schools, districts and states make Annual Yearly Progress (AYP). Schools, districts and states that fail to make AYP are then mandated by the federal government to provide

interventions each year until the school, district and/or state has made AYP and is removed from the at-risk list (SDE, 2008). In this study, the individual student results, inclusive of full academic year (FAY), gender, grade level and previous grade baseline scores are analyzed with individual students test score results from School A and School B, inclusive of full academic year (FAY), gender, grade level and previous grade baseline scores.

Methods

Permission from the urban school district was obtained following the guidelines specifically set forth in the district's board policy (Appendix E). The Institutional Review Board (IRB) of The University of Oklahoma granted permission to conduct research using ex-post facto data without student identifiers prior to the start of this study (Appendix F). CCT test scores in reading and mathematics for the years 2006, 2007, 2008 were retrieved from the school district's student data base. Six factorial ANCOVAs were performed on students' raw data scores for reading and mathematics to determine if there were any statically significant differences in students (boys and girls) that are educated in single-gender classes and students (boys and girls) that are educated in co-education classes. Data were recorded and stored in a limited access database with only a response number to identify each student's scores used in this study. This method for collection of information was used to preserve the anonymity of the subjects. The data were kept strictly confidential and used solely for the purpose of this research study.

The data retrieved from the student data base in the urban school district were compiled, calculated and analyzed using SSPS (version 17) Statistical Software. The results of this study were made available to the Superintendent of the urban school

district. When this study was completed, the results were submitted in an aggregated format and none of the students' identities could be associated with their test scores.

The SGC group is composed of girls and boys educated in single-gender classrooms in one urban middle school identified by FAY, gender and previous grade CCT scores. The COC group is a combination of students from two schools (COC-A and COC-B) identified by FAY, gender and previous grade CCT scores from this urban school district. The independent variable (X) is identified as X_1- classroom type (SGC or COC); X_2 – gender; X_3 – previous grade baseline scores. The dependent variable is CCT test scores in reading and mathematics for sixth graders, seventh graders and eighth graders for years 2006, 2007, and 2008.

Data Analysis

After the State Department of Education released the 2008 CCT scores to each school district, central office administrators verified the findings and divided the results by individual school. This study incorporates student raw test scores from three middle schools in this urban district. During the school years 2006, 2007 and 2008, all students that were full academic year and had previous year CCT test scores will be entered in to SPSS (version 17) by grade level, gender and school type. Using a univariate general linear model with full factorial interactions, descriptive statistics and the six analyses of covariance (ANCOVA) will be analyzed using the data retrieved from the district's student data base. The Bonferroni method will be included into the analysis to allow confidence intervals to be constructed and provide that the overall confidence coefficient is maintained. Factorial ANCOVAs were used to determine if there is any statistical

significance in CCT test scores from students that are taught in single-gender classrooms and students that are taught in co-education classrooms (Table 6).

Table 6

Descriptive Statistics for Comparison of CCT scores

Variable	Year	SSC Boys $\bar{x}$ and *SD*	COC Boys $\bar{x}$ and *SD*	SSC Girls $\bar{x}$ and *SD*	COC Girls $\bar{x}$ and *SD*
sixth gd. Reading	2006				
	2007				
	2008				
Total					
seventh gd. Reading	2006				
	2007				
	2008				
Total					
eighth gd. Reading	2006				
	2007				
	2008				
Total					
sixth gd. Math	2006				
	2007				
	2008				
Total					
seventh gd. Math	2006				
	2007				
	2008				
Total					
eighth gd. Math	2006				
	2007				
	2008				
Total					

Summary

The methodology described for this study will enable the researcher to analyze student data with an instrument that incorporates a built-in regression model. This chapter

outlines the demographics for the sample population used in this study. The ex-post facto data were obtained from the district's student data base.

The following chapter will include the results of the six ANCOVAs and the descriptive statistics for each of the groups and subgroups analyzed. The results will answer the four research questions that prompted this study. The researchers will then discuss the findings and the implications that resulted.

CHAPTER 4

RESULTS

Introduction

The theory surrounding brain-based learning is a lens that holds promise to the many educators looking to maximize the learning potential of each child. Although brain-based learning has been studied by Jensen and Sousa and other top educators for many years, the scientific research into functions of the brain and what it means for learning are emerging quickly. The findings of brain-based learning research are often controversial (Davis, 2008; Jensen, 2000) as it relates to the art of education. However, there are multiple sources of information that have begun to emerge suggesting there is a relationship in brain-based learning and specific brain differences for males and female (Amen, 2005; Gurian, 2003; Jensen, 1998; Sousa, 1995). This study investigates that relationship by analyzing student test data that relates to four specific research questions.

The following research questions were used to determine if there are any significant relationships in student test scores from students taught in single-gender classrooms and students taught in traditional classrooms:

1. Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?
    - sixth grade
    - seventh grade
    - eighth grade
2. Are the differences in question 1 related to the gender of the students?

3. Are there statistically significant differences in mathematics test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

4. Are the differences in question 3 related to the gender of the students?

This chapter is organized to give insight into similarities and differences in test score results from students that were taught in a school with single-gender classrooms and students that were taught in traditional co-education classrooms. The data were arranged by subjects, reading and mathematics, classroom type, grade levels, gender and years of test results. The subjects reading and mathematics were chosen because the U.S. Department of Education has targeted reading and mathematics with federal funding for increased improvement.

The classroom configuration pertaining to gender is the result of information provided to the teachers that teach in the single-gender classroom school. This information led to in-service training of the faculty to better understand the different ways boys and girls learn and to identify strategies that are designed specifically for boys and strategies designed specifically for girls. The strategies teachers used were developed by educators familiar with the brain function process and findings from neuroscience research. The faculty that teaches single-gender classes continues to annually have staff development in the area of single-gender education and brain-based learning.

Teachers at the two co-education schools may or may not have had in-service training in the ways boys and girls learn differently. They may or may not have accessed information regarding brain-based learning strategies. This study was designed to look at relationships that directly affect student achievement in reading and mathematics based on the practice of single-gender classrooms.

This chapter describes the data retrieved from the student data based in an urban school district. The findings to the four research questions were answered from this data. Permission was obtained from the Superintendent and the process of data collection was approved by the Institutional Review Board (IRB) at the University of Oklahoma. Also included in this chapter are analyses and visuals that represent the data. The software program used to analyze the data was Statistical Product and Service Solutions, formerly known as Statistical Package for the Social Sciences (SPSS 17.0).

Description of the Data

The data sets used for this study were from ex-post facto test data for the Core Curriculum Tests (CCT) for school years 2006, 2007 and 2008. The data were disaggregated to include student scores from three middle schools within an urban school district. From these data, the student test scores were then isolated to include students who were enrolled at least one full academic year (FAY) during the years 2006, 2007 and 2008 at one of the three middle schools under study. These students must have had previous year's CCT scores to be included in the final analyses.

The Core Curriculum Tests (CCT) is given each year to all students enrolled in grades 3-8 in the state. Although students in grades 3, 5 and 8 take tests in four subjects: reading, mathematics, science and social studies; only the raw data scores were used for

grades six, seven and eight in reading and mathematics. The State Department of Education takes the raw test data and sets an index by which student scores are identified. This index is called the Optimized Performance Index (OPI) and is categorized into four descriptive sections: Advanced (Adv), Satisfactory (Sat), Limited Knowledge (LK) and Unsatisfactory (Unsat). Table 7 shows the raw scores converted into cut scores for the optimized performance index.

Table 7

Raw Score Conversion for Reading – 50 questions possible

Year	Grade	Advanced	Satisfactory	Limited Knowledge
2006	6	--	--	--
	7	--	--	--
	8	31	23	19
2007	6	29	21	16
	7	26	24	16
	8	30	24	21
2008	6	33	16	15
	7	25	20	14
	8	27	24	19

-- Field tests were given to sixth & seventh grade students in 2006.

The OPI scores are divided into range scores for each of the four sections and the range varies by testing year, by grade level and by subject tested. Table 8 shows the OPI sections and their range in reading for years 2006, 2007 and 2008 and by grade level.

Table 8

Optimized Performance Index (OPI) for Reading

Year	Grade	Advanced	Satisfactory	Limited Knowledge	Unsatisfactory
2006	6	--	--	--	--
	7	--	--	--	--
	8	990 – 838	837 – 700	699 – 638	637 - 400
2007	6	990 – 831	830 - 700	699 – 656	655 - 400
	7	990 – 808	807 – 700	699 – 641	640 - 400
	8	990 – 838	837 – 700	699 – 638	637 - 400
2008	6	990 – 831	830 - 700	699 – 656	655 - 400
	7	990 – 808	807 – 700	699 – 641	640 - 400
	8	990 – 838	837 – 700	699 – 638	637 - 400

-- Field tests were given to sixth & seventh grade students in 2006.

Students who have an OPI score in the range of advanced and satisfactory have passed the Core Curriculum Test (CCT) for that specific subject that year. Students that score in the range of limited knowledge and unsatisfactory did not pass and are targeted for additional assistance and interventions during the following school year. Tables 9 and 10 show the raw score conversion and the OPI system of measurement for mathematics scores for years 2006, 2007 and 2008 and corresponding grade levels.

Table 9

Raw Score Conversion for Mathematics – 45 questions possibl)

Year	Grade	Advanced	Satisfactory	Limited Knowledge
2006	6	--	--	--
	7	--	--	--
	8	36	23	18
2007	6	32	21	14
	7	34	23	16
	8	37	24	17
2008	6	26	18	16
	7	25	21	17
	8	39	24	17

-- Field tests were given to sixth & seventh grade students in 2006.

