AN EXPLORATION OF GENDER DIFFERENCES IN SEVENTH-GRADE SINGLE-SEX MATHEMATICS CLASSROOMS IN A CO-EDUCATIONAL PUBLIC SCHOOL

by

Debra Ann Rohn

A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Curriculum and Instruction

Charlotte

2014

Approved by:

____
Dr. Jae Hoon Lim

____
Dr. Jeong-Lim Chae

____
Dr. Victor Cifarelli

____
Dr. Teresa Scheid

ABSTRACT

DEBRA ANN ROHN. An exploration of gender differences in seventh-grade single-sex mathematics classrooms in a co-educational public school. (Under the direction of DR. JAE HOON LIM and DR. JEONG-LIM CHAE)

The purpose of this exploratory case study was to examine the learning experiences of students enrolled in an all-girls and all-boys math class. Forty-nine (22 boys and 27 girls) seventh-grade students from a rural co-educational public middle school in the southeastern United States participated in the study. Seven different types of data were collected: student interviews, teacher's reflective journal, post-lesson surveys, students' reflective journals, classroom observations, student attitude surveys, and student work samples. The classroom interactions were analyzed focusing on how the two different pedagogical approaches of cooperative and competitive learning contexts shape the cognitive, psychological, and social aspects of students learning mathematics in the two single-sex classes. There were five major findings that emerged: gender differences in group cohesion, gender differences in types of motivation, different patterns of engagement, inclusion and exclusion of a group member, and stress management in individual competitions. These findings also demonstrated the emergence of gender differences in competitive groups yet not in cooperative groups. This study concludes with implications for practice, implications for research, implications for teacher education and professional development.

ACKNOWLEDGMENTS

I express my deep-felt gratitude to the many people who have given their support during the development of this dissertation. I am forever grateful to my co-chairs and committee members. To my co-chair, Dr. Jae Hoon Lim: thank you for your patience, guidance, and support through the whole dissertation process; from your qualitative research course to your recommendations and assistance for collecting, analyzing, and writing about data. To my co-chair, Dr. Jeong-Lim Chae: thank you for your continuous encouragement from my first doctoral course through the mathematical aspects of the dissertation. To my committee member and Ph.D. advisor, Dr. Victor Cifarelli: thank you for all your practical advice and leadership through the Ph.D. program, especially during the stressful hurdles. To my committee member, Dr. Teresa Scheid: thank you for your assistance and comments concerning my research.

I am appreciative to the County Office and administration of my middle school for saying "yes" to my study and to the implementation of single-gender classrooms. To my students and their parents: I am forever grateful for your participation in this research study and for the creation of the single-gender experience. Thank you for your words of encouragement and faith that I would become 'Dr. Rohn'.

Lastly, I am eternally thankful to my friends and family; for their constant and on-going support of my teaching, researching, and writing for this dissertation; and for giving me the time, space, and seclusion I needed in order to finish this journey of earning a doctorate.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Background

As the workplace demands greater technology skill, those with math competencies will have significantly more opportunities for a productive future. Mathematics is considered a gateway to many career fields, such as construction, engineering, and physics. In our constantly evolving and challenging economic environment, those who understand and are successful at mathematics will have significantly more opportunities and options available to them in their future. International influence on mathematics has increased since the Soviet Union's 1957 launch of the first artificial Earth satellite, Sputnik. Business and industry leaders argue that their future employees need to have greater adaptability, communication skills, problem-solving skills, cooperation, and technology skills. According to Bishop and Forgasz (2007), mathematics education has two functions: to prepare students to be mathematically competent citizens of their societies and to prepare students to be future professionals with mathematical careers.

Bishop and Forgasz (2007) find, "students' mathematical attainment has been used as a selective 'filter' for entry to various professions, a fact that mitigates strongly against the ethic of an equitable and accessible mathematics education for all" (p. 1149). This filter reinforces and produces social inequalities and does not permit equitable access to mathematics education for all students (Epstein, Mendick, & Moreau, 2010, Lubienski, 2000, Mendick, 2005a).Mathematics should not just be for the select few, but for everybody in a productive, ever-changing society.

A goal of achieving equity in mathematics education is an impressive and important vision. The National Council of Teachers of Mathematics *Principles and Standards for School Mathematics* (NCTM, 2000) emphasizes the importance of equity by establishing excellence in mathematics education and requiring high expectations and strong support for all students. Mathematics has entered the realm of social sciences, since it is now a contributing factor to the uneven distribution of wealth in society. There is a need to create a society in which all members are given a fair chance to succeed in mathematics. Tirosch and Graeber (2003) emphasize the importance that all students must learn mathematics and teachers have to change and adapt their instruction to meet the needs of a wider range of students. In order to attain equity in the mathematics classroom, a socially-just pedagogy based on a student's race should be used to celebrate the diversity of all students in the classroom. Students with different lens of understanding can expect to experience distinctive mathematics education.

All students should have access to a high quality education regardless of where they live or what school they attend. Equity does not mean that all students should receive an identical education, but an education that is most beneficial to their needs. According to Lipman's (2004) study of struggling schools, those that were more urban with a lower socio-economic status (SES) just taught to the test. Prestigious public schools usually have teachers that have had more education and are more culturally responsive to their students, since they have been trained on the best ways to teach their students. The biggest determinate of how well students achieve is the education of the teachers and the economic status of their parents (Rebell & Wolf, 2008).

National and international assessments show performance differences among students from diverse racial, cultural, and socioeconomic backgrounds (U.S. Department of Education, 2011). The National Assessment of Educational Progress (NAEP) mathematics scores for the last 20 years show scale scores for 4th, 8th, and 12th graders with dramatic differences between White, African American, Hispanic, and Asian/Pacific Islanders. For the last 20 years, African-American students in 4th, 8th, and 12th grade have scored 30 points lower than White students; Hispanic students have scored between 20 and 30 points lower than White students, while Asian/Pacific Islanders have scored about 5 points higher than White students (U.S. Department of Education). These mathematics achievement gaps between White students and African American and Hispanic students have been a pervasive focus of mathematics equity research (Ladson-Billings, 1997).

There is recognition that schooling reinforces social exclusion and stratification of marginal groups and exacerbates social immobility (Gates & Jorgenson, 2009). Students' identities are partially constructed through discourses in the mathematics classroom, which also leads to a socially created view of ability. By using labels or categories, best practices and discourses may shut down within the school. There is a "White Male Myth" that permeates Western culture, because White and/or Asian males are labeled as naturally skilled at mathematics (Stinson, 2010). This clearly is a myth since not all White and Asian males are mathematically skilled. Using a sociohistorical perspective, practices of racism and discrimination have prevented African Americans from becoming equal participants in mathematics, as well as in other areas of society. The Diversity in

Mathematics Education Center for Learning and Teaching (DiME) Group (2007) emphasizes, “that differential access to algebra, which disproportionately excludes African Americans, Latinos, and poor White students from college prepatory mathematics classes, is serving as a form of structural discrimination resembling the use of literacy tests in the ‘60s” (p. 417). African-American students’ beliefs about mathematics and their view as mathematics learners are influenced by expectations of parents, community members, and school personnel.

The Mexican immigrant community also experiences a significant challenge in educating their U.S.-born children/youths in the American schooling system. The academic underachievement among U.S.-born Mexican students has been shown by comparing their mathematics and reading test scores, grades, and dropout rates to other immigrant youth (Valenzuela, 1999). Instead of revealing a pattern of upward mobility that occurs among people of European origin, generational data reveal an invisible ceiling of blocked opportunity for Mexican immigrants. This downward spiraling of ‘subtractive schooling’ increases with each successive generation (Valenzuela). Instead of schools adding to immigrant students’ linguistic and cultural knowledge to show pride in creating a bicultural heritage, schools systematically subtract their uniqueness as shown by their social and academic detriment.

Researchers have varying philosophies on how to teach and learn mathematics. The National Council of Teachers of Mathematics (NCTM) highlights the importance of students’ understanding and ability to use mathematics in everyday life. Students have to be able to do mathematical work individually; however, in today’s society, especially at job sites, students are expected to communicate effectively in mathematical terms.

NCTM suggests that students be afforded more opportunities to communicate their mathematical ideas rather than doing work individually. Consequently, there is a need for teaching practices that utilize cooperative problem-solving situations. The nature of teaching and learning is a process of cognitive socialization through discourse, a process similar to general behavioral and ideological socialization. Mathematics education may be thought of as a communicative process that consists mostly of shared mental contexts and terms of reference through which various discourses of education come to be comprehensible by the user (Edwards & Mercer, 1987).

Currently in mainstream mathematics education journals, there is a heightened interest in wanting to understand the social nature of teaching and learning while simultaneously striving for equity (Gutiérrez, 2010). A recent shift in the views to include sociocultural theories in mathematics education involves social beings and interactions and the consequences for addressing hegemony in society. Some mathematical educators are comfortable with including social and cultural aspects into their work, but most are not so willing to acknowledge that learning and teaching mathematics are not politically neutral. According to Gutiérrez, this sociocultural turn in mathematics education signals a shift in theoretical perspectives while examining the interconnections of power, knowledge, and identity arising from social discourses. Educators that have taken such a stance are on a quest for not just a better understanding of mathematics education in all of its social forms, but also to transform mathematics education in behaviors that privilege more socially just practices. These sociocultural perspectives lead to new possibilities in the relationships among mathematics, people, and the world.

Statement of Problem

Student achievement data continue to illustrate gender gaps and inequities among students, (e.g., males outperforming females in mathematics and females outperforming males in reading) (Friend, 2007). The National Assessment of Educational Progress (NAEP) mathematics scores for the last 20 years show scale scores for 4th, 8th, and 12th graders with males having a consistent 2 to 4 point lead over females (U.S. Department of Education, 2011). The NAEP scores for reading show females with a 6 to 12 point lead over males (U.S. Department of Education, 2011). Each year of NAEP testing shows an increase of scores for males and females; however, the difference in scores between males and females persists. Mathematical performance also tends to favor males on higher cognitive level questions, which leads to fewer females in upper-level mathematics classes (Becker & Jacobs, 1983; Leder, Forgasz, & Solar, 1996). According to Leder, Forgasz, & Solar, females are underrepresented in the most advanced and demanding mathematics courses based on an examination of enrollments at the school level and in higher-education. These achievement differences exemplify the current need for educators and researchers to explore innovative new ways to close the achievement gap to further reduce the inequities found in the school environment.

Mathematical thinking is a cognitive skill that enables people to think logically and analytically. The ability to see powerful mathematical ideas and connections is a way to make sense of the world. Unfortunately this pleasure in seeing the wonder of mathematics is considered a male domain in society. The stereotyping of mathematicians is having a harmful effect on society, since popular culture's view of a mathematically-minded person is characteristically portrayed as a 'nerd' or 'genius' (Epstein, Mendick, &

Moreau, 2010). Epstein, Mendick, & Moreau (2010) explain, “how mathematics is represented as a secret language, mystical, even magical, difficult and aesthetically satisfying to those (few) who understand it, while mathematicians are often mad, or at least eccentric and different, mostly male and almost invariably white” (p. 47). Epstein, Mendick, & Moreau found their participants either distanced themselves from mathematics or embraced it, while either rejecting the mathematical geek image or by creating a new sense of self different from others. If young people, especially females, are going to continue in mathematics past the age of 16, then it is imperative that society modifies its view of who is good at mathematics in conjunction with the nerdy and geeky image, especially in order for girls to pursue careers in the mathematical fields.

Since the 1970s, there has been increasing research activity in the field of gender and mathematics. Leder, Forgasz, & Solar (1996) found that Fennema’s 1974 early review of mathematical research in the U.S. revealed that the research had been fairly limited with an emphasis on performance differences. According to Fennema (1979), there are no differences in intelligence between males and females. Researchers and educators believe that the cognitive differences between males and females are small and possibly attributed to biological aspects. Further, the cognitive differences are found to have less of an impact as compared to the greater pressures imposed by cultural and social stereotypes including behaviors thought to be ‘appropriate,’ and life and educational patterns (Leder, 1992).

Different theoretical models have been proposed to account for the observed gender differences in mathematics learning. The various models share a common feature of placing an emphasis on the social environment, such as students’ reaction to the culture and context of learning, the personal and cultural values placed on learning, and various learner affective and cognitive variables (Leder, 1992). Gender differences in mathematics learning may be influenced by a range of environmental variables, such as school, teachers, peer group, parents, and society. Learner-related variables may also be a factor in mathematics learning and such variables include the following: intelligence, spatial abilities, confidence, fear of success, and persistence (Fennema, 1979; Leder; Pedro, Wolleat, Fennema, & Becker, 1981). Females that reported more anxiety or lack of confidence about mathematics, were less likely to attribute their success to their ability and consequently planned to take less semesters of math in the future (Pedro, Wolleat, Fennema, & Becker). All of these factors and variables testify to the wealth of information and continued attention that is needed to achieve equity and understand gender differences in mathematics learning.

According to Geist and King (2008), the classroom climate, instructional style, learning style, and experiences offered to boys and girls found in many classrooms may not effectively meet the needs of either gender. Traditional methods of teaching may have a negative impact on students, instead of a curriculum that is individualized, developmentally appropriate, and gender responsive (Geist & King, 2008). Single-sex schooling has also been used as an intervention to address gender inequalities in mathematics learning outcomes. There are beliefs that females would benefit most from this program, but there are findings that males may also benefit from a single-sex setting (Yates, 1997). With the passage of the No Child Left Behind Act of 2001 (NCLB), a reinterpretation of Title IX with a provision for grant funding has encouraged research on public single-sex classrooms and schools. Due to these changes in federal laws, using same gender classrooms as a strategy for school improvement has become a legal option. However, the effectiveness of single-sex classrooms to attain gains in academic achievement is a major concern. In a study of single-sex mathematics classrooms, Friend (2007) found that same-sex groupings make no difference academically, but gains in self-esteem may occur. Friend noted other positive and negative consequences of single-sex instruction, including instructional material, gender-specific pedagogy, and reinforcement of gender stereotypes or bias. This leads to the debate of the critical issue of equity in the continuation and formation of ‘separate but equal’ single-sex classrooms.

Previous studies in mathematics education were limited in terms of the research methods, single-sex classrooms in public schools, and an absence of both male and female single-sex classrooms. Recently, in order for researchers to thoroughly examine the social aspects in the classroom, there has been the change from the dominance of quantitative research in mathematics education to more qualitative approaches. In the last decade, qualitative narrative methods are proving to be more fruitful in the mathematical research community (Eisenhart, 1988; Lerman, 2000; Schoenfeld, 2008). Before No Child Left Behind (NCLB) which provided for single-sex classrooms, studies of this arrangement were limited to the private and charter schools in the United States. Almost all previous studies were conducted in all-girls classrooms and exclusively focused on the best way to support girls’ mathematics learning thereby excluding boys from learning in a single-sex environment.

Purpose of the Study

The purpose of the study is to examine the learning experiences of students enrolled in an all-girls math class and an all-boys math class in a co-educational public school. The classroom interactions were analyzed focusing on the cognitive, psychological, and social aspects of students learning mathematics in the two single-sex classes. Students' responses to different pedagogical approaches such as students working in cooperative groups and a competitive atmosphere were examined. This study is framed as an exploratory, multiple case study design in which social phenomena or issues are explored within their natural setting (Stake, 1995).

Research Questions

The overarching research question: How do two different pedagogical approaches, cooperative and competitive teaching strategies, shape students' learning experiences in an all-girls math class and an all-boys math class?

Three sub-research questions are:

1. How do the two different learning contexts shape the cognitive processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?
2. How do the two different learning contexts shape the psychological processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?
3. How do the two different learning contexts shape the social processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?

Assumption of the Study

The following assumption is made for this study. Students who participate in this study are characteristic of students in similar grades and schools in communities with comparable demographics.

Significance of the Study

The first significance of the study is to ‘explore the social and psychological aspects’ of mathematics education. The qualitative design is a tool to provide more meaningful and substantial findings. Since the end of the 1980s in mathematics research, there has been a growing interest in the social aspects of learning and teaching mathematics. This social turn in mathematics has developed from three main disciplines: anthropology, sociology, and cultural psychology. This receptivity to the social aspects of mathematics may be due to political concerns and inequities that occur in society, which may then lead to differential success in the mathematics classroom. In order for researchers to thoroughly examine the social aspects in the classroom, there has also been the change from mostly quantitative research in mathematics education to more of a qualitative approach (Eisenhart, 1988; Lerman, 2000; Schoenfeld, 2008).

A second significance of this study, is the passage of the No Child Left Behind Act of 2001 (NCLB), a reinterpretation of Title IX with a provision for grant funding that has encouraged research on public single-sex classrooms and schools. Due to these changes in federal laws, using single-sex classrooms as a strategy for school improvement has become a legal option. There have been a limited number of studies conducted in single-sex classrooms in public schools. Before the changes in legislature, studies on single-sex math classrooms were limited to private and charter schools

(Friend, 2007; Harker, 2000; Shapka & Keating, 2003; Streitmatter, 1997). This study will add to the growing need for viable strategies to improve mathematics education in public school systems.

The third significance is that most studies on single-sex education only examine all-girls classrooms (Anfara & Mertens, 2008; Shapka & Keating, 2003; Streitmatter, 1997), whereas this study will look at the implications of both all-girls and all-boys classrooms. There has also been a growing interest and need for research about boys (Anfara & Mertens, 2008; Martino, Mills, & Lingard, 2005; Mulholland, Hansen, & Kaminski, 2004; Parker & Rennie, 2002; Streitmatter, 1997; Van de gaer, Pustjens, Van Damme, & De Munter, 2004). This study will focus on the need for research about the social construction of gender in the lives of both boys' and girls' experiences in a public school environment. Given the pressing need for a high-quality mathematical workforce, now is the time to invest maximum effort in discovering what strategies are effective in increasing active participation in the field of mathematics.

Summary of Chapter 1

Gender inequity in mathematics education continues to be a problem in the United States. Therefore this study focuses on single-sex classrooms as a strategy to lessen gender inequities and engage and empower students to prepare for greater career opportunities in the future. This introduction provided background knowledge of the research topic and, single-sex mathematics instruction; a statement of the problem; the overarching purpose of the study; and the guiding research questions; as well as the significance of the study.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

The purpose of the study is to examine the learning experiences of students enrolled in an all-girls math class and an all-boys math class in a co-educational public school. Interactions within the two single-sex classrooms were analyzed focusing on the cognitive, psychological, and social aspects of students learning mathematics. Since this study is situated within a social constructivism and feminist theoretical positions both theories will be explained. The theoretical framework will begin with a description of social constructivism and how it is situated within classroom practices and the teaching of mathematics. Next, feminist theory will be introduced and positioned within the importance of learning mathematics. Subsequently, a review of the literature will first focus on the roles of women in society, the importance of females pursuing mathematical careers, intervention programs designed to keep females in mathematics, and a comparison of single-sex and co-educational classes. Finally, cooperative and competitive learning contexts will be examined followed by social constructivism and feminist theory in cooperative and competitive learning contexts.

Theoretical Framework

Social Constructivism. The theory of social constructivism is based on a social construction of knowledge and reality. Education is a communicative process in which knowledge is received, presented, controlled, negotiated, and understood both teachers and students in the classroom (Glesne 2006). An individual's active construction of knowledge is highlighted as the core concept of constructivism. Learning may require significant mental work from the learner and an individual's active construction of knowledge, as well as an individual's learning may both be invisible to the teacher. Constructivists assume that all knowledge is constructed from prior knowledge, regardless of how one is taught (Cazden, 2001). Social constructivism highlights sources of assistance from peers, teachers, parents, siblings, or non-human sources such as computers in patterns of discourse.