In this study, raw test scores were analyzed by grade level. For example, eighth grade raw scores would include full academic year (FAY) students whereas some eighth grade students had three years of single-gender classes (2008); some students had only two years of single-gender classes (2007); and some students had just one year of single-gender classes (2006). At the seventh grade level, raw test scores would include some full academic year (FAY) seventh grade students with two years of single-gender classes (2008); and some seventh grade students with one year of single-gender classes (2007). Seventh grade students in 2006 were given the field test and those scores are not calculated in these results. Findings in the sixth grade would include full academic year (FAY) raw scores from some sixth grade students for the 2007 school year and the 2008

school year. These sixth grade students would only have one year of single-gender classes. Test scores for the 2006 school year were from field tests and not included in this analysis.

Consequently, the findings do not distinguish the exact numbers of students and corresponding number of years that they participated in single-gender classrooms. It does however; include all students that have had at least one or more full academic years (FAY) of single-gender classrooms. The intent of this study was to explore the relative effectiveness of single-gender classrooms and add to the current body of knowledge. A thorough analysis of this research will allow educators at all levels, board members, community, staff and students to review the research findings of a school using single-gender classes compared to schools using traditional co-education classrooms.

Table 10

Optimized Performance Index (OPI) for Mathematics

Year	Grade	Advanced	Satisfactory	Limited Knowledge	Unsatisfactory
2006	6	--	--	--	--
	7	--	--	--	--
	8	990 – 801	800 – 700	699 - 636	635 – 400
2007	6	990 – 779	778 – 700	699 - 652	651 – 400
	7	990 – 783	782 – 700	699 - 656	655 – 400
	8	990 – 801	800 – 700	699 - 636	635 – 400
2008	6	990 – 779	778 – 700	699 - 652	651 – 400
	7	990 – 783	782 – 700	699 - 656	655 – 400
	8	990 – 801	800 – 700	699 - 636	635 – 400

-- Field tests were given to sixth & seventh grade students in 2006.

Results

Once the approvals from the University of Oklahoma Institutional Review Board (IRB) and the school district were complete, a data file was established to retrieve raw test scores from full academic year (FAY) students enrolled in grades six, seven and eight at one middle school using single-gender classrooms and two middle schools using traditional co-education classrooms from the same urban district. The test scores retrieved were the results of the annual state core curriculum tests (CCT) given in years 2006, 2007 and 2008. The student's raw CCT test scores were input into SPSS (version 17) using a General Linear Model (GLM) and six factorial Analyses of Covariance (ANCOVA) statistical procedures. The independent variables (X) were identified as X_1- classroom type (SGC or COC) and X_2 – gender. The dependent variable included CCT test scores in reading and mathematics for sixth graders, seventh graders and eighth graders for years 2006, 2007, and 2008. The previous year baseline score was used as the covariate.

The number of students from the three middle schools used in this study with CCT scores in reading during the years 2006, 2007 and 2008 was 4128 (N=4128). Students excluded from the sample include students without gender identification, students that took a modified CCT test and students that were field tested in the sixth and seventh grades. Students who were missing a previous baseline score in reading or mathematics were not included in the analyses. The number of students with previous baseline scores for reading was 3114 (N=3114). Students that were missing a post data score for reading or mathematics were not included as well. After allowance was made for non-qualifiers, the number of students included in the reading study was 4064 (N=4064). Table 11 includes sample information.

The number of students with previous baseline scores for mathematics was 3175 (N=3175). The number of students with CCT scores in mathematics during the years 2006, 2007 and 2008 was 4080 (N=4080). Students excluded from the sample include students without gender identification, students that took a modified CCT test and students that were field tested in the sixth and seventh grades. Students who were missing a previous baseline score in reading or mathematics were not included in the analyses. Students that were missing a post data score for reading or mathematics were not included as well. Table 11 includes sample information.

Table 11

Student Sample Summary

	Students					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Reading raw score for previous baseline scores	3114	75.4	1014	24.6	4128	100.0
Reading raw score for post data	4064	98.4	64	1.6	4128	100.0
Mathematics raw score for previous baseline scores	3175	76.9	953	23.1	4128	100.0
Mathematics raw score for post data	4080	98.8	48	1.2	4128	100.0

The single-gender classroom school has a sample size of 503 (n=503) in the sixth grade, 479 (n=479) in the seventh grade and 549 (n=549) in the eighth grade. The two middle schools that make up the sample for the co-education classroom has a sample size of 855 (n=855) in the sixth grade, 845 (n=845) in the seventh grade and 897 (n=897) in

the eighth grade. The total sample size were 1358 (N=1358) in the sixth grade, 1324 (N=1324) in the seventh grade and 1446 (N=1446) in the eighth grade. Thus providing a combined sample for all grades and schools of 4128 (N=4128). The student sample size used for each school and grade is described in Table 12.

Table 12

Student Sample Size by School Type

Grade	School type	N
6	SGC	503
	COC	855
	Total	1358
7	SGC	479
	COC	845
	Total	1324
8	SGC	549
	COC	897
	Total	1446

After the student data were disaggregated to only include students with full academic year (FAY) and students that had a previous year CCT score and post CCT score in reading and/or mathematics, analyses were conducted to find the mean and standard deviation of each group based on single-gender classrooms, co-education classrooms, males and females.

In Table 13 the descriptive statistics for female students in single-gender classrooms indicate that in the sixth grade the mean post score in mathematics decreased 1.62 ($\bar{x}$=25.66). However, the post score in reading for the sixth grade increased 1.09 ($\bar{x}$=31.61). In the seventh grade, mathematics and reading the female scores in single-gender classrooms decreased 4.41 ($\bar{x}$=23.31) and 2.31 ($\bar{x}$=29.38) respectively. The

reading score for the eighth grade females increased 1.86 ($\bar{x}$=23.38) and the mathematics post score increased .57 ($\bar{x}$=30.94). When all three grades, sixth, seventh, and eighth, were analyzed together the females in single-gender classrooms decreased their mean in mathematics by 2.05 ($\bar{x}$=24.12), but increased the mean in reading by a slight .22 ($\bar{x}$=30.68).

Table 13

Descriptive Statistics for Single-Gender Classrooms (Females)

Group	Gender	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
1 SGC	Female	6	Mean	27.28	25.66	↓	30.52	31.61	↑
			N	257	259		253	257	
			SD	7.967	7.646		9.376	8.748	
		7	Mean	27.71	23.31	↓	31.69	29.38	↓
			N	178	241		172	241	
			SD	7.528	7.254		8.354	8.184	
		8	Mean	22.81	23.38	↑	29.08	30.94	↑
			N	167	273		166	272	
			SD	7.569	8.136		8.287	8.386	
	Total		Mean	26.17	24.12	↓	30.46	30.68	↑
			N	602	773		591	770	
			SD	7.994	7.773		8.829	8.486	

In Table 14 the descriptive statistics for male students in single-gender classrooms indicates that in the sixth grade the mean post score in mathematics decreased 2.21 ($\bar{x}$=25.87). However, the post score in reading for the sixth grade increased .67 ($\bar{x}$=30.07). In the seventh grade, mathematics and reading the male scores in single-gender classrooms decreased 2.29 ($\bar{x}$=23.31) and 1.05 ($\bar{x}$=28.46) respectively. The reading score for the eighth grade males increased 1.05 ($\bar{x}$=24.79) and the mathematics

post score increased 2.04 ($\bar{x}$=29.38). When all three grades, sixth, seventh, and eighth, were analyzed together the males in single-gender classrooms decreased their mean in mathematics by 1.13 ($\bar{x}$= 24.67), but increased the mean in reading by a slight .19 ($\bar{x}$=29.31).

Table 14

Descriptive Statistics for Single-Gender Classrooms (Males)

SGC Group	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
Male	6	Mean	28.08	25.87	↓	29.40	30.07	↑
		N	239	242		234	242	
		SD	7.673	7.802		8.930	9.040	
	7	Mean	25.60	23.31	↓	29.51	28.46	↓
		N	173	236		171	235	
		SD	7.847	6.316		8.843	8.182	
	8	Mean	22.75	24.79	↑	28.33	29.38	↑
		N	166	269		163	268	
		SD	6.322	7.738		8.668	9.254	
Total		Mean	25.80	24.67	↓	29.12	29.31	↑
		N	578	747		568	745	
		SD	7.675	7.403		8.828	8.870	

In Table 15 the descriptive statistics for male and female students in single-gender classrooms indicate that in the sixth grade the mean post score in mathematics decreased 1.90 ($\bar{x}$=25.76). However, the post score in reading for the sixth grade increased .88 ($\bar{x}$=30.86). In the seventh grade mathematics and reading the male and female scores in single-gender classrooms decreased 3.36 ($\bar{x}$=23.31) and 1.69 ($\bar{x}$=28.92) respectively.

The reading score for the eighth grade males and females increased 1.45 ($\bar{x}$=24.08) and the mathematics post score increased 1.30 ($\bar{x}$=30.16). When all three

grades, sixth, seventh, and eighth, were analyzed together the males and females in single-gender classrooms decreased their mean in mathematics by 1.60 ($\bar{x}$=24.39), but increased the mean in reading by .20 ($\bar{x}$=30.00).

Table 15

Descriptive Statistics for Single-Gender Classrooms (Males and Females)

SGC Group	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
Total	6	Mean	27.66	25.76	↓	29.98	30.86	↑
		N	496	501		487	499	
		SD	7.829	7.714		9.172	8.916	
	7	Mean	26.67	23.31	↓	30.61	28.92	↓
		N	351	477		343	476	
		SD	7.748	6.799		8.657	8.188	
	8	Mean	22.78	24.08	↑	28.71	30.16	↑
		N	333	542		329	540	
		SD	6.965	7.965		8.473	8.854	
	Total	Mean	25.99	24.39	↓	29.80	30.00	↑
		N	1180	1520		1159	1515	
		SD	7.838	7.596		8.850	8.701	

In Table 16 the descriptive statistics for female students in co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 3.34 ($\bar{x}$=24.63). The post score in reading for the sixth grade decreased .54 ($\bar{x}$=31.85). In the seventh grade, mathematics and reading the female scores in co-education classrooms decreased 4.46 ($\bar{x}$=22.01) and 1.46 ($\bar{x}$=29.83) respectively. The reading score for the eighth grade females increased 1.73 ($\bar{x}$=30.90) and the mathematics post score increased 4.23 ($\bar{x}$=25.36). When all three grades, sixth, seventh, and eighth, were analyzed

together the females in co-education classrooms decreased their mean in mathematics by 1.55 ($\bar{x}$=24.04), and decreased the mean in reading by a slight .29 ($\bar{x}$=30.87).

Table 16

Descriptive Statistics for Co-education Classrooms (Females)

				Mathematics Raw Score			Reading Raw Score		
Group	Gender	Grade		(pre)	(post)		(pre)	(post)	
2 COC	Female	6	Mean	27.97	24.63	↓	32.39	31.85	↓
			N	439	437		434	438	
			SD	7.514	7.676		9.263	9.501	
		7	Mean	26.47	22.01	↓	31.29	29.83	↓
			N	301	429		299	429	
			SD	8.107	7.334		9.422	9.104	
		8	Mean	21.13	25.36	↑	29.17	30.90	↑
			N	293	465		286	465	
			SD	6.883	8.190		8.978	9.190	
		Total	Mean	25.59	24.04	↓	31.16	30.87	↓
			N	1033	1331		1019	1332	
			SD	8.047	7.878		9.317	9.295	

In Table 17 the descriptive statistics for male students in co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 3.93 ($\bar{x}$=25.39). The post score in reading for the sixth grade decreased .63 ($\bar{x}$=30.08). In the seventh grade, mathematics and reading the male scores in co-education classrooms decreased 4.08 ($\bar{x}$=22.72) and 2.07 ($\bar{x}$=28.12) respectively. The reading score for the eighth grade males increased 3.13 ($\bar{x}$=31.09) and the mathematics post score increased 3.84 ($\bar{x}$=26.72). When all three grades, sixth, seventh, and eighth, were analyzed together the males in single-gender classrooms decreased their mean in mathematics by 1.76 ($\bar{x}$=24.96), but increased the mean in reading by a slight .02 ($\bar{x}$=29.80).

Table 17

Descriptive Statistics for Co-education Classrooms (Males)

				Mathematics Raw Score			Reading Raw Score		
Group	Gender	Grade		(pre)	(post)		(pre)	(post)	
2 COC	Male	6	Mean	29.32	25.39	↓	30.71	30.08	↓
			N	407	407		397	408	
			SD	8.438	8.388		9.707	10.035	
		7	Mean	26.80	22.72	↓	30.19	28.12	↓
			N	275	404		273	391	
			SD	8.484	7.925		9.379	9.396	
		8	Mean	22.88	26.72	↑	27.96	31.09	↑
			N	280	418		266	418	
			SD	7.974	8.776		9.800	8.996	
		Total	Mean	26.72	24.96	↓	29.78	29.80	↑
			N	962	1229		936	1217	
			SD	8.731	8.531		9.699	9.554	

In Table 18 the descriptive statistics for male and female students in co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 3.62 ($\bar{x}$=25.00). The post score in reading for the sixth grade decreased .59 ($\bar{x}$=31.00). In the seventh grade, mathematics and reading the male and female scores in decreased 4.27 ($\bar{x}$=22.36) and 1.75 ($\bar{x}$=29.02) respectively. The reading score for the eighth grade males and females increased 2.40 ($\bar{x}$=30.99) and the mathematics post score increased 4.02 ($\bar{x}$=26.00). When all three grades, sixth, seventh, and eighth, were analyzed together the males and females in co-education classrooms decreased their mean in mathematics by 1.66 ($\bar{x}$=24.48), and decreased the mean in reading by a slight .14 ($\bar{x}$=30.36).

Table 18

Descriptive Statistics for Co-education Classrooms

			Mathematics Raw Score			Reading Raw Score		
Group	Grade		(pre)	(post)		(pre)	(post)	
2 COC	6	Mean	28.62	25.00	↓	31.59	31.00	↓
		N	846	844		844	831	
		SD	7.996	8.031		8.031	9.509	
	7	Mean	26.63	22.36	↓	30.77	29.02	↓
		N	576	833		833	572	
		SD	8.284	7.630		7.630	9.409	
	8	Mean	21.98	26.00	↑	28.59	30.99	↑
		N	573	883		883	552	
		SD	7.481	8.495		8.495	9.394	
	Total	Mean	26.14	24.48	↓	30.50	30.36	↓
		N	1995	2560		2560	1955	
		SD	8.401	8.210		8.210	9.525	

In Table 19 the descriptive statistics for female students in single-gender and co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 2.7 ($\bar{x}$=25.01). However, the post score in reading for the sixth grade increased .06 ($\bar{x}$=31.76). In the seventh grade, mathematics and reading the female scores in single-gender classrooms decreased 4.5 ($\bar{x}$=22.48) and 1.77 ($\bar{x}$=29.67) respectively. The reading score for the eighth grade females increased 1.78 ($\bar{x}$=30.91) and the mathematics post score increased 2.88 ($\bar{x}$=24.62). When all three grades, sixth, seventh, and eighth, were analyzed together the females in single-gender and co-education classrooms decreased their mean in mathematics by 1.73 ($\bar{x}$=24.07), and decreased the mean in reading by a slight .10 ($\bar{x}$=30.80).

Table 19

Descriptive Statistics for Both Single-Gender and Co-education Classrooms (Female)

Groups	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
Total	Female 6	Mean	27.71	25.01	↓	31.70	31.76	↑
		N	696	696		687	695	
		SD	7.686	7.675		9.342	9.224	
	7	Mean	26.93	22.48	↓	31.44	29.67	↓
		N	479	670		471	670	
		SD	7.912	7.327		9.039	8.781	
	8	Mean	21.74	24.62	↑	29.13	30.91	↑
		N	460	738		452	737	
		SD	7.178	8.221		8.721	8.896	
	Total	Mean	25.80	24.07	↓	30.90	30.80	↓
		N	1635	2104		1610	2102	
		SD	8.030	7.838		9.145	9.006	

In Table 20 the descriptive statistics for male students in single-gender and co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 3.29 ($\bar{x}$=25.57). The post score in reading for the sixth grade decreased .15 ($\bar{x}$=30.07). In the seventh grade, mathematics and reading the male scores decreased 3.39 ($\bar{x}$=22.94) and 1.68 ($\bar{x}$=28.25) respectively. The reading score for the eighth grade males increased 2.32 ($\bar{x}$=30.42) and the mathematics post score increased 3.13 ($\bar{x}$=25.96). When all three grades, sixth, seventh, and eighth, were analyzed together the males in single-gender and co-education classrooms decreased their mean in mathematics by 1.53 ($\bar{x}$=24.85), but increased the mean in reading by a slight .08 ($\bar{x}$=29.61).

Table 20

Descriptive Statistics for Single-Gender and Co-education Classrooms (Male)

Groups	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
Male	6	Mean	28.86	25.57	↓	30.22	30.07	↓
		N	646	649		631	650	
		SD	8.179	8.171		9.440	9.669	
	7	Mean	26.33	22.94	↓	29.93	28.25	↓
		N	448	640		444	626	
		SD	8.256	7.373		9.172	8.954	
	8	Mean	22.83	25.96	↑	28.10	30.42	↑
		N	446	687		429	686	
		SD	7.396	8.432		9.377	9.130	
	Total	Mean	26.38	24.85	↓	29.53	29.61	↑
		N	1540	1976		1504	1962	
		SD	8.359	8.123		9.382	9.301	

In Table 21 the descriptive statistics for both single-gender classrooms and co-education classrooms indicates that in the sixth grade the mean post score in mathematics decreased 2.98 ($\bar{x}$=25.28). The post score in reading for the sixth grade decreased .04 ($\bar{x}$=30.95). In the seventh grade, mathematics and reading the scores decreased 3.94 ($\bar{x}$=22.70) and 1.73 ($\bar{x}$=28.98) respectively. The reading score for the eighth grade increased 2.05 ($\bar{x}$=30.68) and the mathematics post score increased 2.99 ($\bar{x}$=25.27). When all three grades, sixth, seventh, and eighth, were analyzed together for both single-gender classrooms and co-education classrooms the mean in mathematics decreased by 1.63 ($\bar{x}$=24.45), and decreased in reading by .01 ($\bar{x}$=30.23).

Table 21

Descriptive Statistics for Single-Gender and Co-education Classrooms

Groups	Grade		Mathematics Raw Score (pre)	Mathematics Raw Score (post)		Reading Raw Score (pre)	Reading Raw Score (post)	
Total	6	Mean	28.26	25.28	↓	30.99	30.95	↓
		N	1342	1345		1318	1345	
		SD	7.945	7.921		9.414	9.476	
	7	Mean	26.64	22.70	↓	30.71	28.98	↓
		N	927	1310		915	1296	
		SD	8.081	7.350		9.130	8.890	
	8	Mean	22.28	25.27	↑	28.63	30.68	↑
		N	906	1425		881	1423	
		SD	7.302	8.347		9.056	9.010	
	Total	Mean	26.08	24.45	↓	30.24	30.23	↓
		N	3175	4080		3114	4064	
		SD	8.195	7.986		9.284	9.167	

After reviewing the descriptive statistics, the mean of the eighth grade post score is never higher than the sixth grade pre-score in mathematics. In reading, the single-gender females, single-gender males and females and the co-education females mean scores were slightly higher in eighth grade post CCT compared to the sixth grade pre-CCT scores. A factorial ANCOVA was utilized to test for statistical significance between the two groups and the two genders. Table 22 describes how the groups and gender are labeled in the following tables and the number of students used in the analyses.