Of all the social scientists, psychologists are the most recent to become involved in the study of classroom discourse. Prominent psychologists each having a great deal to say about 'learning' and how teachers should be able to promote it include Bain, James, Gagne, Skinner, Skemp, Piaget, and Broadbent. However, none of their advice was based on actual observations and analyses of what transpires in the classroom. Educational researchers began to study psychology when problems of learning and teaching were considered psychological problems (Moll, 1996; Skemp, 1987). In comparison, while not formally trained as a psychologist, Vygotsky was considered to be an educational or developmental psychologist. Vygotsky's success in reformulating psychology in the Union of Soviet Socialist Republics (USSR) was unparalleled by university trained psychologists (Wertsch, 1985). Like Piaget, Vygotsky studied the development of cognitive processes and agreed that reasoning could develop independently of language, with language and thought having their own, separate mental origins. Vygotsky devised a theory of intellectual development, the zone of proximal development, which recognizes that students undergo profound changes in their cognitive understanding by their engagement in joint activities and conversations with others (Moll, 1996).

Vygotsky regarded education not only as central to cognitive development, but as a quintessential sociocultural activity. He considered education of paramount importance that adults make children an object of pedagogy so they will develop with adult competencies. The zone of proximal development serves to connect a wide range of Vygotskian thought, a key theoretical construct, which captures the individual within the concrete social condition of learning and development (Moll, 1996). The zone of proximal development is further defined as the distance between a student's actual development level as shown through independent problem-solving and a higher level of potential development as a result of problem solving with adult guidance or working in collaboration with peers (Wertsch, 1985). Vygotsky wanted to study the formation of processes as students were actually engaging in activities, rather than fossilized behaviors that were already learned (Wertsch).

Today's classrooms feature little dialogue or interactive teaching, which would characterize a zone of proximal development. Vygotsky wrote about collaboration and direction, and about assisting children through leading questions, demonstrations, and by introducing the starting elements in problem-solving (Moll, 1996). The learning of mathematics should be a social construction of knowledge involving problem-solving, communication, reasoning and proof, connections, and representation (NCTM, 2000). Leading and probing questions should be used to assist the students in the discovery of their solution together. Acquired intellectual skills are directly related to how students interact with their peers in specific problem-solving activities. The students then transfer this knowledge to subsequent problem-solving behaviors. This social system within which students learn is mutually created by the teacher and students, which is central to the Vygotskian analysis of instruction. A major role of schooling is to create social contexts such as working in pairs or groups, which allow students to acquire the means for ‘higher-order’ intellectual activity. In conclusion Moll (1996) affirms that, “The essence of the zone of proximal development concept, however, is the qualitatively different perspective one gets by contrasting students’ performance alone with their performance in collaborative activity” (p. 12).

In social constructivism, basic skills are incorporated into “authentic” meaningful activities through a holistic approach for understanding and applying the zone of proximal development to classroom instruction. Examples of zone of proximal development techniques are when students are given math puzzles involving skills (i.e., order of operations, scientific notation, integers), and have to apply their knowledge to solve the puzzles. The students are placed in groups which allow them to work together and discuss their problem-solving strategies. If they become perplexed on how to solve a given mathematical concept, another student can reinforce and discuss the rationalities of the situation. The puzzle cannot be too difficult or the students become frustrated and shut down the learning process and give up.

Feminist Theory. A recent shift in the views to include sociocultural theories in mathematics education involves the examination of social beings and their interactions as well as the consequences for addressing hegemony in society. The social theory of feminism involves a range or a continuum of political and theoretical feminist positions. The roots of feminist theory date back centuries to when men and women first worked to free women from the oppression of patriarchy. Feminism is both a political statement and a theory of women's position in society focused on gaining equal rights and opportunities and changing power relations between genders (DeMarrais & LeCompte, 1998). Feminism, essential to achieving equality of educational opportunities, has opened doors for females in careers that were exclusively dominated by white males. Feminist theory is primarily concerned with equal rights for women, as well as a transformation men and women experience not only in the workplace but in their daily lives.

Equality of educational opportunity refers to providing the same educational opportunities, expectations, and support regardless of gender. There are gender issues pertaining to equality of education, gender equity, and differential outcomes in economic opportunities and academic achievement for women and men (Bell, 1994; Curry, 2000; Hochschild, 2003). Sexist practices are still evident in both the formal and hidden curriculum in schools. Even though there have been decades of feminist activism, research pertaining to discriminatory practices, and legislation created to provide equality of treatment, inequalities still exist for females in regard to access of education and economic opportunities. Feminist theories can be used as a way to understand schooling and as a way to achieve equality and break down patriarchal domination in schools.

Gender differences in mathematics learning may be influenced by a range of environmental variables, such as school, teachers, peer group, parents, and society. These variables testify to the wealth of information from which researchers can build and continued attention that is needed to achieve equity and understand gender differences in mathematics learning. Mendick (2005a) conducted feminist research in mathematics education examining why more boys than girls choose to study math and who is considered good at math. The females in the study denied their intelligence and being 'good at maths.' Mendick (2005b) states the following:

> Discussions about the relationship between the powerful role of mathematicians and its male dominance have been a part of feminist research and praxis in education in a range of countries since the start of the second wave of the feminist movement. (p. 161)

Mathematics is portrayed as a secret language, mystical, magical, and difficult to understand. Mathematicians are stereotyped as mad, eccentric nerdy, socially inept white males (Epstein, Mendick, & Moreau, 2010).

The liberal feminist theory focuses on the rights of females and transformation of traditional beliefs about feminity and masculinity in addition to achieving full equality of opportunity in all areas of life (DeMarrais & LeCompte, 1998). A liberal feminist position creates a gender-fair, psychologically safe, and separate environment, which suggests that adolescent girls might perform stronger academically in an environment of collaborative learning. Based on feminist theory, single-sex schooling has been used as an intervention to address gender inequalities in mathematics learning outcomes (Piro, 2002). There are beliefs that females would benefit most from this program, but there are findings that males may also benefit from a single-sex setting (Yates, 1997). The concept of gender issues usually focuses on developing feminist theories; however, there has been a growing interest and need for research about boys. For feminist researchers, the current interest in understanding boys is a source of investigation ready for new insights and finding, especially concerning post-structural critical feminist thoughts of equity.

Historical Development

Myths may often guide one's perceptions and ideas about the world and portray people that are rewarded or punished for their actions. Morals, ethics, and conduct are developed from these myths or fables. Accordingly young children learn what is socially acceptable from their society, such as their stereotyped gender roles. Stone (1976) states her introduction of societal views of females in the following:

> As a young child, I was told that Eve had been made from Adam's rib, brought into being to be his companion and helpmate, to keep him from being lonely. As if this assignment of permanent second mate, never to be captain, was not oppressive enough to my future plans as a developing member of society, I next learned that Eve was considered to be foolishly gullible (p. 5).

From such an early time, Eve and consequently all women are thought of as the second in command and not being very bright due to being tricked by a serpent. What about Adam's role and his gullibility? Adam and Eve are considered the first images of a man and a woman which led to the belief that all women were seen as contriving, sexy, simple-minded, and gullible (Stone, 1976). Not as widely known are other myths, in which the woman in other ancient religions was a Goddess, unlike the woman Eve. Under the rule of the Goddess, societal roles differed from those in patriarchal Judeo-Christian cultures. It is believed that the sex of the deity is determined by which sex is in the power role in the society.

Males have the dominate role in United States society; and many of them have been fighting against negatively stereotyped views of women. During the first women's rights conference held at Seneca Falls, New York in 1848, women spoke about political rights as well as the lowly position that the Church had assigned them (Stone, 1976). This first wave of the Feminist Movement exemplifies women fighting against male domination and control. Females were viewed as inferior creatures intended to be silent vessels for childbearing and to be subservient to men. To this day, the struggle for equal rights for women continues and the Church continues to uphold the ideal of male supremacy (Curry, 2000; Lorde, 1984).

Women and education are influenced by many factors such as situational, personal, and cultural. There have been differences in educational opportunities that have been available to females and males, since prior generations thought education and women of independent means were a detriment to the end-all marriage. Even though parents realized that education could provide their daughter's independence, some parents were fearful that too much education might spoil her chances for marriage (Leder, 1992). Despite these views, female enrollment in public schools increased and coeducation became the norm in the 19^{th} century. At the time females performed better and had higher retention rates, but questions were raised if females could cope with the physical demands of secondary schooling. Kroll (1985) stated that females are "organized both bodily and mentally for dealing with an entirely different set of functions, in which mathematics plays a small part" (p. 8). Proposals for addressing this solution included a modified curriculum and segregated education. Due to the increasing costs of public schooling, girls and boys typically learned in the same classes. In the 1940s, educators noticed that boys had more trouble learning to read, since there were more males in remedial classes creating discipline problems (Tyack & Cuban, 1995). The response to curb boys dropping out of school was creating gender-segregated vocational courses, stressing male-only athletic teams, and adopting textbooks made more appealing to boys. Gender-differentiated textbooks for females reflected expectations that females would need to have arithmetic knowledge concerning cooking, working, calculating electric and gas bills, and planning a budget (Breakell, 2001). Tyack and Cuban (1995) identified two kinds of gender discrimination concerning teachers: (a) the common practice of firing women due to marriage and (b) the predominance of male administrators.

Since the 1970s, there has been increasing research activity in the field of gender and mathematics. Leder, Forgasz, & Solar (1996) found, "Fennema's (1974) early review of research in the field was based on work from the U.S. and revealed that research up to that time had been fairly limited, the emphasis having been on performance differences" (p. 947). In the 1980s, laws were passed in the United States requiring all students to take more mathematics and science classes (Tyack & Cuban, 1995). According to Tyack & Cuban, "a positive unintended consequence was that girls took fewer traditional "female" electives and became better prepared to enter scientific and technical fields if they so chose" (p. 62). Before the change in policy due to the crisis announced by *A Nation at Risk*, an education lacking math and science classes narrowed the career options for many females.

Women in society. Culture is a co-construction developed at home, school, and in the workplace. Curry (2000) examines the conflicts that arise within women and society as females rise through the ranks and obtain leadership positions. Culturally embedded in many females' minds is the belief that leadership belongs to men, since girls are raised as followers. Curry highlights the struggle of women to construct themselves as leaders, when they have only been presented with male role models. As depicted by Curry, there are questions of identity and the ideas of balancing socially constructed gender roles and responsibilities within their professional and personal lives. According to Boaler (2002), there is a tendency to attribute certain characteristics and attributes to girls and women, which reflects societal views regarding gender. Even people who believe that both genders have equal intellectual potential differ to the extent to which the genders conform to stereotyping. This includes, regarding gender as a characteristic of the different sexes as opposed to a response to a particular set of conditions (Boaler).

Until females are considered equals in contemporary society, women's rights and beliefs are going to have to be contested in all aspects of society including family, friends, home, school, and at work. Lorde (1984) emphatically states the following:

> Women of today are still being called upon to stretch across the gap of male ignorance and to educate men as to our existence and to our needs. This is an old and primary tool of all oppressors to keep the oppressed occupied with the master's concerns.

Women's advancement in the economy, (i.e., securing a position of merit and financial independence) has led to a dramatic change in society and has undeniably redefined traditional gender roles and relationships. Hochschild (2003) scrutinizes the inequities and the oppression against women and the strain between traditional and egalitarian models of marriage running from the top to the bottom of the class ladder. The modern woman may not have more power than her predecessors, but the power is based differently than in previous eras.

Women in mathematics**.** Mendick (2005b) explains, "Discussions about the relationship between the powerful role of mathematics and its male dominance have been part of feminist research and praxis in education…since the start of the second wave of the feminist movement" (p. 161). There needs to be equality between the genders concerning mathematics and who is 'good at math.' If mathematics is viewed as a masculine, 'nerdy', or genius subject it will be more difficult for females to feel comfortable with performing mathematics. In connection with Curry and the need for female leaders to act more masculine to be effective leaders, Boaler (2002) found the following:

> In mathematics education, researchers have variously discovered that girls lack confidence, develop anxiety, and attribute failure to themselves. These tendencies have generally been presented as properties of girls rather than as responses that are coproduced by particular working environments. This has led educators to propose interventions aimed to change the girls so that they become less anxious, more confident, and essentially more masculine (p. 139).

Concerning the recent presidential debates, for example, it should not be said that any gender is better. Contrary to what some believe females are not anxious and without confidence all the time. Females should not be put under pressure to perform and act like another gender. For instance there are multiple ways to solve mathematical problems, if mathematicians were told 'No, do not think like that,' most of the amazing mathematical and scientific discoveries may never have happened. Mendick (2005a) believes that men and women need to engage in mathematics together and truly enjoy mathematics mutually.

Fennema (1979) was one of the first researchers concerning gendered research in mathematics. Fennema explains, "Male superiority has been accepted as fact, almost without question, for many years. Certainly, if anyone observes adult use, many more males than females use mathematics daily, particularly advanced mathematics beyond arithmetic" (p. 389). Interest in studying gender-related differences in mathematics became more popular by researchers, when it was discovered that lack of mathematical knowledge prohibits females from many occupational fields. Fennema found that there was no difference in intelligence between males and females; however she found males were more likely to stereotype math as a male domain as are parents, teachers, and school counselors. If females do not see math as a possible career, they will not see nor reap the benefits of a mathematics education. Without full engagement, students fully capable of continuing with mathematics will decide early to opt-out of the mathematics courses, if they believe the subject is inappropriate for them and they are not comfortable with taking mathematics (Leder 1992).

The wealth of research concerning gender differences and mathematics learning exemplifies the importance of achieving equity in mathematics education. There still continues to be more males enrolled in upper-level mathematics courses. Performance differences may also be found in favor of males concerning higher-level mathematical cognitive skills. More females are taking advantage of a changing and more encouraging educational, institutional, and professional climate and are successfully succeeding in mathematics (Leder 1992).

Intervention programs. The under representation of females in mathematics and mathematics-related careers led to the creation and utilization of various intervention programs. For instance, according to Leder, Forgasz, & Solar (1996), "The regular surveys of the *Women in Engineering Programs* (WIEP) showed that the number of intervention activities in that field more than doubled from 395 in 1975 to 859 in 1991" (p. 967). One intervention program designed to increase the number of females enrolled in high school classes is *Multiplying Options and Subtracting Bias*. This early intervention program involved a series of workshops that utilized videotapes and discussions in order to increase mathematics course selections in the following three ways: (1) by improving females' attitudes toward mathematics, (2) by increasing females' knowledge about gender-related differences in mathematics, and (3) by changing the attitudes of teachers, counselors, parents, and male peers (Becker & Jacobs, 1983). This intervention plan produced a significant increase in the high school mathematics plans, knowledge of sex-related differences, mathematics usefulness, and a higher percentage of females enrolling in mathematics in subsequent years. Other intervention programs including *Expanding Your Horizons in Science and Mathematics and Women in Mathematics* are effective ways to provide role models of female pursuing mathematics-related careers. Females are able to meet women in mathematical careers and their parents, counselors, and teachers are also able to increase their knowledge of mathematics in career choices. The National Council of Teachers in Mathematics (NCTM) established a task force as an intervention, which was funded by the National Science Foundation, to study the problems in the mathematics education of girls and women and to conduct four regional conferences on Equity in Mathematics (Becker & Jacobs, 1983). Interventions were considered successful if they involved academic counseling, role models, advisors, guest speakers, direct instructions, and field trips. Leder, Forgasz, & Solar (1996) point out that the most beneficial programs develop strategies that are effective for females as well as males.

Co-Educational and Single-Sex Classrooms

Another intervention program that addresses the inequalities in mathematics learning outcomes is the use of single-sex education. Historically private and parochial schools in the United States have proffered choices for students to attend single-sex classes without federal regulation. However, in 1972, Title IX legislation was enacted that prohibited discrimination on the basis of gender or race. Therefore, educational systems receiving federal funds, were then restricted in regard to single-sex public schools. But with the passage of the No Child Left Behind Act of 2001 (NCLB), a reinterpretation of Title IX with a provision for grant funding encouraged research on public single-sex classrooms and schools. On October 25, 2006 the U.S. Department of Education published new regulations governing concerning single-sex education in public schools. These new regulations are part of NCLB sections 5131(a) and 5131(c), which allow coeducational public schools to offer single-sex classrooms with these provisions:

1. provide a rationale for offering single-sex classes
2. provide co-educational classes in the same subject at the same school or an alternate school, which is geographically accessible; and
3. conduct a review every two years to determine if single-sex classes are still needed as a remedy for the inequity which prompted the beginning of single-sex classes.

Single-sex schools are exempted from two of the previous three requirements and only have to provide a co-educational class which is geographically accessible; charter schools are exempted from all of the three requirements (U.S. Department of Education, 2006). In regard to these changes of NCLB, the former U.S. Secretary of Education Margaret Spellings called attention to research demonstrating how some students may learn better in single-sex education environments. The Department of Education then showed its support by giving communities more options in the types of learning environments currently available to their students (U.S. Department of Education, 2006).

There is a growing belief that single-sex classes are a promising intervention on the road to attaining equity in mathematics education. In a co-educational setting there are many factors which keep females at a disadvantage. Leder (1992) denotes, "…time-tabling of courses, choice of curriculum, textbook selection and content, availability of equipment, methods of assessment, counselors' advise, administrators' implementation of certain instructional policies, as well as students' own perceptions of the learning climate" as mitigating factors (p. 610). According to Fennema (1979), peer pressure against female competitiveness is such a strong force; as a result some females will not even compete against males in a mixed-sex classroom setting. Some females will only attain leadership positions once male competition is completely eliminated. Further Fennema states females in single-sex schools are more likely to express an interest in mathematics and take more mathematics courses as compared to females in co-educational schools. Females are also more likely to cope in their mathematics classes if they are with a close friend. Even though there are many advantages to utilizing single-sex schooling as an intervention for attaining female education equity, it should be noted that the long term effectiveness of such programs still must be carefully researched and examined (Fennema).

Jackson & Smith (2000) have found that there is a common belief that co-educational schools are ‘good’ for boys and ‘bad’ for girls; girls are supposed to take care of the boys and help civilize them. Lawrie & Brown (1992) found that girls from co-educational schools found math more difficult and less enjoyable than students in single-sex schools whereas girls in single-sex schools tend to have a more positive attitude toward mathematics and a higher outlook of their mathematical capabilities. In order to find the best practices to help students learn most effectively in any classroom, gender differences need to be taken into account. Traditional methods of teaching may have a negative impact on students, instead of a curriculum that is individualized, developmentally appropriate, and gender responsive. Influences in the classroom such as interest, confidence, peer interactions, teacher interactions, and performance will be examined as they pertain to co-educational and single-sex classrooms as shown in Tables 1 and 2.