Table 22

Descriptive Statistics Between-Subjects Factors

Grade			Value Label	N
6	Group	1	SGC	484
		2	COC	826
	Gender	F	Female	682
		M	Male	628
7	Group	1	SGC	343
		2	COC	571
	Gender	F	Female	471
		M	Male	443
8	Group	1	SGC	325
		2	COC	545
	Gender	F	Female	445
		M	Male	425

The descriptive statistics between genders at each grade level, sixth, seventh, and eighth, and for both single-gender classrooms and co-education classrooms indicate the females had a higher mean score than their male counterparts. Educators are also concerned about the achievement gaps between males and females. The findings indicate that in the sixth grade single-gender classrooms there is a mean difference of 1.68 ($\bar{x}$=31.08). In the sixth grade co-education classrooms the mean difference is 1.53 ($\bar{x}$=31.29). In seventh grade the mean achievement gap in single-gender classrooms is 1.42 ($\bar{x}$=29.76) and 2.05 ($\bar{x}$=29.87) in co-education classrooms. In the eighth grade calculations the smallest gap is in the co-education classrooms at .66 ($\bar{x}$=30.46) and the single-gender classrooms have a mean difference of 1.60 ($\bar{x}$=29.47). Table 23 shows the mean differences between genders and school type.

Table 23

Descriptive Statistics Reading Raw Score (post)

Grade	Group	Gender	Mean		Std. Deviation	N
6	1 SGC	Female	31.89	↑	8.503	251
		Male	30.21		8.867	233
		Total	31.08		8.712	484
	2 COC	Female	32.02	↑	9.427	431
		Male	30.49		9.815	395
		Total	31.29		9.639	826
	Total	Female	31.97	↑	9.092	682
		Male	30.39		9.468	628
		Total	31.21		9.304	1310
7	1 SGC	Female	30.47	↑	7.886	172
		Male	29.05		7.704	171
		Total	29.76		7.817	343
	2 COC	Female	30.85	↑	8.506	299
		Male	28.80		9.229	272
		Total	29.87		8.909	571
	Total	Female	30.71	↑	8.278	471
		Male	28.90		8.664	443
		Total	29.83		8.511	914
8	1 SGC	Female	30.26	↑	7.750	164
		Male	28.66		8.708	161
		Total	29.47		8.265	325
	2 COC	Female	30.50	↑	8.593	281
		Male	30.42		8.871	264
		Total	30.46		8.721	545
	Total	Female	30.41	↑	8.284	445
		Male	29.75		8.841	425
		Total	30.09		8.562	870

A factorial (ANCOVA) was used to test the main and interaction effects of single-gender classrooms and co-education classrooms and gender on post CCT test scores for years 2006, 2007 and 2008 for students in the sixth, seventh and eighth grades. Previous year CCT scores for each student served as the covariate in this study. Students that did not have a previous year CCT score and/or a post CCT score were eliminated from this study.

In SPSS (version 17) the goal was to analyze scores using a univariate general linear model with full factorial interactions. The Bonferroni method was calculated into the analysis to allow confidence intervals to be constructed and assure that the overall confidence coefficient was maintained. The confidence interval is 99.2%. A *p* –value of .008 was used to decrease the chance for a Type 1 error. This was determined by using the customary alpha level of .05 and dividing it by six. Six represents the number of ANCOVAs to be analyzed with the data. This calculation resulted in .008 to protect against Type I errors.

Results for Research Question 1

Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

Using the ANCOVA to measure for significance difference, Table 24 describes the results of the reading raw scores for sixth, seventh and eighth grades in a single-gender

classroom and co-education classroom as well as by gender. There were no interaction effects of any of the three grade levels. The ANCOVA concludes that in sixth grade reading there is no significant difference (F=5.970, sig=.015) found in the relationship between single-gender classrooms and co-education classrooms. In seventh grade reading there is no significant difference (F=.007, sig=.935) found in the relationship between single-gender classrooms and co-education classrooms. In eighth grade reading there is no significant difference (F=6.842, sig=.009) found in the relationship between single-gender classrooms and co-education classrooms.

Results for Research Question 2

Are the differences in question 1 related to the gender of the students? Table 24 indicates that in sixth grade reading there is no significant difference (F=2.333, sig=.127) between male students and female students. In seventh grade reading there is no significant difference (F=2.373, sig=.124) between male and female students. In eighth grade reading there is no significant difference (F=.072, sig=.788) between male and female students. When between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=.570, sig=.450) for students in the sixth grade. In seventh grade, when between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=3.067, sig=.080). When between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=4.865, sig=.028) for students in the eighth grade. Concluding that in research question 1 and

research question 2 there was no statistically significant difference found in student reading scores.

Educators are also concerned about the achievement gaps between males and females. The findings indicate that in the sixth grade single-gender classrooms there is a mean difference between males and females of .22 ($\bar{x}_{\text{males}}$=25.84, $\bar{x}_{\text{females}}$=25.62). In the sixth grade co-education classrooms the mean difference is .80 ($\bar{x}_{\text{males}}$=25.47, $\bar{x}$=$_{\text{females}}$=24.67). In seventh grade the mean achievement gap in single-gender classrooms is 1.23 ($\bar{x}_{\text{males}}$=23.14, $\bar{x}_{\text{females}}$=24.37) and .30 ($\bar{x}_{\text{males}}$=22.85, $\bar{x}_{\text{females}}$=22.55) in co-education classrooms. In the eighth grade calculations the largest gap is in the co-education classrooms at 1.61 ($\bar{x}_{\text{males}}$=26.56, $\bar{x}_{\text{females}}$=24.95) and the single-gender classrooms have a mean difference of 1.09 ($\bar{x}_{\text{males}}$=22.67, $\bar{x}_{\text{females}}$=21.58). Both groups (SGC and COC) have the males scoring higher than the females. This opposes the view found in the literature review regarding boys falling behind girls in achievement. In the other grades with the exception of seventh grade SGC students, the mean difference is not excessive. Table 26 shows the mean differences between genders and school type.

Table 24

ANCOVA Tests of Between-Subjects Effects Reading Raw Score (post)

Grade	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
6	Corr. Model	56977.853[a]	4	14244.463	329.925	.000
	Intercept	10097.073	1	10097.073	233.865	.000
	Readrspre	56142.765	1	56142.765	1300.359	.000
	Group	257.775	1	257.775	5.970	.015
	Gender	100.720	1	100.720	2.333	.127
	group * gender	24.626	1	24.626	.570	.450
	Error	56343.151	1305	43.175		
	Total	1389526.000	1310			
	Corr. Total	113321.005	1309			
7	Corr. Model	36583.900[c]	4	9145.975	281.304	.000
	Intercept	5540.196	1	5540.196	170.400	.000
	Readrspre	35813.431	1	35813.431	1101.517	.000
	Group	.213	1	.213	.007	.935
	Gender	77.138	1	77.138	2.373	.124
	group * gender	99.707	1	99.707	3.067	.080
	Error	29554.152	909	32.513		
	Total	879524.000	914			
	Corr. Total	66138.053	913			
8	Corr. Model	31087.997[d]	4	7771.999	206.108	.000
	Intercept	9728.181	1	9728.181	257.984	.000
	Readrspre	30680.200	1	30680.200	813.616	.000
	Group	257.995	1	257.995	6.842	.009
	Gender	2.732	1	2.732	.072	.788
	group * gender	183.445	1	183.445	4.865	.028
	Error	32617.829	865	37.708		
	Total	851453.000	870			
	Corr. Total	63705.826	869			

Table 25

Descriptive Statistics Between-Subjects Factors – Mathematics

Grade			Value Label	N
6	Group	1	SGC	494
		2	COC	836
	Gender	F	Female	691
		M	Male	639
7	Group	1	SGC	351
		2	COC	570
	Gender	F	Female	474
		M	Male	447
8	Group	1	SGC	331
		2	COC	564
	Gender	F	Female	454
		M	Male	441

Results for Research Question 3

Are there statistically significant differences in mathematic test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

Table 23 describes the results of the mathematic raw scores for sixth, seventh and eighth grades in a single-gender classroom and co-education classroom and by gender. The ANCOVA concludes that in sixth grade mathematics there is significant difference (F=16.632, sig=.000) found in the relationship between single-gender classrooms and co-education classrooms. In seventh grade mathematics there is significant difference (F=7.817, sig=.005) found in the relationship between single-gender classrooms and co-education classrooms. In eighth grade mathematics there is significant difference (F=121.778, sig=.000) found in the relationship between SGC and COC.

Table 26

Descriptive Statistics Mathematics Raw Score (post)

Grade	Group	Gender	Mean		Std. Deviation	N
6	1 SGC	Female	25.62		7.660	257
		Male	25.84	↑	7.828	237
		Total	25.73		7.734	494
	2 COC	Female	24.67		7.685	434
		Male	25.47	↑	8.408	402
		Total	25.05		8.046	836
	Total	Female	25.02		7.684	691
		Male	25.60	↑	8.193	639
		Total	25.30		7.935	1330
7	1 SGC	Female	24.37	↑	7.207	178
		Male	23.14		6.486	173
		Total	23.76		6.879	351
	2 COC	Female	22.55		7.340	296
		Male	22.85	↑	7.845	274
		Total	22.70		7.582	570
	Total	Female	23.24	↑	7.336	474
		Male	22.96		7.343	447
		Total	23.10		7.336	921
8	1 SGC	Female	21.58		6.958	166
		Male	22.67	↑	7.081	165
		Total	22.12		7.030	331
	2 COC	Female	24.95		7.979	288
		Male	26.56	↑	8.980	276
		Total	25.74		8.514	564
	Total	Female	23.72		7.785	454
		Male	25.10	↑	8.523	441
		Total	24.40		8.182	895

Results for Research Question 4

Are the differences in question 3 related to the gender of the students? Table 27 indicates that in sixth grade mathematics there is no significant difference (F=.502, sig=.479) between male students and female students. In seventh grade mathematics there is no significant difference (F=.042, sig=.838) between male and female students. In eighth grade mathematics there is no significant difference (F=3.148, sig=.076) between male and female students. When between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=.118, sig=.731) for students in the sixth grade. In seventh grade, when between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=.021, sig=.886). When between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference (F=1.102, sig=.294) for students in the eighth grade. Concluding that in research question 3 there is a statistically significant difference between group's single-gender classrooms and co-education classrooms for grades sixth, seventh and eighth. The findings for research question 4 indicate there is no statistically significant difference found in student mathematic scores when calculated by gender and analyzed by group and gender (group*gender).

Table 27

ANCOVA: Tests of Between-Subjects Effects Mathematics Raw Score (post)

Grade	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
6	Corr. Model	40517.850[a]	4	10129.462	310.912	.000
	Intercept	3291.009	1	3291.009	101.014	.000
	Mathrspre	40236.617	1	40236.617	1235.017	.000
	Group	541.855	1	541.855	16.632	.000
	Gender	16.365	1	16.365	.502	.479
	group * gender	3.853	1	3.853	.118	.731
	Error	43168.247	1325	32.580		
	Total	935107.000	1330			
	Corr. Total	83686.097	1329			
7	Corr. Model	21389.851[c]	4	5347.463	174.146	.000
	Intercept	4246.361	1	4246.361	138.288	.000
	mathrspre	20996.848	1	20996.848	683.787	.000
	Group	240.038	1	240.038	7.817	.005
	Gender	1.286	1	1.286	.042	.838
	group * gender	.636	1	.636	.021	.886
	Error	28127.350	916	30.707		
	Total	541106.000	921			
	Corr. Total	49517.201	920			
8	Corr. Model	32860.720[d]	4	8215.180	270.912	.000
	Intercept	3222.284	1	3222.284	106.261	.000
	mathrspre	29671.782	1	29671.782	978.487	.000
	Group	3692.824	1	3692.824	121.778	.000
	Gender	95.451	1	95.451	3.148	.076
	group * gender	33.422	1	33.422	1.102	.294
	Error	26988.476	890	30.324		
	Total	592794.000	895			
	Corr. Total	59849.196	894			

Summary

This chapter has presented the statistical results of a research study conducted in three urban middle schools. The data were analyzed using descriptive statistics and Analysis of Covariance. Included in this chapter are the tables and explanations related to the research questions. The four research questions presented throughout this research have been addressed. The following chapter will address additional research information found while conducting this study and include recommendations for further studies.

CHAPTER 5

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

"A review of the research literature suggests that there is little consensus as to whether the learning of boys and/or girls is supported and developed more in single-gender classes than in mixed-gender classes" (Younger & Warrington, 2002, p. 366). As more educators try to make a case for single-gender education, research studies such as this study add credence to offering single-gender classes for some contexts. Through the implementation of single-gender classes in one urban middle school and comparing student achievement scores from the Core Curriculum Test (CCT) with achievement scores from two comparable urban middle schools in the same district it was determined that there is a statistically significant difference for students as a whole in mathematics.

The theoretical framework presented in Chapter 1 provided new information coming forward from the neurosciences regarding brain-based learning. The learning strategies deducted from brain-based education, the literature review and historical background along with this study's outcomes provide implications and recommendations for future study.

Summary of the study

Chapter 1 of this study included the historical background surrounding single-gender classes, some of the laws pertaining to education, the study's theoretical framework, problem statement, purpose of the study and relevance. The purpose and significance of this study is found in the contributions made to the body of literature involving factors affecting student achievement through learning strategies as they relate

to male and female differences. The result of this research will allow researchers and practitioners to continue probing into the possible outcomes of single-gender education.

Also presented in Chapter 1 were four research questions that guided this study:

1. Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

2. Are the differences in question 1 related to the gender of the students?

3. Are there statistically significant differences in mathematics test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?

- sixth grade
- seventh grade
- eighth grade

4. Are the differences in question 3 related to the gender of the students?

Additional information is needed on specific learning strategies for males and specific learning strategies for females. Insight should be shed on how single-gender classes are implemented. Decisions must be made to determine if some classes should be single-gender classes within a co-education school, all classes should be single-gender within a co-education school, or if the entire school should be all male or all female. The law clearly states that students and parents must be given a choice, and the education

received by boys must be equal to the education received by girls. Justice Ginsberg recognized that women have different educational needs and she acknowledged the reality of the difference (*United States v. Virginia*, 1996).

The literature review in Chapter 2 encompassed four major areas: brain-based learning, learning-styles based on gender, differences between single-gender and co-education schooling, and the prevailing research studies on single-gender education. Due to previous legislation (e.g. Title IX), research in the United States on single-gender classrooms is limited. The research available is primarily from other countries and/or parochial schools. The lens of brain-based education has become more instrumental with the emerging information from neuroscience and neurobiology. However, according to Jensen (2000) "Educators should not run schools solely on the biology of the brain. However, to ignore what we do know about the brain would be irresponsible." (p. 79) Chapter 2 concluded with the thought that two sciences, neuroscience and social science were embarking on a new and revised frontier.

In Chapter 3, a detailed method of study was unveiled to investigate the research questions. The population sample of the study included three urban middle schools. One of these middle schools was practicing single-gender classes in the four core areas: Reading, Mathematics, Social Studies and Science. Two of the middle schools were operating with traditional co-education classes. The student populations were thoroughly explained. The student achievement data from the CCT in 2006, 2007 and 2008 were accessed through the district's central office student database. The processes used for statistical analysis were described and explained.

Chapter 4 described the analysis used to process the student data. Descriptive statistics were used to identify the mean and standard deviation of each group and subgroups. The research questions were explored using six factorial analyses of covariance (ANCOVA) with a Bonferroni test calculated into the analysis to allow confidence intervals to be constructed and assure that the overall confidence coefficient was maintained. The confidence interval is 99.2%. A *p* –value of .008 was used to decrease the potential for a Type I error.

The research questions were answered by the various outcomes of the ANCOVAs and recorded descriptively and in tables by groups and subgroups. Included in Chapter 4 was an explanation of how the State Department of Education computes student's scores and how those scores are converted into a four part index called the Optimal Performance Index (OPI). The cut scores and index were presented for each testing year, by grade level and by subject tested.

Summary of the results

The results of this study indicate that a relationship exist between student achievement scores and single-gender education. The findings of this study show that students taught in a single-gender setting achieve a significant difference in mathematics test scores. However, the findings show that there is no significant difference in students taught in single-gender classes and students taught in co-education classes in regards to reading achievement. Sousa (2006) indicates that in overall cognitive performance there is no significant difference between the male and female brain. A discussion of each research question and findings is discussed.

The first research question asks, “Are there statistically significant differences in reading test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?”

- sixth grade
- seventh grade
- eighth grade

Using the statistical analysis of covariance (ANCOVA) to measure for significance difference, the results of the reading raw scores for sixth, seventh and eighth grades in a single-gender classroom and co-education classroom as well as by gender were not significant. There were no interactive effects of any of the three grade levels.

Research question 2 asks, “Are the differences in question 1 related to the gender of the students?” There were no significant difference found in any of the subgroup for reading and its relationship to gender. Concluding that in research question 1 and research question 2 there was no statistically significant difference found in student reading scores.

Results for question 3: “Are there statistically significant differences in mathematic test scores between students in each of the following grades taught in single-gender classes and students taught in co-education classes?”

- sixth grade
- seventh grade
- eighth grade

Using the statistical analysis of covariance (ANCOVA) to measure for significance difference, results of the mathematic raw scores for sixth, seventh and eighth

grades in a single-gender classroom and co-education classroom as well as by gender are found. The ANCOVA concludes that students in sixth, seventh and eighth grade educated in a single-gender classroom school have a statistically significant relationship in mathematics compared to sixth, seventh and eighth grade students educated in co-education classrooms.

Research question 4 looks at research question 3 and its relationship to the gender of the students. The ANCOVA indicates that there is no significant difference between male students and female students educated in single-gender classrooms or co-education classrooms for all three grade levels. When between-subject effects compared males and females in single-gender classrooms and males and females in co-education classrooms (group*gender) there was no significant difference for students in the sixth, seventh and eighth grades. In research question 3, there is a statistically significant difference between groups' single-gender classrooms and co-education classrooms for grades sixth, seventh and eighth. The findings for research question 4 indicate there is no statistically significant difference found in student mathematic scores when analyzed by gender and analyzed by group and gender (group*gender).

Discussion of the Results

Although there was no significance found for Research question 1 in reading, the fact that 70% of the student population is Hispanic and English language learners could be one reason that there was no significant difference found between single-gender classrooms and co-education classrooms. The original concern that prompted this study was the achievement gap between boys and girls in reading and mathematics. No significance for Research question 2 is a positive indicator for reducing the achievement

gap in reading between genders. If significance had been found between genders, this study would conclude with others that there is concern regarding the achievement gap between boys and girls in reading. The descriptive statistics consistently indicate that the boys' raw test score averages in single-gender and co-education classrooms are lower than girls in reading.