TABLE 1: Co-educational classroom influences on females and males

Co-Ed	Females	Males
Interests	Less likely to enroll in advanced science and math classes (Denith, 2008) Rate math as more difficult and less enjoyable than peers from single-sex schools (Jackson & Smith, 2000) Attitudes towards math change in middle school (Streitmatter, 1997)	
Confidence	Problems of self-image and diminished confidence were prominent (Denith, 2008) Apprehension of future college studies (Denith, 2008) Feel they have to work harder than males to be taken seriously and regarded as smart (Denith, 2008) More concerned with processes of schooling (Atweh & Cooper, 1995) Advanced courses are a small highly selective group with high self-confidence in mathematical ability (Denith, 2008)	More confident (Denith, 2008) More concerned with outcomes (Atweh & Cooper, 1995)
Peer Interactions	Have a ‘civilizing’ effect on the boys (Jackson & Smith, 2000) Reference to sexual harassment, sense of invisibility in classrooms dominated by boys (Streitmatter, 1997)	Police what girls are allowed to do in the classroom (Martino, Mills, & Lingard, 2005)
Teacher Interactions	Not pushes as hard as males (Denith, 2008) Receive less encouragement – expected to do well (Denith, 2008) Teacher beliefs about mathematics and what teachers’ and students’ perceptions of valuable learning in school mathematics affect classroom practices (Atweh & Cooper, 1995) Believe girls need ‘something else’ to achieve in math (Atweh & Cooper, 1995) Mathematics teaching is a gendered practice (Atweh & Cooper, 1995) Co-ed schools characterize masculine models of education (Harker, 2000)	Teachers more willing to push males (Denith, 2008) Receive more encouragement from teachers (Denith, 2008) Called on more often, allowed to speak more, given more praise, and constructive criticism (Shapka & Keating, 2003) Believe boys find studying mathematics ‘natural’ (Atweh & Cooper, 1995) Characterized masculine models of education in co-ed schools (Harker, 2000)

Performance	Gender gaps and ethnic differences persist through high school on standardized tests such as SAT (Reid & Roberts, 2006) Even talented girls do not reach their highest potential (Reid & Roberts, 2006) Score lower on standardized tests even though receive higher grades in all other subjects (Streitmatter, 1997)	Usually score higher on standardized tests, but lower classroom grades (Van de gaer, Pustgens, Van Damme, & De Munter, 2004)

TABLE 2: Single-sex classroom influences on females and males

Single-Sex	Female	Male
Interests	More passive, intrinsically motivated, concerned about process (Martino, Mills, & Lingard, 2005) View single-sex classroom favorably (Shapka & Keating, 2003)	Competitive (Martino, Mills, & Lingard, 2005) More ambivalent and some view single-sex classrooms negatively (Shapka & Keating, 2003)
Confidence	Popular belief, but not sustained with data: feeling more confident, enjoying math more, and making more progress (Shapka & Keating, 2003) Reduce stereotypical gender biases (Shapka & Keating, 2003) Still experience anxiety about math do not feel more confident (Shapka & Keating, 2003) Single-sex physics class – girls gained confidence (Van de gaer, Pustgens, Van Damme, & De Munter, 2004) Perception of: better able to concentrate, less non-academic distractions, less discipline problems, less discrimination (Van de gaer, Pustgens, Van Damme, & De Munter, 2004) More willing to take academic risks – sense of freedom to ask questions and answer questions without having to be correct (Streitmatter, 1997)	
Peer Interactions	Enjoy socialization aspects of mixed gender school (Shapka & Keating, 2003) Able to enjoy socialization aspects of mixed gender school (Shapka & Keating)	More fighting, more roughness, and receiving more punishment (Van de gaer, Pustgens, Van Damme, & De Munter, 2004)

Peer Interactions	Downside without boys in class – boys funnier and cause laughing (Martino, Mills, & Lingard, 2005) Girls more at ease with female peers and focus on collaboration, rather than competition (Streitmatter, 1997) Better able to concentrate without distraction of other gender (Mullholland & Kaminski, 2004)	Socialize and complete collaborative projects (Martino, Mills, & Lingard, 2005)
Teacher Interactions	Teachers can modify teaching methods and curriculum to learning style preferences (Van de gaer, Pustgens, Van Damme, & De Munter, 2004) Teachers believe girls have a better learning environment and have higher achievement in mathematics and science classes (Jackson & Smith, 2000) Teacher strategies: more time for explanations, build confidence through encouragement, more peer interaction, and shared problem-solving (Mullholland & Kaminski, 2004)	Teachers can modify teaching methods and curriculum to learning style preferences (i.e. short attention spans, fast-paced tasks, puzzles, & outdoor activities) (Martino, Mills, & Lingard, 2005) Reinforce understanding of how boys learn (Martino, Mills, & Lingard, 2005) Class created for classroom management – teacher created bonding and became close to boys. Problem of seeing all boys as the same (Martino, Mills, & Lingard, 2005)
Performance	Did not make more progress in co-ed – gender composition does not matter, but girls in girls-only school show more progress (Van de gaer, Pustgens, Van Damme, & De Munter, 2004) Positive effects on math and science performance and persistence, not same positive influence on attitudes towards math – did not reduce their anxiety (Shapka & Keating, 2003) Take more math and science classes after single-sex experience and into high school (Shapka & Keating, 2003) Percentage obtaining higher grades is somewhat larger (Harker, 2000)	Research not showing effectiveness of single-sex classroom for boys (Van de gaer, Pustgens, Van Damme, & De Munter, 2004) Boys achievement better in co-ed classrooms progress (Van de gaer, Pustgens, Van Damme, & De Munter, 2004)

Interests. Females' interests are influenced by the multitude of interactions and learning that take place in the classroom. In general, girls' attitudes toward mathematics changes in middle school (Streitmatter, 1997). According to Jackson and Smith (2000) girls rate math as more difficult and less enjoyable than their peers educated in single-sex schools. Girls, parents, and teachers view single-sex classrooms more favorably and according to Martino, Mills, & Lingard (2005), females generally are more passive, intrinsically motivated, and concerned about the process of learning. In single-sex classes, females may be more proactive in the learning process and engage in open discussions with the teacher and their peers, while also preferring cooperative group experiences. Females are also more interested in the process of learning and making sense of what they are learning and connecting with their peers. Blickenstaff (2005) points out that many girls who choose to avoid upper-level mathematics courses such as calculus in high school are less likely to choose a math major in college, since they do not have a strong mathematical foundation on which to build.

Confidence. Confidence can be defined as the belief of one's ability to succeed. In co-educational classrooms, girls have problems with their self-image and diminished confidence. Overall girls express a stronger need to be perceived as confident and successful by their teachers and peers (Denith, 2008). Further, Denith states girls were very concerned with their outward appearance and worked very hard to project an image of being smart. In addition, girls felt that they had to work harder than their male counterparts to be regarded as smart and to be taken seriously (Denith, 2008). Many girls care about what others think of them and fear being labeled as 'dumb' when enrolled in traditionally male-dominated classes. Girls in advanced courses are a highly selective group with high self-confidence in their mathematical ability. Unfortunately, in many mathematics and science fields, there are few female role models and successful female scientists often do not have children, which may lead to the assumption that practicing scientists cannot provide a balanced model of career and family (Blickenstaff, 2005).

Although unsubstantiated, there is a popular belief that females have more confidence, more enjoyment of math, and make more mathematical progress in single-sex classrooms. Shapka & Keating (2003) found in their intervention study of single-sex classrooms that girls expressed enjoyment of the socialization aspects of a gender-mixed school; however, they valued not having to endure the stereotypical biases which tend to discourage females from excelling in co-educational math and science classes. Thus evidence suggests positive outcomes in utilizing single-sex mathematics classes in co-educational schools. There are also affirmative perceptions of single-sex schools providing a better school environment, since students have less non-academic distractions, less discrimination, and less discipline problems, especially in girls' schools (Van de gaer, Pustjens, Van Damme, & De Munter, 2004). In addition Streitmatter (1997) found the girls-only class increased confidence in the girls' mathematical abilities and their overall willingness to ask questions. The girls were also more willing to take academic risks and entertained a sense of freedom to ask questions and answer questions without having to be mathematically correct.

Overall boys are more confident and concerned with outcomes (Atweh & Cooper, 1995). Even with similar achievement, males tend to report overall higher confidence than females. Still male confidence and competitiveness can be a disadvantage, when boys feel threatened when females score well on standardized tests and classroom evaluations. This may discourage females from appearing smart, participating in classrooms discussions, and exuding confidence in their abilities.

Peer Interactions. In co-educational classrooms, girls tend to have a ‘civilizing’ effect on the boys (Jackson & Smith, 2000) therefore; boys tend to have less discipline problems when girls are in the classroom. There are instances of girls being sexually harassed by boys and having a sense of invisibility in classrooms dominated by boys (Streitmatter, 1997). Some boys even police what girls are allowed to do in the classroom (Martino et al, 2005). These examples lead to a common acknowledgment that co-educational classrooms are ‘bad’ for girls and ‘good’ for boys. In single-sex classrooms girls are able to be more at ease with their female peers and focus on collaboration, rather than on competition. Mulholland, Hansen, & Kaminski (2004) found, “Students seemed better able to concentrate on their studies in single-gender classes, without the distraction of the other gender” (p. 27).

Teacher Interactions. Dentith (2008) find that teachers are more inclined to push the boys than the girls to succeed and give much more encouragement for academic success to the males than to the females, whereas they expected girls to do well without the same levels of support. Daily classroom practices are largely affected by teacher beliefs about mathematics and by what students and teachers view as valuable. Atweh & Cooper (1995) point out that both teachers in their study, “believed that girls needed ‘something else’ in order to achieve in mathematics. This included special encouragement, motivation by previous success and support in their social and emotional lives” (p. 306). This example illustrates the notion that mathematics teaching is a gendered practice. Gender differences in ability do not prevent girls from succeeding, but classroom interactions may be related to gender.

In single-sex classrooms, teachers are better able to modify their teaching methods and the curriculum to preferred learning styles (Van de gar et al., 2004). Teachers are also convinced girls have a better learning environment and are able to attain higher achievement levels in mathematics single-sex classes. Boys receive more encouragement from teachers, are called on more often, given more praise and constructive and useful criticism (Shapka & Keating, 2003). Teachers are more willing to push males to succeed and give more encouragement, since they view boys' studying mathematics and science as more important and 'natural'. Single-sex boys' classrooms may use pedagogical methods to reinforce understandings of how boys learn. For instance, teachers can modify their teaching methods and curriculum to boys' learning style preferences, such as short-attention spans preferring fast-paced tasks, outdoor activities, and puzzles (Martino et al, 2005).

Performance. Reid & Roberts (2006) found that ethnic differences and gender gaps persist through high school on 'high stake' tests including, the SAT and statewide achievement tests. This is due to the fact that mathematically-talented females are not reaching their highest academic potential, since they test poorly on standardized tests but tend to attain higher grades in all subject areas. Shapka & Keating (2003) discovered, "a significant positive effect on girls' math and science performance and persistence" (p. 950) in single-sex classrooms, but it did not have a similar positive effect on attitudes toward math; therefore, there was not a reduction in their anxiety level. The girls in the study completed more mathematics courses after their single-sex classroom experience in high school.

Boys usually score higher on standardized tests, but receive lower classroom grades. Research does not show the effectiveness of single-sex classrooms for boys' achievement (Van de gar et al., 2004). Consequently boys tend to perform better in co-educational classrooms. Of all the teacher behaviors observed in their interactions with boys, the teachers' encouragement of boys' behavior is more closely associated to their mathematical performance (Klein, Adi-Japha, & Hakak-Benizri, 2010).

Critical Analysis of Research on Single-Sex Math Classroom

There have been very few research studies of single-sex mathematics classrooms in the United States, since the changes in regulations relating to Title IX and singe sex classes and schools. Very few studies have examined single-sex classrooms within coeducational public school systems (Glasser, 2012; McFarland, Menson, & McFarland, 2011; Steitmatter, 1997). Most of the available research studies are from the UK (Jackson, 2002; Jackson & Smith, 2000; Younger & Warrington, 2002) or Australia (Harker, 2000; Jackson & Smith, 2000; Martino, Mills, & Ligard, 2005; Mulholland, Hansen, & Kaminski, 2004). There is also one large study of 400 students from Belgium (Van de gaer, Pustjens, Van Damme, & De Munter, 2004) and one from Canada (Shapka & Keating, 2003). Younger & Warrington's (2002) research site was a school in the UK that has been using single-sex teaching since the early 1970s. Younger & Warrington state, "there has been a remarkable consensus within the school, a conviction that single-sex groupings have supported students' learning and have met an educational need within the city in which the city is located" (p. 355).

Some research that is available on single-sex mathematics classrooms is lacking in scope as compared to my research study. Even taking into account that articles may be a portion of larger research, their magnitude and range are limited in focus. For example Che, Wiegart, & Threlkeld (2011) conducted a study on both boys and girls in a co-educational charter school. Their research questions only looked at the strategies on how the boys and girls solved the mathematical task. They looked at a sample of 119 students, but they only examined how those students worked out one math problem which is very limiting in opportunity for students' success. A smaller sample size and more problems would yield more comprehensive data. McFarland, Menson, & McFarland (2011) quantitatively examined boys and girls achievement scores comparing single-sex to co-educational classrooms. This study only analyzed performance data and, as the authors indicate, the research did not examine gender- specific teaching strategies that could be utilized in single-sex classrooms with the purpose of increasing achievement scores. Sometimes it is prudent to concentrate on a small sample or narrow research questions in order to gain depth in an analysis. For instance, Streitmatter (1997) concentrated her study on a girls-only pre-algebra and algebra class over a 2-year period. There was one research question; the data consisted of observations of 24 girls and interviews with 14 of these girls. Martino, Mills, & Lingard (2005) examined the boys-only class as a means of controlling boys' behaviors in order to raise their achievement levels. This research concentrates on only the boys in single-sex classes, but the reason the class was created is cause for concern. "By removing these 25 'naughty' boys from mainstream classes, it was thought that some of their specific behavioral problems could be contained and addressed without necessarily impacting other students" (Martino, Mills, & Ligard, 2005). Creating single-sex classrooms in order to address behavioral management issues may be possible in Australia, but not in the United States due to legal constraints.

Many of the aforementioned quantitative research studies compare achievement and performance levels of the students' mathematical abilities (Harker, 2000; MacFarland, Menson, & McFarland, 2011; Shapka & Keating, 2003; Van de gaer, Pustjens, Van Damme, & De Munter, 2004; Younger & Warrington, 2002). Quantitative research examines numerical data, causes, and effects as opposed to qualitative data, which is conducted to understand social phenomena. This qualitative dissertation comprehensively examines the phenomena of both boys and girls single-sex classrooms concerning the social, cognitive, and psychological aspects of students learning mathematics.

Cooperative and Competitive Learning Contexts

Characteristics of cooperative and competitive. A cooperative learning context is an instructional method in which students work together to achieve a common goal (Sherman & Thomas, 2001). Students in cooperative small groups are given learning tasks in which they are expected to work as a team and communicate with their group members (Mulryan, 1995). Cooperative learning activities should be enjoyable as well as motivating for the students (Mulyran, 1994). Group members are rewarded based on the quality of their work according to the criteria set by the teacher. Durrick and Eccles (2006) believe cooperative activities engage students by having them work collectively with their peers to produce a shared product. Leikin and Zaslavsky (1997, p. 332) emphasize, "The social interactions involved in group problem solving enable each student to extend his or her zone of proximal development," as theorized by Vygotsky. Accordingly, students are able to solve problems cooperatively, before they are able to solve the problems individually. Johnson, Johnson, and Roseth (2010, p. 9) confirm, "Students learn together so that they can subsequently perform higher as individuals." Consequently, the purpose of a cooperative learning context is to make students think more critically.

Cooperative groups optimally should consist of three or four students, depending on the level of the task, social skills, and age of the students (Johnson, Johnson, and Roseth, 2010). The desks should be arranged so the students face each other and are in close proximity with their group members. It is imperative that each group member understands the procedures and guidelines of the group activity. Small groups should provide a supportive and safe environment for students with a range of ability-levels (Martinie, 2003). Nobody should be blamed or reprimanded for less subject matter knowledge (Lavasani & Khandan, 2011). Students should appreciate help from their peers, while they are discussing problems and working towards solutions. The teacher's role involves monitoring group work, guiding students by answering and asking questions, and holding students accountable for their learning (Martinie). It is essential the teacher communicate the norms and behaviors of working in cooperative groups to the students. To obtain the maximum benefits of working in cooperative groups, students must adapt their engagement and behavior to the numerous demands of the setting (Mulryan, 1995). The intention of using small cooperative groups in the mathematics classroom is to provide students with an effective and supportive learning environment in which students can explore the mathematics curriculum (Leikin & Zaslavsky, 1997).

A competitive learning context involves students trying to outperform each other (Durick & Eccles, 2006; Tauer & Harackiewicz, 2004). Students are characteristically less social with students, since students focus on their own learning (Durick & Eccles). According to Roseth, Johnson, and Johnson (2008), competitive interaction patterns involve withholding and/or hiding resources and information and acting in distrustful ways. Students are competing for time and working parallel with each other. Competition can facilitate performance when the tasks involved require quick, well-learned responses instead of difficult new material and can have a positive effect for students in certain situations due to intrinsic motivation (Tauer & Harackiewicz). Competitive contexts can increase the desire to do well along with a sense of excitement or challenge, which may cause students to become more involved in an activity thus increasing intrinsic motivation (Tauer & Harackiewicz).

Benefits of cooperative instructional approach. Roseth, Johnson, and Johnson (2008) state, “it may be inferred that positive social relationships are not only one of the results of cooperative goal structures but are also one of the processes contributing to higher levels of achievement” (p. 238). Cooperation within the group encourages more frequent use of higher level reasoning strategies and students become more socially skilled than students working competitively or individually (Johnson, Johnson, & Roseth, 2010). Therefore, in cooperative groups students can be exposed to more cognitively demanding mathematical content as compared to a whole class setting (Mulryan, 1995). Peers can help fill in gaps in students’ understandings and correct any misconceptions, since they share a similar language and can explain concepts in a language that their peers can comprehend (Webb, Farivar, & Mastergeorge, 2002). The explanations must be relevant to the students' needs, timely, correct, and sufficiently explained in order for the target students to correct their misconceptions and aid in their comprehension (Webb, Farivar, & Mastergeorge, 2002). Therefore, cooperation supports achievement, positive relationships, and greater psychological health. Johnson, Johnson, & Roseth believe the higher the quality of relationships among students the higher their academic achievement. The more students are exposed to cooperative group experiences, the more mature their cognitive, social, and moral decision-making, and the more they will take other student's perspectives and ideas into account in the mathematics classroom.

Leikin and Zaslavsky (1997) highlight, "A major concern among mathematics educators, in addition to promoting students' activeness, is meeting low-achieving students' needs for help in the course of learning mathematics" (p. 334). Sometimes high achievers have a tendency to dominate group work or to work alone, while some students exhibit relatively passive behaviors (Mulryan, 1995). Becoming more active learners as well as displaying more enthusiasm and motivation about mathematics is more feasible for high-ability students; the real challenge remains doing so for low-ability students (Leikin & Zaslavsky). In the absence of highly structured activities, low-achievers may become relatively uninvolved in cooperative groups or may become too dependent on their peers (Mulryan). These students may work less in groups due to the belief that their individual work is not easily noticeable to the teacher and do not believe they are accountable for their share of the group work. Groups which accentuate the importance of working together, explaining, understanding, and helping each other are more likely to give higher-level help as compared to other groups (Webb, Farivar, & Mastergeorge, 2002). Students must be willing to give elaborated help as well as clearly explain and articulate problem solving in a helpful and meaningful way to the student(s) seeking help. It is important that students monitor their group members' understanding and not 'do' the work for others due to time pressures, incomplete explanations, and lack of understanding. Lavasani and Khandan (2011) state, "Through discussion, consultation, and help seeking, the students acquire the ability to abolish their learning problems, propose different solutions, and learn the different guidelines from their teachers and their school-mates" (p. 7).