Research question 3 shows a significant difference in mathematics when students are taught in single-gender classrooms compared to students taught in co-education classes. However, when boys and girls were analyzed for an interaction effect a significant difference was not found. Again these results indicate a closing of the achievement gap between genders. The descriptive statistics indicate that the boys are still ahead of the girls in the raw test score averages in mathematics.

Implications for Practice

In accordance with the findings of this study, there are outcomes that indicate students taught in single-gender classes for mathematics produce higher test results as a group in comparison to students taught mathematics in the traditional co-education schools. It may be beneficial to educate boys and girls separately in mathematics classes. Teachers need to realize that intelligence and creativity are separate abilities, and that both can be modified by the environment and schooling (Sousa, 2006).

Historically, boys have achieved better test scores in mathematics than girls. The literature review revealed studies that say different parts of the brain mature at different times based on gender. In this study it is assumed that through teacher training and the application of learning strategies based on gender preference and brain-based research, students in single-gender classes achieved significantly more than students taught in co-

education classes. According to findings in the literature review, girls taught with girls in mathematics could eliminate the stress of boys' presence and their natural abilities to understand spatial and conceptual problem solving that advances their mathematics abilities. It also gives girls the opportunity to 'talk' together through the problem-solving process for better comprehension. Because girls work better in a quieter environment, it also allows girls to learn in a more subdued area for better concentration.

Peer pressure, hormones and self-esteem are factors that play a role in the learning process, especially at the middle school level. The absence of the opposite gender could provide a more conducive environment for learning to occur for both boys and girls. However, is it peer pressure, hormones or self-esteem that creates the outcomes found in the drop in mean averages in the seventh grade? Because there is such a broad span in maturation rates for young adolescents, how can a researcher narrow the cause for the drop in mean averages? Due to the state trend running parallel to the findings in this study, one could assume it is related to the state curriculum and its objectives. Are the state learning objectives written with brain-based learning, maturation continuums and cognitive development in mind? Something is happening in the learning process that has the potential to have a negative effect on student achievement in the high school grades. How do students make up for a drop in test scores?

The gender of the teachers was not factored in this study, but could be a variable in further research. "Teachers try to change the human brain every day. The more they know about how the brain learns the more successful they can be" (Sousa, 2006, p.5). More than just single-gender offerings and specific learning strategies, teachers and administrators should use action research based on data to help them discover what it is

that their kids need to be academically successful. During this time of high stakes testing and federal accountability, educators must not be afraid to try new techniques for structuring the environment, utilizing new research and pioneering new ways that students can learn. Additional studies should be conducted in schools where the concentration of students is not English Language Learners. In a school where student's native language is English, the significance in reading could be substantial for single-gender classrooms.

Recommendations for Further Research

A qualitative design study would offer the researcher the opportunity to survey the teachers and students about what they think the positive and negative results are regarding single-gender classrooms. Students' perceptions regarding the amount of stress that is present in co-education classrooms compared to single-gender classrooms could lend insight into peer pressure and self-esteem issues. If stress has an impact on how the brain learns, and stress is dealt with differently based on gender, it would be important to know if stress is a factor. Does the absence of stress based on gender provide significance for student achievement in mathematics?

In order to pin-point a more defined study based on strategies, it would be advantageous to educators to know exactly which teaching strategies at each school are used with males and which strategies are used with females in mathematics that produce a statistically significant difference in the learning results. Further studies could include variables for lighting, auditory affects and other sensory perceptions. Studies could look at the alpha dominance by gender and the possible effects it has on learning achievement within the classroom setting.

How does a single-gender classroom dynamic effect discipline? The findings in the literature review indicates that although many of the research studies do not show statistical significance in academic achievement, the data revealed that single-gender classrooms has a positive effect on student discipline (Gillis, 2005). How important is discipline in the process of teaching and learning? Further studies are needed to determine the significance of discipline on student learning.

An interesting finding emerged from this study regarding test score data trends. According to the data findings, sixth grade students at the three schools studied come to middle schools with an average mean raw test score in mathematics and reading. Each year an average mean score is determined through the CCT. The results show that the post testing mean decreases below the pre-test mean from the sixth grade. By the end of the eighth grade year, the post-test mean does not exceed the entering pre-test mean raw score. Table 28 reflects these data trends.

The challenge is to discern why all categories of students (SGC, COC, males and females) enter middle school with a higher pre-test average mean in mathematics and leave middle school with a lower post-test mean. In reading, females from SGC increase from sixth grade pre-test score to eighth grade post-test score as well as both (SGC and COC) males and females averaged together, and COC males. The other three categories: SGC males, COC females and COC males decreased in sixth grade pre-test score to eighth grade post-test score.

Table 28

Comparison of Pre-Test and Post-Test Data

			Mathematics		Reading	
Group	Gender	Grade	Pre	Post	Pre	Post
			$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
SGC	Female	6	27.28		30.52	
		8		23.38		30.94
	Males	6	28.08		29.40	
		8		24.79		29.38
	Both	6	27.66		29.98	
		8		24.08		30.16
COC	Female	6	27.97		32.39	
		8		25.36		30.90
	Males	6	29.32		30.71	
		8		26.72		31.09
	Both	6	28.62		31.59	
		8		26.00		30.99

The State Department of Education data show this to be the same trend state-wide (State Department of Education, 2009). Table 29 shows the trend of all students state-wide for years 2006, 2007 and 2008.

Table 29

State Test Score Trends

		Mathematics			Reading		
Year	Grade	N	(pre) $\bar{x}$	(post) $\bar{x}$	N	(pre) $\bar{x}$	(post) $\bar{x}$
2006	6	44,154	29.1		44,037	35.1	
	8	46,408		27.3	46,327		35.9
2007	6	42,057	30.2		41,685	35.0	
	8	42,303		28.0	42,592		37.3
2008	6	41,871	30.0		41,581	36.7	
	8	41,334		28.3	41,343		36.2

Data were extracted from State Department of Education Technical Manuals for 2006, 2007 and 2008.

During this time in our nation where the accountability for student achievement rest in the hands of the teachers and administrators that work with students on a daily basis, it is critical that research continues to uncover important factors that affect student learning. This study should be just one in the continuum of many more to come that deepens the knowledge on single-gender classrooms and brain-based education.

REFERENCES

Amen, D. G. (2005). *Making a good brain great.* New York: Random House.

American Association of University Women (1998). *Gender gaps: Where schools still fail our children*. Washington, DC: AAUW Education Foundation.

American Association of University Women (1992). *How schools shortchange girls*. Washington, DC: AAUW Education Foundation.

Burke, P. J. (1989). Gender identity, gender and school performance. *Social Psychology Quarterly, 52(*2), 159-169. Retrieved June 27, 2008, from http://www.jstor.org/database

Cohen, M. (1998). A habit of healthy idleness: Boys underachievement in historical perspective. In Epstein, D., Elwood, J., Hey, V., & Maw, J. (Eds.) *Failing Boys?* Buckingham: Open University Press.

Creswell, J. (2003). *Research design: Qualitative, quantitative, and mixed method approaches.* Thousand Oaks, CA: Sage Publishing.

Dam, G. T. M. T. & Volman, M. M. L. (1991). Conceptualizing gender differences in educational research: The case of the Netherlands. *British Journal of Sociology of Education, 12(3),* 309-321. Retrieved July 3, 2006, from http://www.jstor.org/database

Davis, K. L. (2000). A case study in gender equity for basic instruction programs. *Physical Educator, 57(1),* Retrieved July 3, 2006, from http://web109.epnet.com.ezproxy1.lib.ou.edu

Dictionary.com (2009) On-line dictionary. Retrieved June 8, 2009, from www.dictionary.com.

Ding, N. & Harskamp, E. (2006). How partner gender influences female students' problem solving in physics education. *Journal of Science Education and Technology*, On-line November 23, 2006. Retrieved June 30, 2008, from http://www.metapress.com.ezproxy1.lib.ou.edu/content/6v5h264038247347/

Don, M., Ponton, C. W., Eggermont, J. J., & Masuda, A. (1993). Gender differences in cochlear response time: An explanation for amplitude differences in unmasked auditory brain-stem response. *Journal of the Acoustical Society of America, 94(4),* pp. 2135-2146. Retrieved July 9, 2007, from www.jstor.com/database

Downs, C. (2007, Spring/Summer). Single-gender class score success in Stetson, *Stetson University Newsletter*. Stetson University, FL: University Press.

Epstein, D., Elwood, J., Hey, V. & Maw, J. (Eds.) (1998). *Failing boys?* Philadelphia: Open University Press.

Federal Register (2002, May 8) *Office for civil rights: Single-gender classes and schools: Guidelines on Title IX requirements: 20 U.S.C. 1681*. Retrieved July 9, 2006. http://www.ed.gov/legislation/FedRegister/proprul/2002-2/050802a.html

Francis, B. (1999). Lads, lasses and (new) labour: 14-16-year-old students' responses to the 'laddish behavior and boys' underachievement' debate. *British Journal of Sociology of Education, 20(3),* pp. 355-371. Retrieved July 3, 2006, from www.jstor.com/database

Francis, B. (2000). *Boys, girls and achievement: Addressing the classroom issues*. New York: Routledge/Falmer.

Frean, A. (2008, January 23). Boys, brains and toxic lessons. *The Times of London, p. 30.*

Gambell, T. J. & Hunter, D. M. (1999, Winter) Rethinking differences in literacy.

Canadian Journal of Education, 21(1), pp. 1-16. Retrieved July 3, 2006. http://links.jstor.org/sici?sici=0380-2361%28199924%2924%3A1%3C1%3ARGDIL%3E2.0.C0%382-G.