Competitive learning context in school mathematics classes. The reason for choosing a competitive learning context in a mathematics classroom is to assign students individual goals and reward them upon completion. Competitions can be an exciting challenge and increase the desire for students to do well. Therefore students may become more involved in an activity and increase intrinsic motivation (Sherman & Thomas, 1986). Sherman and Thomas conducted a study on two high school mathematics classes and found data that strongly supports, "the effectiveness and motivating qualities associated with intergroup competition among small cooperating classroom groups." Intergroup competitions take into account that in the real world there are activities that involve both cooperative and competitive elements. There have been very limited studies conducted on intergroup competition (Tauer & Harackiewicz, 2004). Overall there have been a limited number of studies on competitions in the mathematics classroom with even fewer containing intergroup competitions and/or middle school level. There are a few practitioner journals containing examples of competitive games and puzzles with the whole article being only a couple pages in length. In summary, there is a strong need for research on competitions in the middle school mathematics classroom, arising from advantages of utilizing competitions to increase student motivation and effectiveness and elementary teachers' adoption of competitions while practicing operations (Durick and Eccles, 2006).

Durick and Eccles (2006) found that elementary school teachers, who experienced a more positive experience in teaching math because of their comfort level or expertise, were more likely to use competitive math activities. The tendency for math teachers to use competitive activities depends on the nature of the math content, in addition to the teachers' perceptions of the material. In elementary school, students are practicing arithmetic operations and the application of rules. Therefore, the use of competitions at the elementary school level can facilitate performance, when the task involves quick well-practiced responses, as opposed to new and difficult concepts (Durick & Eccles).

Boys and girls in cooperative and competitive learning tasks. Cooperative learning can be used as teaching technique to lessen mathematics anxiety especially in females. Lavasani and Khandan (2011) found cooperative learning significantly decreases mathematics anxiety and increases help-seeking behaviors. When anxiety is reduced since students are not criticized, they develop confidence in their abilities to learn mathematics. Esmonde (2009) also points out girls are characteristically more cooperative compared to boys which lead them to excel during group work activities. Mulyran (1994) found differences between boys and girls were minimal, but girls emphasize the importance of social variables over academic variables as compared to boys. In cooperative groups girls are more likely than boys to engage in taking turns, help their peers, and verbal organization (Townsend & Hicks, 1995). Therefore, the social satisfaction of working in cooperative groups may be greater for females.

According to Crockenberg, Bryant, and Wilce (1976), females tend not to be competitive and are more accommodating and try to please others, whereas males can be very exploitative and competitive. Females may fear success because success means another student fails and success could be viewed as 'competitively aggressive' and consequently unfeminine (Crockenberg, Bryant, & Wilce, 1976). Therefore not winning in a competitive situation would be less devastating for girls than boys. Competition may be used as a classroom strategy to add excitement for boys into an otherwise dull situation (Crockenberg, Bryant, & Wilce, 1976). Additionally this study emphasizes the need for research involving gender in the mathematics classroom as demonstrated by the limited amount of literature involving boys and girls in competitions.

Social Constructivism and Feminist Theory in Cooperative and Competitive Learning Contexts.

The perception of the role of mathematics in society has a major influence on the development of the school mathematics curriculum and instruction (White-Fredette, 2009). Due to the fact mathematics has monumental importance outside the classroom, there is an emphatic need for students to have a deep understanding of mathematics inside the classroom (Hennessey, Higley, & Chesnut, 2012). Mathematics is no longer considered knowledge that must be memorized in a rote fashion. Every facet of today's society requires knowledge and interpretation of mathematics. Social constructivists advocate mathematics as something people do as well as a social construction of knowledge (White-Fredette, 2009). Learners need to be engaged early in mathematics, while they are sense-making and constructing their own mathematical understanding. Strong feelings among mathematics educators exist on the best ways to teach mathematics at the K-12.

In the mathematics classroom, constructivists view knowledge as how students individually make sense of experiences within their understanding of reality (Hennessey, Higley, & Chesnut, 2012). When students experience a conflict with their prior understanding, the changing of their understanding is learning. Prior knowledge is built upon the lack of connection with new concepts and ideas. Social constructivism includes the nature of the learning situation, since students make sense of their situation within a social context illustrated in cooperative and competitive groups. Students can increase their mathematical understanding by using a constructivist framework within their group discussions, where they construct a meaningful system of solutions for their topics. Hennessey, Higley, and Chesnut state, “By asking the students to take responsibility for their learning (through discussion and problem solving) they learn more and participate in the needed reflection to grasp the ideas of the lesson” (p. 192). Constructivist teaching supports students and teacher’ reflection and promotes interactive mathematical communication (Hennessey, Higley, & Chesnut). It is important the discussion become a vital part of the teaching process so teachers can regulate whether the lesson and the construction of knowledge is heading forward appropriately. As students work in their cooperative groups, the teacher must infer what the students understand, which can be challenging. The teacher must also have the skill to communicate with their students effectively in order to create or resolve misguided conceptual ideas through interactions.

The feminist perspective highlights the roles of belonging and becoming with increasing importance. Females especially need to feel a social connectedness, which is a key factor in cooperative groups as groups work together and become closer connected units. Cooperative learning is one technique to promote more equitable learning experiences in the mathematics classroom (Esmonde, 2009). Advocates emphasize that cooperative learning contexts foster social skills as well as academic content. Successful cooperative groups are more likely to attain correct concepts, be attentive to other group members' behaviors, share group supplies, and respond to each other's ideas. Differences in group achievement are more likely to be a result of social variation, instead of variations in access to knowledge. A key benefit of cooperative learning is the preparation of students for future learning, lectures, worked examples, and jobs (Esmonde). The feminist perspective is significant to how students' construct their individual identity through skin color, sexuality, age, and disability within the mathematics classroom as well as in society as a whole. The more diverse a community, the better equipped the students will be able to negotiate a practice that does not compromise their identity (Griffiths, 2006).

A negative aspect of cooperative groups considers students' positional identities. According to Esmonde, "In diverse classrooms, girls, working-class students, students of color, and students who are generally considered low achieving by their teachers and peers may be marginalized and thus prevented from engaging in meaningful sense-making discussions with their group" (p. 1024). In some classroom context, the students that are viewed as more competent lead the group, while others wait for instructions. Teachers are able to equalize differences among students and create more equitable participation among students. Students then negotiate ways of working together that involves less hierarchy and more cooperation among group members. Single-sex classrooms can be used as an intervention to reduce the dominance of males in co-educational mathematics classrooms. A challenge remains for mathematics educators, researchers, future educators, and community leaders to consider how to best support, organize, and transform K-12 mathematics classrooms.

Summary and Introduction to Chapter 3

This chapter reviewed the literature pertinent to this study. The chapter provided a discussion of the social constructivist theory and feminist theory that will form the theoretical framework of the study. An overview of the literature on the historical developments of women in society and women in mathematics followed. An extensive discussion of the major aspects of co-educational and single-sex classrooms was presented detailing the aspects of interests, confidence, peer interactions, teacher interactions and performance. In addition, a critical analysis of research on single-sex mathematics classrooms was provided. A thorough examination of cooperative and competitive learning contexts was given including research on characteristics, benefits, and school mathematics classes.

The following chapter will explain the method chosen to study the learning experiences of middle school students enrolled in an all-girls math class and an all-boys math class, which has an exploratory multiple case study design. A thorough description of the research site, participants, and the methodology of how the data will be collected and analyzed will also be discussed.

CHAPTER 3: METHODOLOGY

Research Design

This research project was designed as a qualitative case study involving one all-girl seventh grade mathematics class and one all-boy seventh grade mathematics class in a rural co-educational public middle school. The design is relevant for the study, since the purpose was to explore the middle school students' learning experience in a natural classroom setting. Qualitative research listens or describes 'the data' or the 'other' and consequently reveals new understanding while simultaneously building new locally contextualized theory (Ezzy, 2002). Qualitative research describes and clarifies the social processes that make life significant. Given that the purpose of the study was to examine the learning experiences of students enrolled in an all-girls math class and an all-boys math class, it is critical that the learning experiences are thickly described and clarified within the educational environment.

The case study methodology was selected in order to recount a detailed description of the uniqueness and commonalities of the lived experiences of learning mathematics in an all-girls or all-boys classroom (Stake, 1995). Merriman (1998) states the following:

> A case study design is employed to gain an in-depth understanding of the situation and meaning for those involved. The interest is in process rather than

> outcomes, in context rather than a specific variable, in discovery rather than a confirmation (p. 19)

In research, case studies have contributed uniquely to knowledge of individual, organizational, social, and political phenomena (Yin, 1994).

Generalization is a concern with case study research, since only a single case or just a few cases are studied; however, these few cases will be studied at length. The researcher is to generalize particular results to a broader theory. In case studies, a particular case is thoroughly examined. Overall there is an emphasis on uniqueness, which implies knowledge of others that differ from this case, but the first emphasis is on truly understanding the case itself (Stake, 1995).

There are three different types of case studies: exploratory, descriptive, and explanatory (Yin, 1994). These types of designs may be used together in particular studies. Each type of case study has distinctive characteristics yet there may be overlap between the different strategies. A descriptive case study presents a detailed account of a phenomenon under study and chronicles a sequence of events (Merriam, 1998). Descriptive case studies are useful in presenting basic information about a program or practice. Regardless of the area of inquiry, basic descriptions are given first before hypothesizing. Explanatory case studies answer “how” and “why” questions. In conclusion, each type of case study calls for a different research design and data collection strategy guided by the research questions (Yin, 2003).

This study presents exploratory case studies with, the following overarching research question guiding the study: How do the two different pedagogical approaches cooperative and competitive learning context shape students’ learning experiences in an all-girls math class and an all-boys math class? An exploratory case study approach examines “what” questions, with the goal being to develop hypotheses and propositions or further inquiry (Yin, 2003). The design used for an exploratory study should state a purpose, in addition to criteria by which an exploration will be judged as successful (Yin, 2003).

Site of Research

The site of the research is a middle school located in the southeastern region of the United States. Historically this district was largely a farming community with cotton as the primary cash crop supplemented by vegetables. In the 1960s, a lake was created in the region by flooding the fertile farmland, significantly changing the landscape. Soon weekend and summer getaway homes began to appear along the lake and after a few years these homes were replaced by more luxurious lake homes. The population increased as people that grew up in the surrounding counties and people new to the southeastern United States moved to the community. In the 1970s, local family members began to commute to work to surrounding textile mills. Most African Americans lived in a small region in the district by a nearby church until the 1980s. The school is located in an economically diverse rural community with a population of approximately 15,000. The racial makeup is approximately 95% White, 3% African American, and 2% Hispanic. Some of the students are from a wealthy community situated close to the lake; some live in a working class community, and some live in a mobile home community with parents without jobs. Overall, there are families of all races that are struggling economically. Approximately 71% of residents over 16 are employed in this rural community; with 85% of those commuting to work alone in a vehicle. The largest employers are manufacturing (approximately 20%), transportation, warehousing, and utilities (12%), and construction (10%). The median household income is approximately $52,000 with 4% of families below the poverty line. Approximately 83% of the residents have a high school education or higher and 20% have a bachelor's degree or higher (Wikipedia, 2012).

The middle school in this study has a population of approximately 750 students in grades 6-8 and about 50 teachers. The school has socioeconomic mix of students with some from upper-middle class, middle class, working class, and lower class income levels. Many of the families, who have relocated to this area from across the country for different types of employment, including NASCAR, insurance, banking, and nuclear energy, are volunteers at the school. Overall, parents are very involved in the school, especially the PTA which consists of mostly upper-middle class white parents that provide many helpful resources and funds. Parents and community members also volunteer their time to help the Community in Schools program which provides support for at-risk students. The parents have an open line of communication to the school through weekly Take Home Tuesday Folders, e-mails, Alert Now recorded phone messages, monthly school newsletter, parent-teacher conferences, the school website, and teacher website pages providing information on homework, tests, and schedules. The school has a plethora of programs in place to reinforce its high academic standards to students and families.

During the 2009-10 academic year the school's demographic data were as follows: 88.7% White, 2.2% African American, 0.8% Asian, 5.6% Hispanic, and 2.6% other. The number of students on free and reduced-price lunch was 31.7%. The number of students who speak English as a second language was 1.2%. According to the School's Report Card for 2010-11, students scored an overall 93% math and 82% in reading on the End of Grade Tests (EOG). The performance of students grouped by their EOG scores who passed both reading and math tests for the 2010-11 school year is as follows: 82.7% White, 50% African American, 65% Hispanic, 79.4% Male, and 81.8% Female. As indicated by these EOG scores, African-American and Hispanic students scored considerably lower than Whites students.

This research study was conducted during the 2012-13 school year, which coincided with the implementation of the Common Core Curriculum. The new EOG tests in math reflected the more rigorous standards. According to the School's Report Card for the 2012-13 school year, the 7^{th} grade math score was 49% for the middle school in the study. The students in the single-sex classrooms did meet expected growth; regrettably, there were other teams in 7^{th} grade that did not meet growth. Overall, the single-sex classrooms were a positive experience for the teachers and the students, which may have contributed to the team making expected growth in mathematics. During the school year, the girls asked more questions about mathematics either to their teacher or their peers, as compared to co-educational classrooms. The girls were not inhibited and concerned about not looking smart and being teased by boys, as traditionally has been the case in co-educational classes. The boys usually worked diligently during class in the absence of girls. Since discipline was not an issue, time was not lost on punishment or discipline referrals. Unfortunately a request to have single gender classes for the 2013-14 was denied by the principal, but it is being considered in the future.

The 50-teacher population at the middle school in this study consists of grades 6-8 classroom teachers, elective teachers, EC teachers and teacher aids, an AIG teacher, and media specialists. According to the School's Report Card for 2012-13, the teacher turnover rate was 12%. To meet the 21st century needs of the students, all classrooms are equipped with Promethean boards. Other technology includes lumens, mobile laptop carts, TI navigators, iPods, and two computer labs. Learn 360 is also utilized to enrich classroom instruction. Teachers also take part in a multitude of committees and intervention such as: School Improvement Team (SIT), Thinking Map Strategies, Math Counts, Battle of the Books, Student Council, Beta Club, Jazz Band, and various clubs. Teachers observe each other and are observed by administration in order to ensure each teacher's accountability to student and professional success. Each teacher also completes a self-assessment of their needs for growth and has conferences with administrators regarding their progress.

Classroom Context

The participants chosen for this study were the students in the researcher's all-girl seventh-grade general mathematics classroom and all-boy seventh grade mathematics classroom for the 2012-2013 school year. The classrooms consisted of 22 boys and 27 girls between 11 and 13 years old. The all-boys classroom consisted of 5% Asian, 5% Hispanic, and 90% Caucasian students. The all-girls classroom consisted of 7% African-American, 7% Hispanic, 4% Multiracial or African-American & White, and 82% Caucasian students. Participation in the study required a parental consent form and a student assent form filed with the researcher.

Implementation of Single-Sex Classrooms

I discovered the following steps on how to implement single-sex classrooms in a public school as I prepared to undertake this study. First, I obtained permission from the public school system's county office to have single-sex classrooms. Second, I obtained permission from the school's administration, which consists of the principal and the assistant principal. Thirdly, I obtained approval from the School Improvement Team. Fourth, letters were sent home to parents/guardians obtaining their permission and allowing them to opt out of the single-gender classrooms. Lastly, the schedules were changed for the students to have single-sex classrooms in both mathematics and language arts. The entire process of implementing single-sex classrooms in a public school was time-consuming; however, the benefits far outweighed any negative aspects of the process.

Research Process

The teacher, also the researcher, taught mathematics for the 2012-13 school year in two single-sex classrooms one all-girls and one all-boys. Throughout the school year, the teacher followed NCTM's recommendations and utilized instructional strategies that facilitated logic thinking skills and problem solving. The problem-solving type lessons encouraged students to work in pairs and/or groups to solve upper-level thinking problems; therefore, the classrooms turned into 'mathematical communities' rather than collections of individual learners. Some of the competitive lessons in the study also involved group work. The different groups worked competitively against each other to solve the puzzle and/or mathematical problems quickly and accurately. Another type of competitive lesson involved the students working individually and competitively against their peers. Before each cooperative and competitive activity began, the teacher explained the directions and the rules, before distributing needed supplies. As facilitator of the activities, the teacher answered student questions and issues as they arose during the activity. Hints were given to facilitate the learning process when students became too frustrated in solving challenging puzzles. At the end of the activity, the paperwork was collected along with supplies used during the activity.

The teacher developed four pairs of lessons intended to create either cooperative or competitive learning environments which were videotaped for research purposes. As shown in Appendix A, these four pairs of lessons were taught in four different months. The pairs of lessons utilized different instructional strategies with the first lesson using a cooperative learning design, followed by a competitive lesson design the next day. The purpose of employing different teaching strategies was to examine the students' responses and class dynamics under different learning contexts. Two pairs of lessons taught in the fall and two in the spring were each approximately 30 minutes in length. After each pair of lessons, the students were given the post-lesson survey to describe what students learned during the activity (see Appendix B). On the following day, two students were interviewed to gain an even more in-depth examination of the learning that occurred during the mathematical activity (See Appendix C).

Another pedagogical grouping intervention that was used in this study was the single-sex mathematics classrooms. In single-sex classrooms, the psychosocial stresses are removed from the learning environment since competition among the sexes is eliminated. As girls work together in a single-sex environment, their psychosocial self-confidence increases along with academic confidence (Gurian, 2001). Boys learn to find safety by working with other boys who understand them while they also learn to manage their own behavior (Gurian, 2001). Boys systematically overestimate their abilities and are impressed by boys that take risks, while girls tend to underestimate their abilities (Sax, 2005). All-girls classrooms make it easier for girls to take risks without fear of boys making fun of them or belittling their achievements. Moderate stress has been shown to improve boys' test performance, but degrades young girls test performance (Sax, 2005). All gender-specific strategies utilized in the classrooms have the potential to help students excel psychologically, socially, and cognitively in a safe and supportive environment. Students' responses to the different instructional approaches and learning environments have been closely documented using video recording and other measures that follow. The teacher modified instruction as needed to accommodate the needs of the boys and girls as shown by their psychological responses situated in a single-sex math classroom. For instance, the girls may not have shown as much interest with integer football examples of gaining and losing yards, but were concerned about gaining or losing pounds. For another example, some girls preferred asking me questions privately, whereas the boys felt comfortable asking questions during whole class instruction.

Data Collection Methods

The school decided to have single-sex mathematics and language arts classrooms for the 2012-2013 school year with the approval of the School Improvement Team (SIT). A letter, Appendix D, was sent home to parents in July 2012 giving their child the opportunity to participate in the single-sex classes for the upcoming school year or the opportunity to opt out and have their student remain in co-educational classes. Next, approval was obtained from the Institutional Review Board (IRB) at the university at which the research was conducted. The school system also provided a letter of permission for the research to occur in their schools as part of the IRB process. In order for their student to take part in the study, parents were then required to return a parental consent form; the students were required to return a student assent form to the researcher (see Appendix E). Students' names were replaced with pseudonyms to maintain anonymity. The name change record with students' pseudonyms is given in Appendix F. A seating chart is given in Appendix G to show how the students were grouped together in their cooperative and competitive groups. The same groups were maintained throughout the school year, with minor changes being made due to students moving out of the school and absences on data collection days.

This case study utilized multiple data collection methods including observations, surveys, interviews, reflective journals, and school-based documents. The data also included observation field notes, observation of the classroom, student work, interview audiotapes, and interview and observation transcriptions.

Data Collection Context

On a monthly basis, lessons were taught in pairs with the first lesson representing a cooperative learning design and the second lesson demonstrating a competitive classroom context. In each lesson the students were situated in small groups of three or four students, except for the individual tangram competition. Since the students were in single-sex classrooms, the groups were either all-girls or all-boys. During the classroom lessons, I acted as a facilitator of the lessons. At the beginning of each lesson, I gave instructions for the activity and then monitored and answered student questions while they completed their tasks in groups. At the end of the lesson, I facilitated a whole group discussion or closure of what the students learned while completing the activity. The students' work was collected at the end of closure discussion.

TABLE 3: Learning design

Month and Year	Type of Lesson	Topic/Task
November 2012	Cooperative Group	Making Integer Puzzle
	Competitive Group	Solving Integer Puzzle
December 2012	Cooperative Group	Making Equation Puzzle
	Competitive Group	Solving Equation Puzzle
January 2013	Cooperative Group	Taxes, Discounts, Tips
	Competitive Individual	Tangrams
March 2013	Cooperative Group	Irregular Geometric Shape Stations
	Competitive Group	Problem-Solving

Table 3 shows the timeline of the different learning contexts as they were taught in pairs on a monthly basis. In November the students' tasks were to make an integer puzzle in their small groups of three or four students. (See Figure 1 on p. 60) Each student was given a sheet of notebook paper on which they drew a 3 by 3 table or puzzle grid on the top half of the paper. Students' demonstrated their work on the bottom half of the paper. Each group was provided with a blank puzzle grid on which the group's final version of the puzzle would be illustrated. The students worked with their group members to create and solve integer equations. They also came to an agreement with their group members on the placement of the problems and answers on the puzzle grid. The students placed their integer expressions within the puzzle grid with an integer expression on one square, which joined with the answer on the adjacent puzzle piece. The students also positioned problems and answers on the edge pieces to make the puzzle more challenging, since the students working out the puzzle would not know which problems were edge pieces. If the edges of the puzzle were left blank, then the students would know which squares outlined the puzzle. While creating the puzzle, the students tried not to have any two problems with the same answer, since that would have increased the level of difficulty. Due to time constraints and the difficulty of the task, students were encouraged to work in cooperative groups. The students were challenged to create their own integer expressions, which required upper level thinking as opposed to just solving expressions given to them. The students only had one class period in which to create the puzzle. Due to the amount of integer expressions and answers that were needed for each puzzle the students had to work cooperatively to finish the task in a timely manner. I acted as a facilitator during the activity by doing the following: explained the directions at the beginning of the class, answered students' questions that arose during the activity, guided students questions and misconceptions, gave encouragement for students to help each other, operated as timekeeper, and directed the whole class discussion at the closure of the activity. At the end of the class, the students' notebook paper and group puzzle grids were collected. Thus, the students created an integer puzzle in a small group during the cooperative lesson in November.

Figure 1 is an example of an integer puzzle created by the girls in their cooperative groups. This puzzle has problems that require 2, 3, or 4 steps in order to solve them. For instance the middle square contains the problem 12 + 2 x 10 + 10 ÷ 5, which has 4 steps. There are also problems with parentheses or fractions. This puzzle was not chosen for the boys to solve based on the level of difficulty due to the use of fractions and 3 or 4 step problems.

FIGURE 1: Example of integer puzzle girls created (cooperative)

The competitive lesson in November consisted of the students solving an integer puzzle. Out of the seven puzzles created in each class during the previous day, I chose one of the puzzles created by each gender for the other gender to solve. Therefore the boys created an integer puzzle for the girls' class to solve and the girls created an integer puzzle for the boys' class to solve. The puzzles that were chosen to be solved were based on correctness of answers, legibility, and difficulty of the puzzle. The selected puzzles had a medium difficulty level. The puzzle the boys solved is shown in Figure 2. The puzzle is easy to read and contains no mathematical errors. All of the problems require two steps in order to solve them. Figure 3 depicts the integer puzzle the girls solved. Similar to Figure 2, this puzzle is easy to read, has no mathematical errors, and all problems are solved in two steps. Thus the boys and the girls created and solved puzzles that were similar to each other.

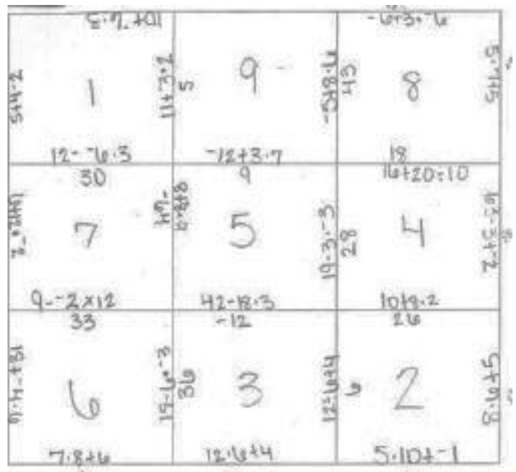


FIGURE 2: Integer puzzle boys solved (competitive) in November

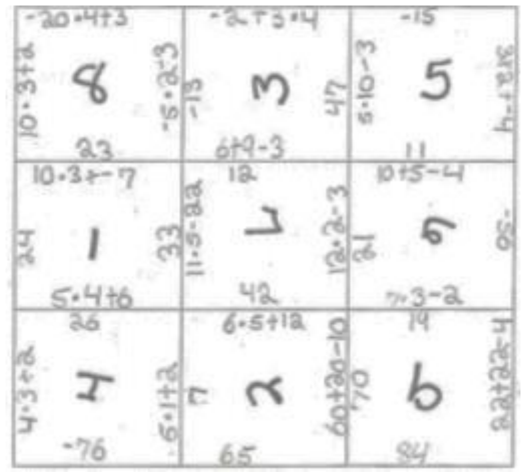


FIGURE 3: Integer puzzle girls solved (competitive) in November

Before class began, I made seven copies of the puzzle that each group would solve. Each puzzle was cut out along the black lines; thus, nine puzzle pieces were put into seven plastic baggies. At the beginning of class, I gave each of the seven groups a plastic baggie. The groups were in competition with each other, with the first two groups to complete their puzzle correctly received brain food or candy. Students showed their work on notebook paper, as they solved the integer expressions. They also drew a 3 by 3 puzzle grid on their paper in order to provide the correct answers. Their answer key only had to give the numbers given in the center of each square; consequently the students did not have to write down the multiple integer expressions shown on each square. Students' notebook paper and the puzzle baggies were collected at the end of the activity. I acted as a facilitator during the competitive activity by doing the following in a much quicker manner than during the cooperative lesson: explained the directions at the beginning of the class, answered students questions as they arose during the activity, guided students questions and misconceptions, gave encouragement to work quickly, acted as umpire to judge correctness of puzzle, operated as timekeeper of which groups finished first and second, and directed the whole class discussion at the closure of the activity. In summary, the competitive lesson in November consisted of the students solving an integer puzzle, which was created by the opposite gender.

December's tasks had the same format of those in November. The primary difference between the task given in November and December was the type of problem. The cooperative lesson in December tasked the students with the creation of a 2-step equation puzzle on a 3 by 3 grid. The students had the option of using multi-step equations, but most of the groups opted for using a 2-step equation design due to time constraints. Some of the groups made their puzzle more challenging by choosing to include fractions and decimals in their problems. The competitive lesson in December involved the students solving an equation puzzle. The equation puzzle the boys solved during the competition is shown in Figure 4. All of the problems are 2-step equations; one of the answers contains a decimal. The equation puzzle the girls solved is shown below in Figure 5. Two of the equations in the puzzle shown in Figure 5 are multi-step equation. For example in square 5, $6X - 2 + 12 = 28$ is a 3 step equation as is $40X + 20 – 0 = 60$. As in November, the puzzles that were selected to be solved were based on correctness of answers, legibility, and difficulty of the puzzle. Therefore, the competitive lesson in December consisted of students solving an equation puzzle, created by the opposite gender.

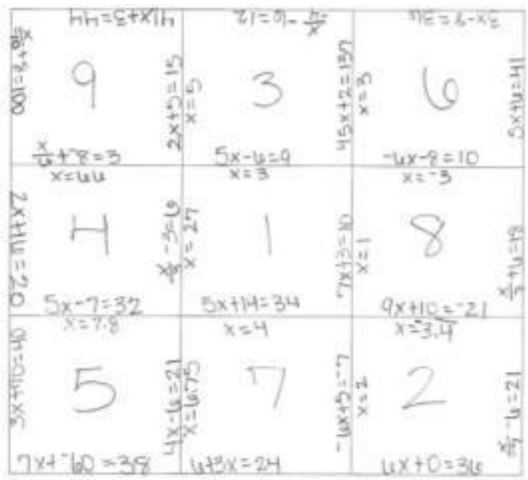


FIGURE 4: Equation puzzle boys solved (competitive) in December

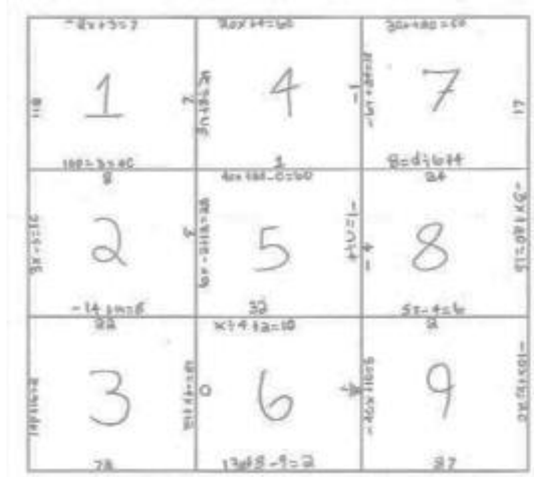


FIGURE 5: Equation puzzle girls solved (competitive) in December

For January the cooperative lesson involved the students solving taxes, discounts, and percent problems. The first three station cards are shown below in Figure 6. Students were given an index card with a scenario and up to four problems to solve. Some cards also included a menu or sale ad. There were seven stations in total; students had about six minutes at each station. When the timer rang, the students moved in their groups from one station to another to solve problems. The students solved their problems and showed their work on notebook paper. The students moved from station to station with their calculators, pencils, and their notebook paper. The students answered most of the questions at each station; however, if they had extra time at a station, they solved any previously incomplete problems. This lesson was chosen as a cooperative lesson so the students could ask each other questions to aid in their comprehension. The students had to complete their task in the assigned time frame, even those with additional menus and sale ads. Accordingly in January the learning design of cooperative groups required the students to solve tax, discount, and percent problems.

The competitive lesson in January involved the students solving tangrams individually (Dean, 1995). First, the students cut out the seven tangram shapes with scissors. After the initial instructions and directions were given for the tangram game, a picture was put up on the projection screen. The students had to use all seven shapes to form the picture that was displayed that could include a swan, duck, bunny, or the letter E. The students were in competition with each other to see who could create the given shape first. The students raised their hands when they thought they were right; I examined their creation for correctness. When students became discouraged by the difficulty of the activity, I gave encouragement to boost their confidence. This activity was chosen as a competitive lesson due to the fact that it could be played like a game and the student that solved the shape correctly received brain food. Therefore, the competitive lesson in January consisted of the students solving tangram puzzles using all of their seven tangram pieces.

Station #1

1. Mrs. Renzo wants to buy enough fabric for 1 child's cape. At a cost of $2.89/yd, how much will the cape cost?

2. Harold is making 2 adult capes. At a fabric cost of $3.29/yd, how much will the capes cost?

Size	Fabric
Child	2¼ yards
Teen	3½ yards
Adult	4 yards
Large Adult	5½ yards

* Table shows amount of fabric needed to make a cape in different sizes.

Station #2

Welcome to the Bistro!

You are ordering a Royal Luau Jr. Pizza, a Gatorade, and a brownie à la mode.

1. What is the total price of the food?
2. What is the tip – 15%?
3. What is the tax on the food – 6%?
4. What is the total amount of money needed to eat at the Bistro?

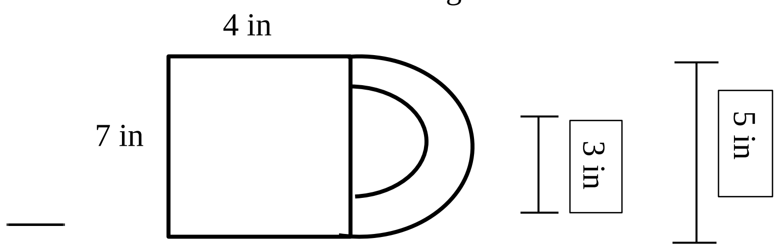
Station #3 Shopping at Wal-Mart. Buying: 2 cans of Progresso Light Soup 1 box of Special K cereal bars 2 containers of Daisy cottage cheese 1 Silk soy milk Find: Tax is 6.5% 1. Total of food 2. Tax 3. Total of food with tax

FIGURE 3: Taxes, discounts, and percent station cards 1-3 for January (cooperative)

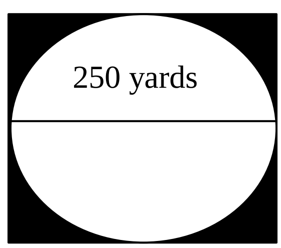
In March the cooperative lesson was solving for the area of irregular shapes. There were seven stations in total and the students had about five minutes at each station. The problems for stations 1-3 are given in Figure 7 shown below. The students copied the shape and dimensions given on the problem card onto their notebook paper; they solved for the area of the irregular figure using calculators. The students showed the steps on how they worked out each problem on their notebook paper. When the timer rang, the students moved in their groups from one station to another to solve problems. The students rotated from one station to another with their calculators, pencils, and their notebook paper. This lesson was chosen to be cooperative due to the complexity of the problems and the need for students to work cooperatively in order to solve the problems correctly. Therefore in March the learning design of cooperative groups required the students solve for the area of irregular shapes.

For the competitive lesson in March, students worked in groups to solve four different problem-solving scenarios as shown below in Figure 7 (Blum, Hart-Davis, Longe, & Niederman, 2002). Therefore, there was group collaboration even in a competitive learning context, since the competition was between groups and collaboration was necessary to win in each situation. Students solved their problems and showed their work on notebook paper. With the first problem, students were encouraged to use scraps of paper to represent each of the family members and to move the pieces back and forth across the river to help them cross the river. The answer to each problem was discussed and shared before moving onto the next problem. This lesson was chosen as a competitive lesson due to the ease of determining the correctness of the answers and when the groups were finished solving the problems. Therefore, the competitive lesson in March involved the students solving four different problem-solving scenarios within their groups.

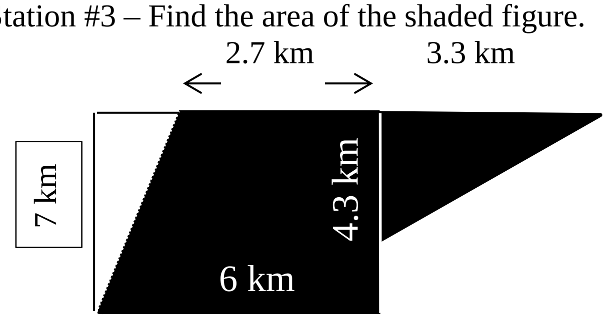
Station #1 – Find the area of the figure.



Station #2 – Find the area of the shaded part.

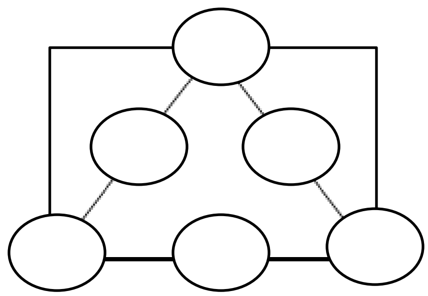


Station #3 – Find the area of the shaded figure.



Problems Solving

1. Floating Family – Mom & Dad and two kids have to cross a river, and they find a boat, but it is so small it can carry only one adult or two kids. Luckily both the kids are good rowers, but how can the whole family get across the river.
2. Slippery Slopes – Brenda the Brave sets off to climb a mountain which is 12,000 feet high. She plans to climb 3000 feet each day, before taking overnight rests. A mischievous spirit, however, decides to test Brenda's resolve. Each night, Brenda's sleeping bag, with her soundly asleep in it, magically moved 2000 feet back down the mountain, so that when Brenda awakes in the morning she finds herself only 1000 feet higher than she was the night before!
Not one to give up, Brenda eventually succeeds. But how many days does it take her to reach the summit?
3. Magic Triangle – Can you write the numbers 1 through 6 in the circles, using each number once, so that the total you get by adding the numbers along each side always comes up to 9?



4. Tricky Connections – Three new houses have been built along a highway in Alaska. Each house needs an electricity supply; however the permafrost means nothing can be buried underground, and no supply must ever cross a driveway. Too, a new safety law states that no electricity supply may cross a water pipeline.

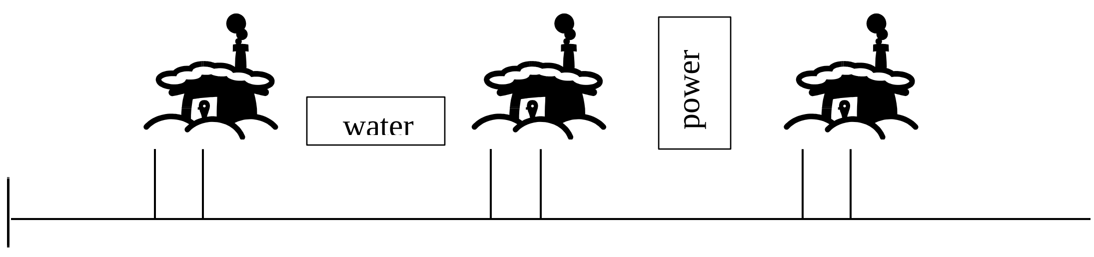


FIGURE 4: Irregular shape stations (cooperative) and problem-solving questions (competitive) for March

Surveys and Interviews. On the day following the lessons, the students completed the post-lesson survey consisting of six open-ended questions pertaining to the mathematic lessons (See Appendix B for the Post-Lesson Survey). After the post-lesson surveys were collected, two students from each of the all-boys and all-girls classes were interviewed in order to gain a further understanding of the social, cognitive, psychological aspects of the mathematical lessons. These semi-structured interviews followed the interview questions shown in Appendix C. The interviews ranging from approximately 5 to 10 minutes in duration were audiotaped. The two students from each class were selected based upon their responses to the post-lesson survey and/or their actions during the pair of lessons. Since there were 4 pairs of lessons, a total of 8 boys and 8 girls were interviewed (4 x 2 = 8). In addition, during the last survey, all students in the two single gender classes were asked if they would like to be interviewed. Three boys expressed their interest to have an interview which was then conducted. In total, 19 students, eight girls and 11 boys, were interviewed in this study.