Gill, J. (2004). *Beyond the great divide: Co-education or single-gender?* Sydney: University of New South Wales.

Gillis, M. B. (2005).Gender-based education: The pilot year of single-gender classes at a public elementary school. *Unpublished doctoral dissertation*. Mississippi State University, Mississippi. Retrieved June 18, 2008, from www.libraries.ou.edu/database

Gurian, M. (2001). *Boys and girls learn differently.* San Francisco, CA: Jossey-Bass.

Gurian, M. (2007). *Nurture the nature*. San Francisco, CA: Jossey-Bass.

Gurian, M., & Ballew, A. C. (2003). *The boys and girls learn differently: Action guide for teachers.* San Francisco, CA: Jossey-Bass.

Gurian, M., & Stevens, K. (2005). *The minds of boys: Saving our sons from falling behind in school and life.* San Francisco, CA: Jossey-Bass.

Gurian, M., Stevens, K., & King, K. (2008). *Strategies for teaching boys & girls: Secondary level.* San Francisco, CA: Jossey-Bass.

James, A. N. (2007). *Teaching the male brain: How boys think, feel, and learn in school.* Thousand Oaks, CA: Corwin Press.

Jensen, E. (1998). *Teaching with the brain in mind.* Alexandria, VA: ASCD.

Jensen, E. (2000). Brain-based learning: A reality check, *Educational Leadership, 57(7),* pp. 76-80. Retrieved June 13, 2008, from http://web.ebscohost.com/database

Jensen, E. (2006). *Enriching the brain*. San Francisco, CA: Jossey-Bass.

Jensen, E., (2008). *Brain-based learning: The new paradigm of teaching.* (3rd ed.). Thousand Oaks, CA: Corwin Press.

Jimenez, E., & Lockheed, M. E. (1989). Enhancing girls' learning through single-gender education: Evidence and a policy conundrum. *Educational Evaluation and Policy Analysis, 11(2),* pp. 117-142. Retrieved July 3, 2006, from www.jstor.org/database

Lee, V. E., & Marks, H. M. (1992). Who goes where? Choice of single-gender and coeducational independent secondary schools, *Sociology of Education, 65*, pp. 226-253. Retrieved July 3, 2006, from www.jstor.org/database

Lewin, T. (1999). What are little boys made of? *Ms.* Oct.-Nov. pp. 88-91.

Little, D. M., Klein, R., Shobat, D. M., McClure, E. D. & Thulborn, K. R. (2004). Changing patterns of brain activation during category learning revealed by functional MRI (fMRI). *Cognitive Brain Research, 22*, 84-93. Retrieved July 9, 2009, from www.sciencedirect.com/database

Mael, F. A. (1998). Single-gender and coeducational schooling: Relationships to socioemotional and academic development. *Review of Educational Research, 68(2),* pp. 101-129. Retrieved July 3, 2006, from www.jstor.org/database

McFadden, D. (1998). Gender differences in the auditory system. *Developmental Neuropsychology, 14(2/3),* pp. 261-298. Retrieved June 3, 2009, from www.libraries.ou.edu/LORA/database

Medin, J. A. & Medin, A. L. (2005). *Single-gender public schools: Who needs them and why*. Bloomington, IN: Phi Delta Kappa International.

Murrell, P. (1992). Afro centric immersion: Academic and personal development. Perry,

T., & Fraser, J. (Eds). *Freedoms plow: Teaching for a multicultural democracy*. London: Routledge, pp. 92-114.

National Association of Independent Schools (2002). *NAIS Statistics 2002, Vol. 6.* Washington, D. C.: Author. 1425, 10seventh Congress. Retrieved May 9, 2006, from http://www.ed.gov/policy/elsec/leg/esea02/107-110.pdf

National Association of Single Gender Public Education, NASSPE (2004). *Advantages for girls.* Retrieved June 4, 2008, from www.singlegenderschools.org

National Commission on Excellence in Education (1983, April). *A nation at risk: The imperative for educational reform.* Retrieved May 15, 2006, from http://www.ed.gov/pub/NatAtRisk/index.html

No Child Left Behind Act of 2001. Public Law 107-110, January 8, 2002, 115 STAT. *No Child Left Behind Act of 2001*. Senate 540, Retrieved May 9, 2006, from http://www.ed.gov/policy/elsec/reg/edpicks.jhtml?src=ln

On Purpose Associates (2008). *Brained-based learning.* Retrieved Feb. 7, 2009, from http://www.funderstanging.com/content/brain-based-learning.

Payne, R. (2003). *A Framework for Understanding Poverty*. 3rd Ed. Highlands, TX: Aha! Process Publishing.

Riordan, C. (1990). *Girls and boys in school: Together or separate?* New York: Teachers College Press.

Riordan, C. (1994). Single-gender schools: Outcomes for African and Hispanic Americans. *Research in Sociology of Education and Socialization, 10,* pp. 177-205. Retrieved March 17, 2006, from www.libraries.ou.edu/LORA/database

Rocha, F. T., Rocha, A. F., Massad, E. & Menezes, R. (2005). Brain mappings of the arithmetic processing in children and adults. *Cognitive Brain Research, 22,* 359-372. Retrieved July 9, 2009, from www.sciencedirectcom/database

Romanin, B., Education Consultant, Personal Interview. Oklahoma City, OK. March 24, 2009.

Salomone, R. C. (2003). *Same, different, equal: rethinking single-gender schooling*. New Haven: Yale University Press.

Sax, L. (2005). *Why gender matters: What parents and teachers need to know about the emerging science of gender differences.* New York: Broadway Books.

Sax, L. (2007). *Boys adrift: The five factors driving the growing epidemic of unmotivated boys and underachieving young men.* New York: Basic Books.

Shucard, J. L., & Shucard, D. W. (1990). Auditory evoked potentials and hand preference in 6-month old infants: Possible gender-related differences in cerebral organization. *Developmental Psychology, 26(6),* pp. 923-930. Retrieved June 8, 2009, from www.libraries.ou.edu/LORA/database

Singh, K., Vaught, C., & Mitchell, E. (1998). Single-gender classes and academic achievement in two inner-city schools. *The Journal of Negro Education. 62(2),* pp. 157-167. Retrieved July 3, 2006, from www.jstor.org/database

Single-gender Education (2003, September). *The Washington Times.* Retrieved July 15, 2008, from http://www.washingtontimes.com/functions/print.php?

Slocumb, P. D. (2004). *Hear our cry: Boys in crisis.* Highlands, TX: Aha! Process Publishing.

Smith, A. (2002). *The brains behind it: New knowledge about the brain and learning.* Strafford, England: Network Educational Press.

Sousa, D. A. (1995). *How the brain learns.* Reston, VA: NASSP.

Sousa, D. A. (2003). *The leadership brain: How to lead today's schools more effectively*. Thousand Oaks, CA: Corwin Press

Sousa, D. A. (2006). *How the brain learns*, 3rd Ed. Thousand Oaks, CA: Corwin Press.

Streitmatter, J. (1999). *For girls only: Making a case for single-sex schooling*. Albany, NY: State University of New York Press.

Sylwester, R. (2007). *The adolescent brain: Reaching for autonomy*. Thousand Oaks, CA: Corwin Press.

Symonds, K. W. (2004). After the test: Closing the achievement gaps with data. *Learning Point Associates.* Naperville, IL: NCREL.

Times Educational Supplement (1998). Failing boys 'public burden number one'. 27 November, p. 1. Retrieved July 3, 2006, from www.jstor.org/database

Tinklin, T., Croxford, L., Ducklin, A. & Frame, B. (2001). *Gender and pupil performance in Scotland's schools*. Centre for Educational Sociology: University of Edinburgh. Retrieved July 30, 2006, from www.ERIC.com/database

United States v. Virginia. No. 94-1941, 518 U.S. 515 (1996). Retrieved November 17, 2007, from www.supreme.justia.com/us/518/515/case.html.

Unterhalter, E. (2007). *Gender, schooling and global social justice.* New York: Routledge.

Van Houtte, M. (2004). Why boys achieve less at school than girls: The difference between boys' and girls' academic culture. *Educational Studies. 30(2),* pp. 159-173. Retrieved July 3, 2006, from www.libraries.ou.edu/LORA/database

Vorchheimer v. School District of Philadelphia. (1976). 532 F.2d 880 3d Cir. 1976, affirmed by an equally divided court, 430 U.S. 703 1977. Retrieved Feb. 10, 2008, from www.ed.gov/caselaw/

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Walkerdine, V. (1998). *Counting girls out: Girls and mathematics*. New York: Routledge.

Warrington, M. & Younger, M. (2001). Single-gender classes and equal opportunities for girls and boys: Perspectives through time from a mixed comprehensive school in England. *Oxford Review of Education. 27*(2), pp. 329-356. Retrieved June 27, 2006, from http://www.jstor.org/database

Warrington, M., Younger, M. & Williams, J. (2000). Student attitudes, image and the gender gap. *British Educational Research Journal, 26*(3), pp. 393-407. Retrieved June 27, 2006, from http://www.jstor.org/database

Wikipedia: The free encyclopedia. (2004, July 22). FL: Wikimedia Foundation, Inc. Retrieved July 10, 2008, from http://www.wikipedia.org

Witelson, S. F., Glezer, I. I., & Kigar, D. L. (1995). Women have greater density of neurons in posterior temporal cortex. *Journal of Neuroscience, 15(5),* pp. 3418-3428. Retrieved June 21, 2009, from www.sciencedirect.com/database

Wolfe, Patricia. (2001). *Brain matters: Translating research into classroom practice.*

Alexandra, VA: ASCD.