Table 4: Major reason selected for interview

Name	Major Reason Selected for Interview
Isaac	Very animated and happy during both lessons. Group finished first during competition.
Andy	Group had differences of opinion on how to solve problems. Survey: Wrote the group did not work so well together, since they kept messing up.
Anthony	Received help from Andy on how to solve problems
Robert	Hard Worker.
Elijah	Not always working to fullest potential.
Christopher	Animated worker – Jeremy’s table partner
Robbie	Group leader. Showed frustration and stress in competitions.
Dylan	Animated worker. Volunteered for interview.
Zander	Hard worker in Christopher and Jeremy’s group. Volunteered for interview.
Michael	Volunteered for interview.
David	Volunteered for interview.

Name	Major Reason Selected for Interview
Hallie	Much discussion with group members. Survey: Liked working with group, “cause we got the work done.”
Bella	Much discussion with group members.
Leah	Survey: “…when I got one wrong they would show me how to do it.”
Anna	Positive and smiling while working. Very thorough answers on survey.
Savannah	Survey: “I liked we didn’t have to do independent work, you got to work with others.” Struggles with math.
Rachel	Hard worker. Showed frustration during tangrams.
Emily	Very verbal during closure discussions. Volunteered for interview.
Kylie	Survey: Enjoyed solving tricky problems with her group. Volunteered for interview.

The major reasons the students were selected to be interviewed are shown in Table 4. I was curious to learn what very enthusiastic workers Isaac, Christopher, and Dylan enjoyed about being in their group. Andy and Anthony were in the same group during November and December. They both worked intently with each other and interacted with extreme deliberation on how to solve problems and about the correctness of their answers. Robert and Dylan were chosen, since they were hard workers; Robbie was chosen because he was a group leader and yet showed much frustration during competitions. Elijah was chosen because he was not always working and would stop and watch others in his group. Dylan, Zander, Michael, and David also wrote on their last Post-Lesson Students Survey that they wanted to be interviewed.

Hallie and Bella were chosen to be interviewed because they got into intense discussions with their group members. Hallie and Leah were in the same group. These girls both spoke in positives about group work in their surveys, including getting the work done and their group members explaining how to solve problems. Anna gave thorough answers on her survey and was always smiling while she worked. Consequently I was curious as to what further information she would share. Savannah was a new student that struggles with math yet she wrote in her survey positives about group work.

Rachel was always a very hard worker and showed a lot of frustration while working independently with tangrams. Emily and Kylie, both in the same group, volunteered to be interviewed. Although each student interviewee was selected for different reasons, they were all chosen on the basis of opportunity to gain a deeper understanding of how they learned mathematics in groups. Analysis and data collection occured simultaneously with the observation and post-lesson surveys given. Further analysis was conducted to determine which participants to interview, then the analysis continued.

The Student Attitude Survey (SAS), was administered to explore the participants' present and future views of mathematics (Appendix H). Given in the late spring, the SAS measured attitude, interest, and confidence. The survey consisted of 15 questions: three were multiple choice that allowed two or three answers, three were Likert scale, and nine were open-ended responses. School-based documents were also collected such as school demographics and EOG scores, while classroom floor plans were created. In total these seven types of data were collected during the school year: student interviews, teacher's reflective journal, post-lesson surveys, students' reflective journals, classroom observations, student attitude surveys, and student work samples.

Classroom Observation. Field notes were taken as needed during the lessons with modifications and additions added at the end of the lesson or school day as time permitted. Transcriptions of the videotapes were made upon viewing of the videos at the end of the study. The co-chairs of the dissertation committee were given copies of the classroom videotapes. Archival/document data of student work were collected from the recorded lessons to gain further insight and analysis of student' mathematical comprehension. Students' reflective journals consisting of six questions were collected from the students in December and May in order to gain a thorough understanding of their views of working and learning mathematics in a single-sex environment.

Data Analysis Methods

Some of the data analysis began simultaneously with data collection to determine which students were interviewed. This process of concurrent data analysis and collection allows the analysis to be created by the participants as opposed to the analysis left until after the data collection has ended (Ezzy, 2002). Video transcripts which described what was happening in the classroom during the lesson were created while viewing the videotapes. Real time observation information, field notes, were combined with information from the video clips. Interviews were transcribed from the digital recorder. Next, all observation narratives and interview transcripts were made accessible for thematic coding, the next process of data analysis.

Connections were then made between the different types of analysis (see Table 5). The first sub-research question, How do the two different pedagogical approaches shape the cognitive processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?, was answered by analyzing the data gathered from classroom observations, student work samples, post-lesson surveys, student interviews, teacher's reflective journal, and students' reflective journals. The second sub-research question, How do the two different pedagogical approaches shape the psychological processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?, was answered by analyzing classroom observations, post-lesson surveys, student interviews, students' reflective journals, and student attitude surveys. The last sub-research question, 'How do different pedagogical approaches shape the students learning experiences in an all- girls math class and an all-boys math class?', was analyzed by comparing the data from classroom observations, post-lesson surveys, student interviews, students' reflective journals, and teacher's reflective journal.

Table 5: Connections between different types of analysis

Sub-Research Question	Data/Instrument Used	Participants	Data Analysis Plan
1. How do the two different pedagogical approaches shape the cognitive processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?	Classroom Observations Student Work Samples Post-Lesson Surveys Student Interviews Teacher's Reflective Journal Students' Reflective Journals	All Students All Students All Students 19 students Teacher All Students	Students' level of understanding
2. How do the two different pedagogical approaches shape the psychological processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?	Classroom Observations Post-Lesson Surveys Student Interviews Students' Reflective Journals Student Attitude Survey	All Students All Students 19 students All Students All Students	Students' preferences and thoughts
3. How do the two different pedagogical approaches shape the social processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?	Classroom Observations Post-Lesson Surveys Student Interviews Students' Reflective Journals Teacher's Reflective Journal	All Students All Students 19 students All Students Teacher	Students' interactions and communication while socializing and working

The procedure of coding in thematic analysis involves identifying themes or concepts that result from the data. First, open coding was used to create an emergent set of categories (Ezzy, 2002). In vivo coding, which involves taking codes from the participants' own responses, was used to capture certain meaning or experiences (Charmaz, 2006). The process of constant comparison was utilized to identify how certain pieces of data could be grouped together to 'specify a category', as described by Ezzy (2002). Similarities and differences between the various items of data were also examined. Relationships and patterns among the data were summarized and themes were identified.

Risks, Benefits, and Ethical Considerations

This study posed minimal risks to the participants in the study. The students were observed, interviewed, questioned in the regular mathematics classroom. Ethical considerations included obtaining IRB approval, parental consent forms, and student assent forms in order to conduct the study. The school system also gave permission to have students in single-sex classrooms. Those who did not want to be part of the single gender classes or this study were able to opt out. Four boys that wanted to be in single-gender classrooms, but opted out of the study stayed in the single-gender mathematics class as they wanted. They were seated away from the video and audiotaping on data collection days and their work was not included in the study. Proper institutional approval including an IRB review and final approval were obtained in a timely manner. All data has been kept confidential in a locked file cabinet; all participants' names were replaced with pseudonyms to maintain anonymity as is shown in Appendix F.

A prime ethical consideration of this study is the dual role of the teacher and the researcher. I played a large role in designing this exploratory case study, since I wanted to study the students' experiences, as well as the pedagogical experiences of single-sex mathematics classrooms. Had another teacher agreed to teach the single-sex classrooms, it would have left out my understanding of mathematics and sensitivity for gender-specific issues. Being the teacher allowed for a more in-depth focus on the students' experiences and less on pedagogical issues. The students were more comfortable sharing their concerns and questions with their teacher than an outside researcher that was only in the classroom on 'research days'. Some students may have felt a conflict in sharing their honest feelings about the lesson, since they were also graded for their work by the teacher-researcher. The students were reassured at the start of the study that their behaviors caught during the videotaping would not be cause for punishment. An advantage of being in the teacher role was not having to address the issue of hurting another teacher's feelings when analyzing students' reactions to another teacher's pedagogy. Undertaking the dual role of the teacher-researcher added to the responsibility of conducting informal data analysis while making instructional decisions. The role of the researcher assisted the role of the teacher due to a thorough analysis of the data, which allowed for data-driven instructional decisions. In this study, the advantages of being the researcher well outweighed the potential disadvantages of the dual role of teacher-researcher.

Among the benefits of this study was the students' ability to express their preferences for how they learn and solve math problems. In the past, students had told me that some of their previous teachers had only allowed them to solve math problems a certain way, but I encouraged all students to use different strategies to solve mathematical problems. As long as their answers were correct, the students were allowed to use their preferred strategy to solve mathematical problems. Students have different learning styles such as being auditory, visual, or haptic. This study does not examine those learning preferences; however, in synopsis, everybody learns, retains, and utilizes information in their own unique style. In addition, some students may not have given voice to their personal thought process in the past; this study allowed them to be heard. Students who previously viewed themselves in a negative light were able to improve their confidence to solve math problem by taking part in the study. They were also able to give their views on the role of mathematics in their life currently and in future planning. The study also gave students opportunity to explain how they solved mathmatical problems.

Policymakers, educators, and industry leaders want to increase the number of students that enter fields of science, technology, engineering, and mathematics (STEM) fields, particularly among women, minorities and persons with lower socio-economic status. Given the pressing need for a high-quality mathematical and scientific workforce, now is the time to invest maximum effort in understanding what strategies are effective in increasing active participation in STEM fields. This study examines issues of access and equity in the mathematics classroom to promote mathematical success for all students that leads to stellar career options.

Subjectivity Statement

After obtaining a bachelor’s degree in the science field, I worked for an environmental and wildlife protection organization for approximately four years. Then, I decided to obtain a second bachelor’s degree; this time, in middle grades education in math and science. Shortly thereafter I earned a master’s degree in middle grades education in math. Currently, I am a doctoral candidate in the PhD program of Curriculum and Instruction in Mathematics Education. Similar to many female participants in the research I have analyzed, I decided not to pursue a graduate degree in the mathematics and science fields. However, unlike many females, I actually enjoy solving math problems and thinking about the world mathematically.

I am very passionate about providing equal access to education for females and males and strongly believe in the social theory of feminism. Equality of educational opportunity refers to providing the same opportunities, expectations and, support regardless of gender. Equality of education does not look at the unique aspects of boys and girls with the intention of providing programs that are geared toward their diverse needs. There are gender issues pertaining to equality of educational opportunities, gender equity, and differential outcomes in economic opportunities and academic achievement for women and men. Sexist practices are still evident in both the formal and hidden curriculum in schools. Even though there have been decades of feminist activism, research pertaining to discriminatory practices, and legislation created to provide equality of treatment, females in society do not have equal access to educational and economic opportunities. Feminist theories can be used as a way to understand schooling and as a way to achieve equality and break down patriarchal domination in schools.

As I gaze through a strong feminist and social constructivist lens with many years of college education and teaching middle school, it is important to critically examine the positive and negative aspects of this knowledge. Given that I have been teaching seventh grade for many years, I am very knowledgeable about the physical, psychological, emotional, and intellectual aspects of adolescents. Students at this age level can be very funny, engaging, hard-working, and loveable, as well as being challenging, moody, and heart-breaking. Since I had been teaching at the same school district for fourteen years before the study began, I had the opportunity and access to propose an administrative change of single-sex classrooms. This combined experience and knowledge steered me in the direction of wanting the single-sex classrooms to be a success. Two months after implementing the single-sex mathematics classrooms, the students, parents, teachers, and administration were all pleased with the arrangement. The following concerns surfaced before data collection began. Will things change for the better or worse as I begin my research and the school year progresses? Being the teacher, I will do everything in my power to make the school year a successful one for my students. But as a researcher, will I try too much to make the single-sex classrooms a success for everyone? Will I be able to look at the data objectively? Taking on the dual role of being the teacher and the researcher adds to the challenge of subjectivity. As their teacher-researcher, is it realistic for my students to have the same enthusiasm at the prospect of single-sex classes that they had at the middle school's Open House as at the conclusion of the school year and my data collection?

It is critically important to examine the dual roles of my theoretical perspective and my prior understanding on my research process in constructing high-quality, persuasive, and authentic findings for my research. Before I began my research, I wanted the single-sex classrooms to be a success, but I also knew I needed to be able to analyze the data accurately and concisely then step back from the data and look at all aspects through a positive and negative lens. For instance, a negative finding may actually turn out to be a future critical discovery. I also had to be aware that my students were at very different places in their lives and viewed the world differently than me. Although I am passionate about mathematics and its importance to economics and the future, I have to realize that my students may not be as enthusiastic about the world of mathematics. Even though my goal was for my students to be successful and hopefully go on to higher education, some students may not share these goals and be content with earning a high school diploma.

In summary, the implementation of the single-sex classes for the 2012-13 school year was a success. Both classes enjoyed the experience and were very protective of others entering their classroom during math class. They even extended the single gender experience to the lunch room with separate boys and girls tables. The girls became very close socially and developed strong bonds of friendship. In the mathematics classroom, the girls felt free to ask any questions in front of the whole class as well as their peers without being intimidated by the boys or acting shy around them. In the boys' classroom, the students also worked very hard and concentrated on their work. The boys developed respectful attitudes towards the girls on the team, especially since they only had science and social studies classes together. I have received very positive feedback from parents of students in the study and other parents at the middle school to resume the single-sex classes. Even though the single-sex classes were a success, the principal decided not to have the single-sex classroom classrooms for the 2013-4 school year, but is considering it for the 2014-15 school year.

At the start of the school year, I wanted the single-sex classroom to be a success. Being a teacher on the team, I played a role in making it a positive learning atmosphere, but I think the learning experience became a phenomenon on its own. The students and the parents embraced the learning environment and enjoyed the deeper concentration and connection among the students. There were less discipline referrals than prior years for some students. The students wanted to stay in the classroom and remain with their team members. Middle school is a very challenging time for adolescents as they continue to grow and develop. Whatever successful method that can be implemented to improve this very perplexing time in their life should be embraced. Many of the students, especially the girls wanted to have the single-sex classes extended into their 8th grade classrooms. Now, I can confidently attest that the students and parents had the same smiles on their faces at the end of the school year as they did during the school's Open House from the results the students achieved.

At this point in time, I have collected and analyzed my data from the boys and girls single-sex mathematics classes. Before data collection began, I was concerned with if I would be able to look at the data objectively. This was compounded by the fact that I took on the dual role of teacher and researcher for this study. Even though I stopped videotaping in March, I did not collect the last journal and survey until May. While I was still teaching, I was not able to start the transcription nor begin to analyze data. This was partly due my combined roles and partly due to physical and mental exhaustion. Once I had distanced myself enough my teacher role during the summer months, I was able to start transcribing interviews, write up video observations, and analyze the data objectively. I transcribed the data directly from the different sources, which revealed items that could be considered positive and/or negative. While analyzing the data, I was able to more thoroughly understand a student's reasoning, since I was familiar with the student and knew his or her past and present mathematical knowledge from our classroom experience. This additional information became useful as I situated the findings into the larger context of learning mathematics through a feminist and social constructivist lens.

Strategies for Quality

In order to maintain quality data analysis, seven types of data were collected during the school year to triangulate the data. These were: student interviews, teacher's reflective journal, post-lesson surveys, students' reflective journals, classroom observations, student attitude surveys, and student work samples. Field notes were taken when possible during the lesson and at the end of the lesson (Ezzy, 2002, Yin, 1994). Transcriptions of interview files were also be made as soon as possible to maintain a first hand account of the recorded data (Yin, 1994). The researcher consulted with her dissertation committee members as needed throughout the study. The researcher also conducted peer debriefing as needed during the study. Discussing the research while data collection was being conducted allows a preliminary analysis of the data (Ezzy, 2002). This permits the researcher to modify and adapt previously unanticipated dimensions of the research experience. An in-depth understanding of the data does not only come from an individual researcher, but from the responses of others to the researcher's interpretations (Ezzy, 2002). An essential component of developing an accurate and trustworthy account of the data is by utilizing an on-going dialogue with other researchers.

Summary and Introduction to Chapter 4

In this chapter, the research design of qualitative exploratory case study methodology was explained. The research site was described by giving a detailed account of the community, school, and classroom. This section also covered data collection methods and contexts; data analysis methods; subjectivity statement; risks, benefits, and ethical considerations, as well as strategies for ensuring integrity.

CHAPTER 4: FINDINGS

The purpose of this study was to examine the learning experiences of students enrolled in an all-girls math class and an all-boys math class in a co-educational public school. Students' responses to different pedagogical approaches such as students working in cooperative groups and a competitive atmosphere were examined in two single-gender classes. The overarching research question was: How do two different pedagogical approaches, cooperative and competitive learning contexts, shape students' learning experiences in an all-girls math class and an all-boys math class?

Three sub-research questions were:

1. How do the two different learning contexts shape the cognitive processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?
2. How do the two different learning contexts shape the psychological processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?
3. How do the two different learning contexts shape the social processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?

The competitive learning context provided highly contrasting experiences to boys and girls. Multiple sources of data in this study reveal that there was a clear gender difference between boys and girls engaged in competitive group work. Based on the very nature of competitive learning context, boys and girls both worked as quickly and as accurately as possible during the competitions where ardent discussions occurred in the tense dynamic atmosphere. Even though both the boys and the girls enjoyed the competitive nature of winning a prize, some of the girls' groups were more concerned with the learning aspects of the activity and preserving their group. The competitive learning contexts changed the boys' behaviors drastically. Boys were very motivated given the competitive group work, and became even boisterous during the competitions. They rushed to an incorrect conclusion that they had finished the given task and raised their hands. Sometimes, entire groups stood at their seats claiming that they were the first to solve the given problem. Furthermore, the boys sped up their work process in order to win the competition and left a group member working at a slower pace behind.

Overall data analysis indicated that both boys and girls in a cooperative classroom context had a similar learning experience as a whole. Boys and girls working in cooperative groups reported that they enjoyed working with their group members and asking each other for help. Occasionally both boys and girls became frustrated with their group members while solving for mathematical problems and puzzles. However, the students still perceived their cooperative group work as a positive experience as evidenced in their survey and interview data. My classroom observation also indicated both classes exhibited a positive atmosphere during their cooperative group work; the slight difference between the two was the level of noise. Girls worked more quietly and more seriously together and seemed to solidify their friendship bonds during the group work. The voice level in the boys' classroom was louder than the girls' classroom, which might have made it a bit more difficult at times for some boys to concentrate.

In competitive groups, the boys were very motivated and boisterous during the competitions to the extent that some of the boys' groups would raise their hands when they thought they had finished and some entire groups even stood at their seats. The boys would also speed up while working competitively to the extent of leaving a slower working group member behind. Overall the girls worked quieter than the boys during the competitions. Both the boys and the girls enjoyed the competitive feature of winning a prize, although some of the girls' groups were more concerned with the learning aspects of the activity and preserving their group. Both the boys and the girls worked as quickly and as accurately as possible during the competitions. Ardent discussions were more likely in the tense dynamic atmosphere during the competitions. Both the boys and the girls utilized the same solution methods, but differed in their patterns of engagement and how they showed their work. Therefore, there were more gender differences in the learning context of competitive groups.

Five major findings emerged from the seven types of data collected as shown in Table 6. These major findings will be explained with an appropriate set of supporting evidence. Three of the five major findings show gender differences in a competitive environment. The fourth finding shows how some boys worked in the different contexts of competitive and cooperative groups. The fifth finding reveals how boys and girls managed their stress during challenging situations in both learning contexts. These findings are organized with the cognitive, psychological, and social aspects of learning mathematics. A detailed examination of the findings will be given in this section along with evidence from the data collected from the student interviews, teacher's reflective journal, post-lesson surveys, students'reflective journals, classroom observations, student attitude surveys, and the student work samples.

TABLE 6: Summary of Findings

Finding	Sub-Research Question	Learning Context
Gender differences in group cohesion	Social	Competitive
Gender differences in types of motivation	Psychological	Competitive
Patterns of Engagement 1. Student perceptions on when group work is finished 2. Boys groups had more discussions about solutions 3. Students had same solution strategy, but showed it differently 4. Students used same solution strategy, but different processes	Cognitive	Competitive
Inclusion and exclusion of a non-working member (Boys Only)	Social	Cooperative and Competitive
Stress management in individual competitions	Social and Psychological	Competitive

Gender Differences in Group Cohesiveness

Gender differences surfaced in group cohesiveness in a competitive group learning context. For example, some of the boys found it challenging to work cohesively in groups during competitions, whereas the girls worked hard to preserve the group and worked as a team. The boys would leave a non-working member behind at the expense of the unity of the group, while the girls were concerned about other girls' feeling bad if they lost during group competitions. This finding describes the social aspects of how the all-boys and all-girls classrooms demonstrated gender differences in group cohesiveness. In the all-boys classroom, there were a total of seven groups of three to four students. One group was not included in the study, since either the student or parent did not give permission. Of the six all-boy groups, two of the groups had a member that was not working to their fullest potential. Brian and Jeremy had a quiet demeanor and also struggled with understanding math concepts. In class Brian usually worked individually and preferred to work at his own pace, which was generally slower than the other students. Rarely did Brian ask for help from the teacher, but accepted assistance when the teacher walked around the room and monitored student progress and misconceptions. In contrast Jeremy sometimes raised his hand for help to aid in his understanding of math concepts and he also asked his table partner, Christopher, for additional help. During the competitive group work in this study, both boys worked quietly by themselves. Jeremy daydreamed as he looked around the classroom. Some of the evidence focused on Jeremy's behaviors, since he was a participant in one of three groups that was the focal point of the camcorder video data.

In their surveys, some of the boys expressed their frustrations of working in a group competitive learning environment. In their December surveys, 4 out of 25 (27%) of the boys did not appreciate the excess talking and not working as compared to 1 out of 27 (4%) of the girls. A couple of the boys said they may have to "ignore them", since the loud students were distracting. In addition to the negative of "It might be loud" Carter stated in his journal, he did not appreciate another group member's and other students' elevated voice levels. Similarly, Dylan stated negatives of "talk, be loud" in his journal. Dylan was uncomfortable talking, whether it pertained to him having to talk or other boys' talking. He also did not appreciate the noise level of the classroom. During Zander's interview he stated, "Christopher he goofs off a little bit and kind of disrupts me sometimes when I am trying to talk." Christopher also had a tendency to get off topic and did not mind his manners when his group members were trying to express themselves. Michael expressed in his journal that it was loud during the competition, which sometimes caused him to lose focus and get off-track from his mathematical task. In summary, the boys were frustrated by the volume of excess on-task or off-topic conversations during competitions which they did their best to ignore.

Not only did the boys ignore the excess noise in the classroom, but some boys also left out a non-working member of their group. Christopher, Jeremy's table partner, stated in his December survey, "You had to wait or explain to some people how to do stuff." This statement coincides with Jeremy's group not taking the time during competitions to explain mathematical concepts to Jeremy. This phenomenon surfaced with data collected in December, which was the second set of data collected. On their third survey in January, the boys expressed a need for more teamwork. Carter, who was in Brian's group wrote there was an, "uneven distribution of work among the group members." Brian tried to answer the mathematical questions, but usually just worked quietly by himself. Consequently, Carter observed not every member was doing his fair share of the work. Jeremy stated in his last survey in March, "They ignored me." Unfortunately this was a valid observation, especially during competitive events. The phenomenon of Jeremy's working habits will be explored more closely in the next two sections. In Elijah's journal he said he was, "Left behind, if you don't know how to do something." Overall the boys had a problem working cohesively in a group environment when working in a hurried or excited state during competitions. The boys comprehended that their groups were loud at times and that not all of their group members were working to their fullest potential. Yet, they did not attempt to quiet their fellow group members or to quiet the volume of other groups, even though it became a hindrance to some of the boys' concentration levels. Since the boys were in competition with other groups, they did not want to slow down and explain how to solve difficult problems. The unity or harmony of the boys' groups was lacking during competitions and the group left behind a non-working member such as Jeremy or Brian.

In contrast, the girls wanted to preserve their competitive group and value that they worked together. In their November surveys, the girls all mentioned teamwork, working together, and helping each other as a positive aspect of group work. In their next survey in December, 21 out of 23 (91%) of the girls stated that they liked working together and learning with their friends. As compared to 9 out of 22 (41%) of the boys wrote about working and learning with their friends. The girls also said that there was no arguing; everybody stayed focused. In the January and March surveys, the girls stated that there were disagreements among their group members when members had varying opinions as to how to find the correct solution to the problems. In their journals, the girls repeatedly stressed the importance of teamwork as a positive aspect of working closely in a competitive environment. Arianna's positive feedback was, "work faster, try harder, give it your best, and can work with team to come up with the answer." Similarly Rachel expressed, "We get to have fun and we get to be competitive. We get to work together and we try harder." Rachel also thought the competition was enjoyable in addition to working hard with her group members. Polly stated, "We had fun, get to work in teams, and get to be with our friends." Like Rachel, Polly also liked working with her friends. The girls wanted to preserve the group and valued that they worked together and helped each other.

While working in competitive groups, the girls' main concern was competing against their peers. Whereas the boys did not express any concern about their friends in other groups who may lose in a competition. Hailey stated a negative of the competitive atmosphere as, "going against your friends." Hailey liked the competition, but did not like competing against her friends in other groups. Bella wrote in her journal, "[Friends] Might get down on themselves." Bella was concerned that the girls would feel bad if they lost the competition and would blame the loss on each other. Overall the girls wanted to preserve their friendships and the bonds that they created within their group and circle of friends. The girls were torn between the enjoyment of the competition and the knowledge that some girls had to win the competition and some had to lose. Bella was concerned with the losers' self-esteem after the competition. Consequently, the girls wanted to preserve the group and valued working together, while some boys found it challenging to work cohesively in groups during competitions.

Gender Differences in the Type of Motivation

Students exhibited gender differences in the type of motivation while in a competitive group learning context. Both boys and girls enjoyed the competitive aspect of winning a prize during individual or group competitions, but for different reasons. Each gender exhibited intrinsic and extrinsic motivation differently as they solved mathematical problems. The boys were very motivated by winning the prize, which became a disadvantage to some overly competitive groups. The girls' demonstrated both intrinsic and extrinsic motivation, since they valued the learning aspects as well as the extrinsic reward. This finding revealed the psychological aspects of how gender differences were demonstrated by the types of motivation in a competitive group environment.

The girls valuing group learning worked together as a team during competitions to help others in their understanding, have fun, and with hopes of winning the prize as their reward. Both genders wanted to win the prize however, some of the boys wanted to win so much that they ignored a non-working member which would slow them down. The girls valued the group learning, but some of the boys cared more about the prize and became overtly competitive.

Learning aspects valued by girls were addressed during the closure of the solving equation puzzle competition. When I asked, "What is a strategy we used when working out the equation puzzle?" Anna remarked, "Teamwork" Then I asked, "How did you show this?" Jasmine said, "Discussion." Emily answered, "Our group didn't really work for candy. We kinda took our time to do our best." Emily's group did not rush to win the competition, since they all worked together to make sure their group members understood the problem and the answers. In Hallie's journal, she validated this teamwork with her journal entry, "We all worked together, we worked fast and hard, and we got it right because we took our time." Hallie's statement exemplifies the teamwork of her group during the competitions. Her group worked together as fast as they could, but they were also concerned about the accuracy of their answers. The girls, concerned with the learning aspects of teamwork, used discussions within their group to solidify the comprehension and accuracy of their work.

Thirteen out of 27 (48%) of the girls indicated in their journals they had fun during the competitions as compared to 3 out of 22 (14%) of the boys, which is shown in

Table 7. For instance Anna stated, “So much fun!!! We get to learn off each other more and experience new things.” Anna liked the competitive learning experience of working with her group members. Kylie said a positive was, “Having fun, getting work done faster, and sharing opinions.” Kylie thought the competitions were fun and in her group thought members were able to express their thoughts on how to solve the problems. Since everybody in the group worked together, they accomplished their work in a more expedient fashion. Lauren wrote in her journal positives of working competitively were, “Work harder, can be fun, learn things we didn’t know.” Lauren appreciated working intensely and learning from her group members in a fun, exciting atmosphere. Similarly, Ashley stated competitions were, “A lot funner and make you think faster.” Ashley thought that working in a competitive environment was more enjoyable than working individually or in cooperative groups. She appreciated the fast pace of the competitions, which caused her to think more rapidly. Kim expressed in her journal, “Have fun, work hard, try to win.” Similar to Lauren, Kim also liked the vigorous pace of the competitions in order to be victorious in the competition. In synopsis, the girls valued the learning aspects of having fun, working at a faster pace, and learning from each other, while working in competitive groups.

TABLE 7: Boys’ and girls’ motivation from journal entries

Motivation	Boys	Girls
Teamwork - intrinsic	0%	8 out of 27 (30%)
Fun - intrinsic	3 out of 22 (14%)	13 out of 27 (48%)
Prizes - extrinsic	4 out of 22 (18%)	7 out of 22 (32%)

While only four boys wrote about the reward of brain food in their journals seven girls noted this reward in their journals. The following entries in Amelia’s, Hailey’s, and

Bella's journals acknowledge their understanding of the reward. Amelia stated, "If you win the challenge, you get brain food. If you don't win the challenge, you don't get brain food. Hailey said, "It's fun, if you win you get brain food." Bella also wrote, "If you were the one done first, you would get a prize." However, not all the girls expected to receive candy as Claire states, "We could get brain food." Charlotte was more interested in doing the best if everyone worked hard in their group. Leah similarly wrote, "You might get a prize at the end of the game if you win", viewing the competitions as a game and realizing that some would win the prize and some would not. Hallie mentioned an important point of competitions, which is students may have rushed to answer the questions and then made mistakes, since they wanted to receive candy. Overall the girls were glad that they could win a prize during the competitions; however, the prize was secondary to their performance.

Four boys, Brian, Carter, David, and Robbie, mentioned candy as a reward in their journals. Brian wrote, it's "fun, get candy sometimes, and timed." Brian liked the competitions and the idea of sometimes winning candy. Some boys stated in their survey responses that they liked brain food, "…made us work harder" and competitive. David wrote that he enjoyed brain food if his group won. Robbie's journal entry stated, "You get a cool prize, but sometimes you work really hard and you don't get anything." Consequently, Robbie did not like the aspect of working really hard in the competition and then not receiving the prize. Robbie's competitive nature was revealed during the problem-solving activity. When Robbie overheard that another group had solved the problem, he made a very grave face and looked at the group to his right. Robbie released his frustration at not winning by momentarily holding his face in his hands, putting his face on the table, and then saying “Dang it.” As it turned out, the other group did not have the correct solution. Michael, the boy sitting beside him, told a joke to release the tension of the situation. Then Robbie’s group continued to work on their problem, but chose a different strategy, and worked more determined than ever to win the competition. Robbie’s actions illustrated the boys’ competitive nature in their quest to win the prize of brain food.

The boys became overtly competitive and very excited about winning, which at times became a detriment to their group. When the groups were close to being done or thinking they were done, the group members would raise their hands and two or more group members would stand. This behavior exemplified the group’s excitement and eagerness of winning the competition. Carter wrote in his journal, “You win stuff and it makes you want to win more.” Therefore, Carter wanted to win and wanted to continue to win. During Isaac’s interview that follows, he discussed the competition during which he was worried about making a mistake due to emphasis on speed:

> R: What did you enjoy most about the lesson?...
>
> I: I put that we finished first.
>
> R: Okay. So were you happy cause that was the competitive part. So did you like finishing first and that it was a competitive lesson?
>
> I: Uh huh.
>
> R: Okay and did that change how you worked since it was competitive?
>
> I: Yes, I wanted to work a little bit well and a little bit faster. I didn’t really want to work too fast. I didn’t want to mess up on anything.

Isaac said in his first statement that he really enjoyed winning and finishing first. In his third statement, he showed that he knew there was a limit to how fast he could work and still be able to attain the correct answers. Therefore, the boys were aware that rushing could lead to an incorrect answer. Anthony stated in his journal, “The negative of working competitively is you get rushed and miss problems.” Andy expressed his negative, “You sometimes get wrong answers.” Dylan noted, “Rushing and miss problems.” The boys became a little too competitive in their eagerness to win then realized they had to balance how fast they could work with the accuracy of their answers.

Similar to the boys, the girls were also concerned with rushing during the competitions and erring with wrong answers. An example is Hallie’s journal entry where she mentioned competitions where students may rush to answer the questions and then made mistakes, since they wanted to receive candy. Sophia wrote, “Make mistakes when our group is in a rush.” Sophia highlighted that as they were working together, her peers made errors since they worked quickly during the competition. In Julia’s journal she stated, “Work fast, mix up answers.” Julia also pointed out the problem of working at a hurried pace may cause them to write down answers incorrectly or answer them inaccurately. Kim wrote in her journal, “Go too fast and don’t think about math.” Kim recognized the group needed to take the time to think about math rules and how to solve them correctly. Both genders were troubled by the balance of how fast they could work and the correctness of their answers.

A difference between the boys and the girls is that the girls shared the concern of arriving at wrong answers by working too quickly. Some boys understood the risk of working too fast, but they could not build a consensus in their group about this risk and thus could not modify other group members' behaviors. The frequency of this concern from boys and girls were pretty much the same. Consequently, the boys' groups tended to make rushed decisions as compared to the girls' groups.

As stated previously some of the groups became too competitive, which caused them to leave out a non-working member. Henry stated in his journal, "A negative of working competitively is that someone might try to ask for help." The girls hardly expressed this concern. Overall the girls worked together as a team sharing opinions and helping each other learn. Henry's comment was in contrast to how the girls worked, since Henry did not want to be slowed down in having to explain an answer or problem to his group members. Christopher mentioned in his journal,…there, "Could be heat or tension in the room," which exemplifies the hurried competitiveness of the classroom atmosphere. Christopher was in a group with Jeremy, Zander, and Benjamin. On December's video of the boys solving an equation puzzle, Jeremy's group members were working very hard in order to win the competition; they did not slow down to explain problems or strategy to Jeremy who needed more explanation and who began to play with the plastic bag designed for keeping puzzle pieces. During the competitive group event in March, Jeremy was still not working. This group obviously ignored Jeremy and the fact that he was not working; subsequently they did not encourage him to participate or ask him questions about the activity. The group seemed to accept that Jeremy was not working, focusing their attention on solving the problems as quickly as possible. Therefore the boys cared more about the prize and became too competitive, while the girls valued the learning aspects of having fun, working at a faster pace, and learning from each other as described previously.

Patterns of Engagement

Students showed different patterns of engagement in a competitive group environment during March's problem-solving activity. As the students had more of a chance to engage in problem solving, patterns became more apparent during March's learning experiences. The first two patterns of engagement depicted gender differences between the boys and the girls, while the third and fourth patterns focused on group differences: (1) Students perceive differences on when group work is done. The boys and the girls had different perceptions on when they thought group work was completed. The girls believed everyone had to solve the problem, whereas some boys believed they were finished when they watched their group members solve the puzzle. (2) Boys groups engaged in more discussions regarding the solutions. While the boys worked, they participated in dynamic discussions, while the girls preferred less discourse in order to concentrate on the problem. The third and fourth patterns focused on group differences (3) Students used the same solution strategy, but showed it differently. (4) Students used the same solution strategy, but through different processes. Both genders used the same solution strategy to solve a problem, while some of the girls counted with their hands to help solve the problem in addition to using paper and pencil. This finding describes the cognitive aspects of how the all-boys and all-girls classrooms displayed different patterns of engagement while they worked in a competitive learning context.

Students' Perceptions Differ on When Group Work is Done. The boys and the girls had different perceptions on when they thought group work was completed. In March the students solved four different kinds of problems in a competitive problem-solving activity as shown in Figure 7. The students had not been exposed to these kinds of activities and learning objectives previously. Consequently, the students had to work in their groups to create or discover a way to solve these problems. For the Floating Family problem, the students were told to rip up scrap pieces of paper to represent each of the family members who needed to be transported across the river. When the girls worked on the Floating Family problem, they believed each girl had to solve the problem, whereas the boys believed they were finished when they watched their group members solve the puzzle.

In the girls' class, each person created her own scraps of paper they worked with to help solve the Floating Family. While solving the problem, the girls at times watched another girl attempt to solve it by getting through the first couple of steps until she messed up or could not solve it any farther. Then each girl would try it with their individual pieces and try to get a step farther. Once one person solved it, it was still a challenge for all the girls in the group to be able to solve it and additionally write down the steps. Figure 8 shows the girls using their individual pieces. Hallie was reading and moving her pieces from what she had written on her paper in order to check her written work. Ashley sitting to her left was working in a similar manner with her own pieces. The girls engaged in the social process and discussed complications or difficulties with their group members. The girls were not satisfied just watching another student solve the problem. They needed to prove to themselves that they could solve the problem as part of the learning process. The girls proved they did not solve the problem to show-off to each other, since they each solved the problem quietly by themselves. Each girl had to get the family across the river by moving her pieces in order to solidify their understanding and additionally to confirm the written steps on their notebook paper.

FIGURE 8: Hallie and Ashley (left) and boys (right) solving the Floating Family

Most of the boys' groups followed the given instructions and ripped up one piece of scrap paper to represent the mom, dad, and kid1 and kid2. The boys shared the paper pieces and watched the one set of pieces being used in their group as shown in Figure 8. Each boy did not have to confirm his individual understanding by manipulating the paper scraps to get the family across the river. In some of the groups that did use the paper pieces to solve the problem, many of the boys watched their other group members move the pieces around and decided not to use the hands-on pieces to help their own understanding. The boys felt they gained their understanding by watching group members manipulate the pieces. For example, Kevin watched Logan and Anthony move the pieces in the group exercise. Kevin never touched the pieces, but discussed the problem with his group members. Aiden and Elijah also were just observers and watched when David and Thomas moved the paper pieces, which helped solve the problem in their group. However, the boys discovered a challenge in writing down the final answer in steps. The boys were content when one person in the group solved the problem and that person was able to write down the steps correctly for the group. Yet the boys liked to show-off in front of their group members when they solved the problem quickly and correctly. The boys considered the group work finished when any member solved a problem and then presented the solution to the other members. Therefore, the perception of group work was different for girls and boys regarding when they were finished. The girls expected that everyone had to solve the problem by moving the paper pieces, whereas the boys believed they were finished just by observing their group members answer the problem. Hence the girls and boys utilized different ways of engaging in group work with one method not being superior to the other.