Wright, B. J. (2007). *Yes we can if we choose*. Salt Lake City, UT: American Book Publishing.

Younger, M. & Warrington, M. (2002). Single-sex teaching in a co-education comprehensive school in England: An evaluation based upon students' performance and classroom interactions. *British Educational Research Journal, 29(3)*, 353-374. Retrieved July 3, 2006, from http://www.jstor.org/database

Yurgelun-Todd, D. A., Killgore, W. D. S., & Cintron, C. B. (2003). Cognitive correlates of medial temporal lobe development across adolescence: A magnetic resonance imaging study. *Perceptual and Motor Skills, 96*, pp. 3-17. Retrieved July 3, 2006, from www.jstor.org/database

APPENDIX

APPENDIX A – PARENT LETTER

May 10, 2005

Dear Parents,

At _____, we are striving to provide your students with the best education possible and use the best methods to do it. Currently, there is research that indicates students achieve better when they are divided into classes by. We want your opinion. We want to know how you feel about next school year in each grade, splitting up the boys and girls in Language Arts classes, Math classes and Computer classes only. They would still be mixed in Social Studies, Science and all other electives.

Research tells us that girls start falling behind academically in Math and Computers at the middle school level. Since the State Criterion Reference Test puts so much emphasis on Reading and Math scores, it is our opinion that we would like to try to minimize distractions by grouping students by in the above three mentioned classes. In order for us to evaluate your preference in educating your students, please mark the post card and place it in the mail to us as soon as possible.

If you would like to review the research materials, or visit with me about this matter, please do not hesitate to call me at _____.

Sincerely,

Principal

APPENDIX B – RETURN POSTCARD

PARENT RESPONSE

After reading the attached letter, I would like to vote:

☐ YES, I want my student to have some separate classes.

☐ NO, I do not want my student to have some separate classes.

_____ _____

Parent/Guardian Signature Telephone

APPENDIX C – MEMORANDUM TO SUPERINTENDENT

MEMORANDUM

TO: Superintendent

THROUGH: Educational Director

FROM: Middle School Principal

RE: Segregation Proposal

DATE: May 6, 2005

Enclosed please find our plan to implement scheduled classes for the 2005-2006 school year. Our research to maximize student achievement has yielded us a plan to segregate students by in Language Arts, Math and Computer Technology. Our intention is to provide differentiated instruction based on research methods that capitalize on learning modalities for specific classrooms. We believe that through staff development, student centered master schedule, strong instructional leadership and a collaborative focus with the parents, this environment will not only increase academic student achievement, but will increase the internal student purpose to strive for life-long learning.

Also included is a copy of the parent letter that will be in English and Spanish, requesting their input to obtain their support for this approach in their student's education. A postage paid postcard will be included with the letter for parents to respond. A list of research-based resources used to evaluate this proposal and a copy of Brain-based research information are also included.

Thank you for your review and consideration for this request. Our students deserve the best opportunity for learning and we are striving to achieve that for them.

APPENDIX D – SCHOOL DISTRICT PROPOSAL LETTER

Proposal

Class Specific Segregation

In an effort to maximize every learning opportunity available to students, it is our professional opinion that we need to utilize various research strategies in structuring student classes. Research identifies gaps in the way students learn. We know learning styles must vary because girls hear 2 to 4 times better than boys. In an effort to level the learning field, our Title 1 committee has chosen to purchase and install individual room sound systems that will provide complete room sound through a teacher worn microphone.

Often, teachers must deal with student self-esteem and the way it affects their academic success. A girl will make straight A's, but think she's stupid and feel discouraged; the boy who's barely getting B's, but thinks he's brilliant, consequently, you want to offer a teaching style that motivates and encourages the girls, builds them up, while you give the boys a reality check; make them aware of their position and challenge them to do better. Small group learning works best for girls, while they will naturally break into groups and problem check, boys however, often need structure and prefer formal terms of address.

Best practices for teaching math differ fundamentally between boys and girls. Navigational tasks are handled by completely different areas of the brain in boys and girls. This anatomical difference has major implications for teaching math topics. There is no difference in what boys and girls can learn, just in how they learn best. When teaching literature, emotional activity is processed in completely different areas of the brain in older girls compared to older boys.

Reading fiction, role playing and books on relationships work well with girls, however, boys prefer non-fiction – descriptions of real events or battles, illustrated accounts of the way things work, and books filled with action. Boys do not want to deal with feelings.

The most important factor is the recognition that boys and girls learn differently. There is evidence that single-gender classrooms break down stereotypes. Girls in single-gender educational settings are more likely to take classes in math, science and information technology (computers). Boys however are more likely to pursue interest in art, music, drama and foreign language when grouped homogenously.

Gurian states, "A variety of co-ed schools around the country are using single-classes" (2004). Principal John Michaelson from San Francisco's Marina Middle School reports that parents and students like the program. It's more cohesive and less distracting. His evidence shows that test scores and grades are rising for enrollees in the separate- classrooms and groupings. Virginia has had separate classes since 1994, student's grades rise, especially in math and science. Teachers report fewer discipline problems and more participation from students.

The logic behind separate classes includes hormonal upheaval the middle school student experiences. As these young people battle with the vast degree of difference in maturing, boys are learning to control their gender and aggression, while girls are developing their own complexities of physical and emotional development. During this awkward time, they pick extreme reactions in dealing with problems which affects academic learning stress.

We feel that during this time students need opportunities to learn proper social skills and the ability to interact in a positive way. However, we also realize the need students have to learn in an environment that promotes success without the distractions of differences. Our goal is to allow girls that are not as proficient in math to learn in an environment where the teaching style focuses on the way girls learn best. Boys, otherwise will have the opportunity whose brain systems are not verbal to learn in a classroom environment that does not cause embarrassment or failure. We understand this is not a save all solution, but we feel that it will eliminate many stressors.

For the past two years, we have divided students by as well as, ability and grouped them accordingly for standardized testing. The results were extremely noticeable to everyone. Students worked longer and harder on the tests. Students remarked that they enjoyed the arrangement because there weren't any distractions. One

male student said he did better because he was able to concentrate on his test and not worry about impressing his "girl" in class.

As we have watched student progress over the past few years, and tried a variety of teaching models, our experience and research lends us to believe that with parental and community support, along with effective staff development, this plan will generate increased student learning, increase test scores and promote a positive educational environment.

Resources

American Association of University Women Educational Foundation Publications:

Latinas in School, Angela Ginorio and Michelle Huston; 2001

Beyond the Wars, AAUW Symposium; 2001

Girls in the Middle: Working to succeed in School, Research for Action, Inc.; 1996

Separated by Gender: A critical look at Single-gender education for girls; 1998

Gaps: Where Schools Still Fail Our Children, American Institutes for Research; 1998.

Growing Smart: What's working for girls in school; Univ. of Minnesota, 1995

Boys and Girls Learn Differently! Michael Gurian, Jossey-Bass Publisher; 2001

The Wonder of Boys, Michael Gurian, Jossey-Bass Publisher; 2000

Education Week: March 2, 2005, The Promise and Peril of Single-gender Public Education by Leonard Sax.

March 23, 2005, Report: Boys' and Girls' Well-Being Tracks Closely by Gender Christina A. Samuels

March 24, 2004, Federal Study Examining Single-gender Public Schools by Michelle R. Davis

October 13, 2004, The Persistence of Myths in Math by Rosalind Barnett & Caryl Rivers

October 20, 2004, Number of Single-gender Schools Growing by Tal Barak

March 10, 2004, Rules on Single-gender Education Allow Room to Experiment by Michelle Davis

September 10, 2003, Single-gender Programs for At-Risk Students by Rosemary C. Salomone

May 15, 2002, Department Aims to Promote Single-gender Schools by Michelle R. Davis

www.singlegenderschools.org Why Gender Matters: What Parents and Teachers need to know about the Emerging Science of Gender Differences, Leonard Sax, M.D., Ph.D.

APPENDIX E – SCHOOL DISTRICT LETTER OF APPROVAL FOR STUDY

February 23, 2009

Marilyn Vrooman

RE: Research Study

Dear Marilyn,

In reference to your request for research data, you are granted access to the 5th, sixth, seventh, and eighth grade CCT test scores for Reading and Mathematics from the public school district's data base. In addition to the test score data, you may also access the disciplinary records. I understand that this is a longitudinal study from 2002 through 2008 conducted through the University. It is understood that the student data is without identifiers will be matched through randomized sample from other public middle school students for studying achievement gaps. This information will be supplied without identifiers for use in your research project.

I appreciate your interest in student achievement and hope that your study will yield outcomes that we can use to increase student performance. Please contact me at Planning, Research and Evaluation Department for access to the information you need.

Sincerely,

Director
Planning, Research and Evaluation

APPENDIX F – IRB APPROVAL

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

IRB Number: 12505
Category: 4
Approval Date: March 23, 2009

March 23, 2009

Marilyn Vrooman
Education Admin Curriculum & Supervision
6405 Gaelic Glen Drive
OKC, OK 73142

Dear Ms. Vrooman:

RE: Eliminating Achievement Gaps with Single-Sex Classes

On behalf of the Institutional Review Board (IRB), I have reviewed the above-referenced research project and determined that it meets the criteria in 45 CFR 46, as amended, for exemption from IRB review. You may proceed with the research as proposed. Please note that any changes in the protocol will need to be submitted to the IRB for review as changes could affect this determination of exempt status. Also note that you should notify the IRB office when this project is completed, so we can remove it from our files.

If you have any questions or need additional information, please do not hesitate to call the IRB office at (405) 325-8110 or send an email to irb@ou.edu.

Cordially,

Lynn Devenport, Ph.D.
Chair, Institutional Review Board