Boys Groups Had More Discussions About the Solutions. While the boys worked on the Slippery Slope and Floating Family problems, they participated in dynamic discussions, while the girls preferred less discourse in order to concentrate on the Slippery Slope problem. Robert’s group was leaning over their table discussing the problem and looking at Robert’s paper. Since the boys were engaged in their conversation, they did not write down work on their paper. None of the other three boys in Robert’s group had any work or drawings on their papers, they only had the final answer for ten days work written on their paper. Similarly in Robbie’s group, only he and Gabriel had T-tables on their paper, while Michael and Dylan only had the answer written on their papers. When Robbie’s group first started to solve the problem Robbie stated, “Alright, if I explain it will you write it down for me?” Robbie then started to explain the problem. But then as Gabriel was writing on his paper, he started verbalizing how he was solving the problem. Robbie hushed Dylan’s questions, concerned they would interrupt Gabriel’s train of thought. Gabriel then continued to write his answers and explained his table to his fellow group members.

After analyzing the video and their work samples for the Floating Family, some of the boys groups proceeded to engage in discussion in order to solve the problems. In

Michael, Robbie, Gabriel, and Dylan's group, the boys decided not to use paper scraps to help them solve the "Floating Family." This group began discussing the problem in a light hearted and fun manner. Michael said, "And one kid brings it back?" Robbie reads from his notebook paper, "Two kids go across…" Michael pointed out, "The boat can't carry more than 2 kids." Robbie continued with his explanation, "...and one kid brings it back." Michael and Robbie discussed the problem with smiles on their faces. Dylan interrupted, "Listen, Listen!" Robbie ignored Dylan, "And then the kid stays there, and then the dad goes over and then the other kid brings it back. Then the mom goes over…" Robbie paused hearing Christopher exclaim, "We got it." Robbie then had a serious look on his face. The previous scenario was part of a transcript which occurred about five minutes after the boys started solving the problem. In the first couple of verbal exchanges Michael and Robbie discussed the problem. In Michael, Robbie, Gabriel, and Dylan's group, the boys decided not to use paper scraps to help them solve the Floating Family. Robbie already had a couple of steps written down before having the discussion with Michael. Then Dylan tried to interrupt the two with his thoughts on the problem, but was ignored as Robbie continued to talk. Robbie always took the leadership role of the group; consequently he directed and monitored the group's focus. All of sudden, another group shouted claiming that they had solved the problem. Robbie stopped working and looked at the group. He looked very disappointed and discouraged hearing that another group might have finished the task. Robbie's group also saw the group that thought they were finished, Christopher's group, was using the paper pieces. After he learned that the other group did not win, Michael in a light-hearted manner started ripping up pieces of paper.

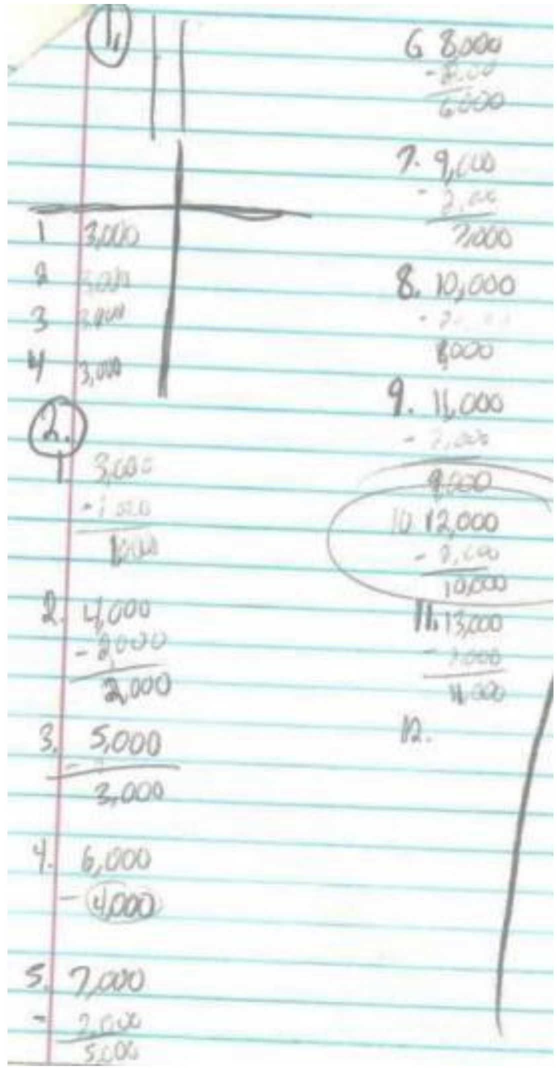
Michael decided to begin using another strategy, since his group's discussion of the problem had ended without a good solution.

The girls did not engage in the same discourse as the boys while solving the Slippery Slope problem. At times the girls would start a conversation on how to solve the problem, but paused or broke off the conversation when they realized that their solution was incorrect. Rachel's group would share ideas such as Rachel's counting on her fingers, but then each girl in the group, Claire, Bella, and Hailey would then concentrate on solving the problem on their individual papers. Stella's group was not interested in discussing how to solve the problem as a whole group. They were interested in solving the problem individually and sharing any useful strategy. Hence Stella's group did not use a collective thinking process as a whole group. Stella tried to start a conversation with the group and pull information from them, but the girls did not respond and continued to work individually on their own papers. Stella had the correct answer on her paper, but her group members were not interested and/or did not agree with her solution. As shown earlier Andrea solved the problem, but counted the days incorrectly with the notches placed by each movement on the mountain. Thus the boys and the girls had different patterns of engagement with the boys being more interested in solving the problem rather than all the group members knowing how to solve the problem. Therefore, the boys had more interaction as compared to the girls, since the girls preferred less discourse in order to concentrate more on their own work. The girls were glad when another group member solved the problem, but each girl also wanted to solve it on their own. Furthermore, showing off was not something the girls wanted to do so those who had solved a problem first did not overtly contest their right solution until all group members had enough time to work on the task.

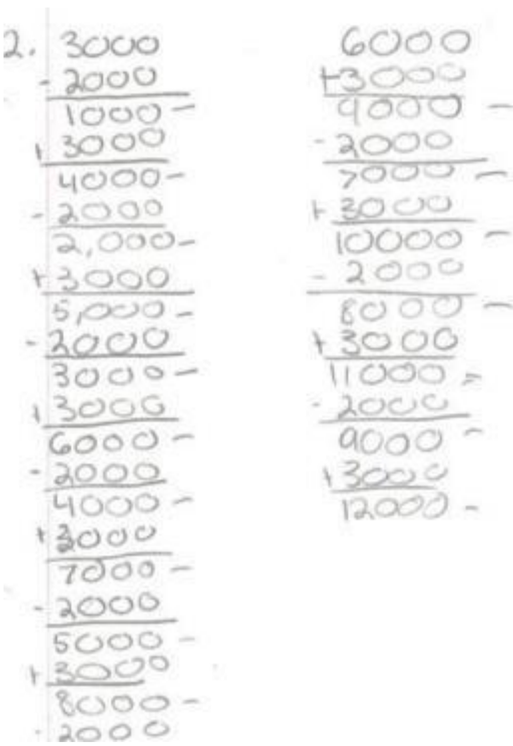
Students had Same Solution Strategy, but Showed it Differently. Gender-specific groups used the same solution strategy to solve the Slippery Slope problem, but each illustrated the strategy differently. The only suggestion I gave for the Slippery Slope problem was to make a T-table comparing the days to the elevation. The T-table was the method of the solution process for the Slippery Slope. About 26% of the girls demonstrated different way of showing their work to solve this problem. Some of the work samples are shown in Figure 9. Amelia's work shows that she subtracted 2,000 each day due to the slippery slope. For example on Day 2 she was at 4,000 feet, but had to subtract 2,000 which was then an elevation of 2,000 feet. Amelia circled the answer at Day 10, since Brenda the Brave reached the top of the mountain at 12,000 feet. Andrea work showed two steps. First she subtracted the 2,000 feet and then added the 3,000 feet gain throughout the day. Her math was correct, but she thought it took 17 days to reach the summit of the mountain. On the side of each addition or subtraction, Andrea put a dash which represented a new day, which was incorrect since Brenda lost 2,000 feet and gained 3,000 feet in the same day. If the dashes were put in the correct place, her answer would also have been 10 days. Jasmine's work utilized a number line design. The numbers on the number line represented the days. The curved lines or jump marks represented how far up the mountain Brenda climbed; the numbers on the very top represented Brenda's elevation after the 2,000 feet slide down the mountain. For her visual representation, Claire drew a mountain and showed jump marks for each day. Each jump was a 1,000 foot increase; therefore the jumps up the side of the mountain increased from 1,000 to 2,000 to 3,000 to 4,000 to 5,000 feet. Her work to the right of the mountain visual showed some mathematical errors. Claire has the elevation at 6,000 in error for Day 2. She added the 3,000 feet gain for Day 2 to the 3,000 feet given on Day 1, instead of adding 3,000 feet to the 1,000 feet after the slide down the mountain. Rachel who was in Claire's group used an accurate counting method on her fingers which represented the increase and decrease in elevation.

Girls used the same kind of solution strategy, but they showed their work differently. Boys used the same kind of solution strategy, but they still showed their work pretty much the same way. The girls showed different ways to get the numbers used in the T-table. Andrea and Amelia illustrated how to add or subtract to get the numbers that could be used in the T-table. Jasmine's number line design was a different of representation of the T-table, but it still showed the days' increases and decreases. Claire's design also depicted the jumps up the mountain as could be shown on the T-table. The numbers given to the right of the mountain could have been enclosed in a T-table. Rachel's finger counting was another way to arrive at the numbers that went in the T-table.

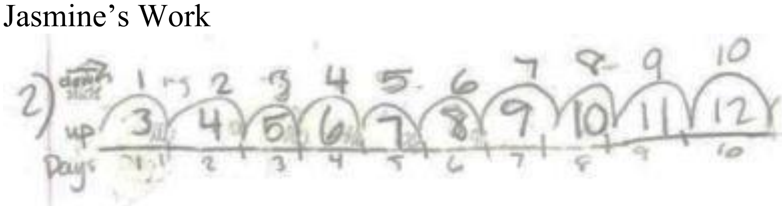
Amelia's Work



Andrea's Work



Jasmine's Work



Claire's Work

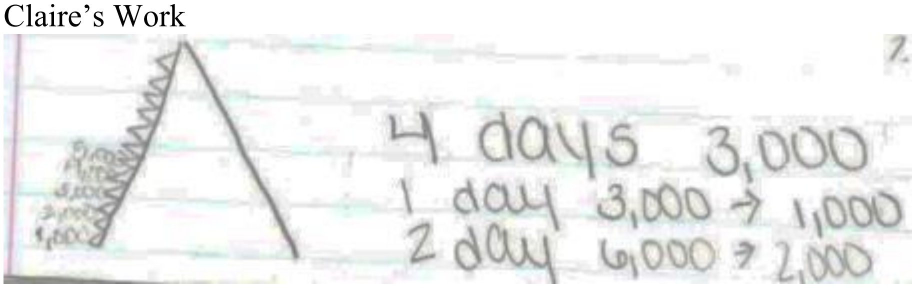
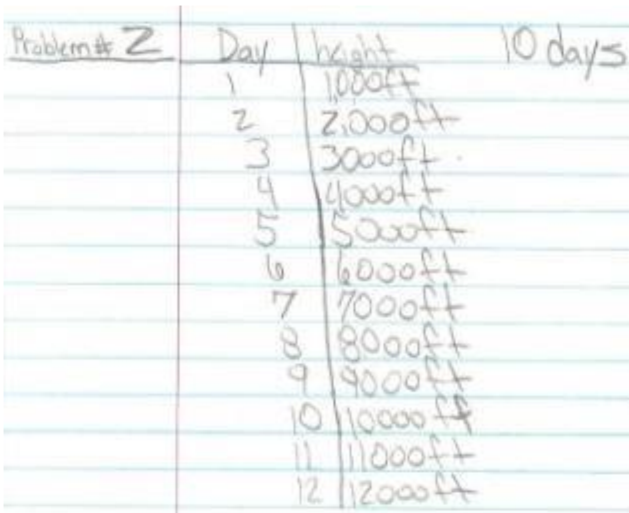
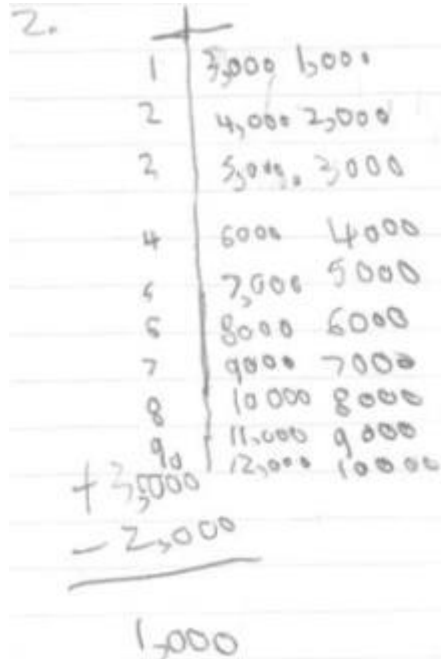


FIGURE 9: Girls' Slippery Slope problems

Benjamin's T-Table



Robbie's T-Table



Robert's T-Table

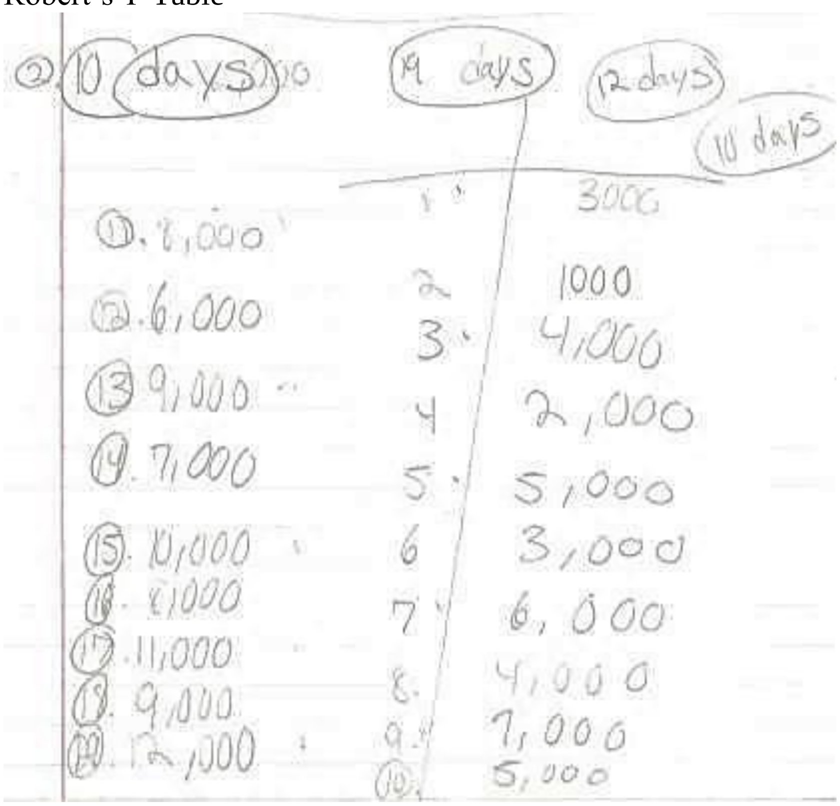


FIGURE 10: Boys' Slippery Slope problems

Similar to the girls, the boys used the T-table as a way to organize their work to solve the problem. The boys only used T-tables to show their work. Some of the boys just copied the final answer when it was revealed through class discussion; two boys did not indicate an answer on their paper. As shown in Figure 10, Benjamin's paper had the final T-table with the days and the total elevation reached for the day of 1,000 feet. Benjamin erased his incorrect answers and replaced them with the correct answers. However, Benjamin did not stop at the summit of the mountain of 12,000 feet when it was reached during the day on Day 10, but continued to Day 12. Robbie's T-table showed the day, amount ascended, and final elevation. Below the table, Robbie correctly gave the first day's elevation of 3,000 feet and subtracted the descent of 2,000 feet, which gave the first day's final elevation of 1,000 feet. Robert's paper had 3 different answers of 10 days, 19 days, and 12 days and his T-table shows some errors. The first day he wrote 3,000 feet and subtracted 2,000 feet to arrive at a total for day 2 of 1,000 feet. Instead of adding 3,000 feet and subtracting 2,000 feet in the same day, Robert added 3,000 feet on the first day and then subtracted 2,000 on the next day for his sequence. In summary, the boys only showed a T-table to show their work, whereas the girls also utilized subtraction methods, a number line, and an illustration of a mountain with changes in elevation. Both the girls and the boys used the same kind of solution method of creating a T-table, but the girls utilized different ways to show their work.

Students Used the Same Solution Strategy, but Different Processes. The boys and the girls used the same solution strategy to solve the Magic Triangle problem; however, some of the girls counted with their fingers to help solve the problem. The Magic Triangle problem consisted of three circles representing the three sides of the triangle.

The students could write the numbers 1 through 6 in the circles, using each number once, so that the total always equals 9 by adding the numbers along each side. I refrained from suggesting use of a particular method, rather noting that there was more than one way to solve the problem. Both the boys and the girls utilized the guess and test method in which different combinations of numbers was used for each side of the triangle. Both the boys and the girls used a systematic way of checking for numbers using the guess and check method, which involved plugging in different combinations of three numbers with a total of 9. If the total did not equal 9, then another combination of numbers was used. This method was repeated until all the numbers 1 through 6 were used in the triangle.

Some of the boys in their groups worked individually on their papers solving the puzzle trying different number combinations using the guess and check method. These groups solved their puzzle very quickly. Other groups were more verbal and expressed their frustrations. They tried different combinations such 6, 2, 1 and then 6, 1, 2, but then could not solve the puzzle before time was up. Michael even wanted to know if they could use negative numbers. The boys used the guess and test method with some boys using different patterns of engagement. Some groups were quiet and seriously working. Others were frustrated and voiced comedic exchanges during their discussions.

The girls also used the guess and check method using different number combinations that added up to 9. For instance Andrea suggested using 126 or 612 or 216 to her group members. When Andrea was talking aloud while solving the puzzle, she said, “612, 243, and I just need 1 more number.” At this point Andrea had two sides solved, but was having trouble completing the third side. Shortly thereafter Andrea stated, “We could use 1, 3, 5, on something.” At this point Andrea offered another combination of three numbers, which showed that she was trying to modify what she had already written down in her solution circles. Stella, Arianna, and Andrea all counted using their fingers to check their work while trying to solve this problem, but not as uniquely as Rachel utilized for the Slippery Slope. Rachel used her fingers more as a manipulative in motion to represent the changes in elevation up and down the mountain. Stella was very obvious when using her fingers to help her count as shown in Figure 11. She talked to herself and counted with her fingers, “Ah so close.” Arianna was more subtle in using her fingers and almost had her palm flat on the table, while watching the subtle movement of her fingers as she counted. As indicated in these examples, the girls and the boys utilized the same solution strategy of the guess and test method to solve the magic triangle, which involved solving for different combinations of numbers for each side of the triangle. Some of the girls also counted with their fingers to help solve the problem. Cognitively the girls utilized their fingers to help them answer and make sense of the problem during the problem solving process. This finding describes the cognitive aspects of how the all-boys and all-girls classrooms displayed different patterns of engagement in how they exhibited their work.

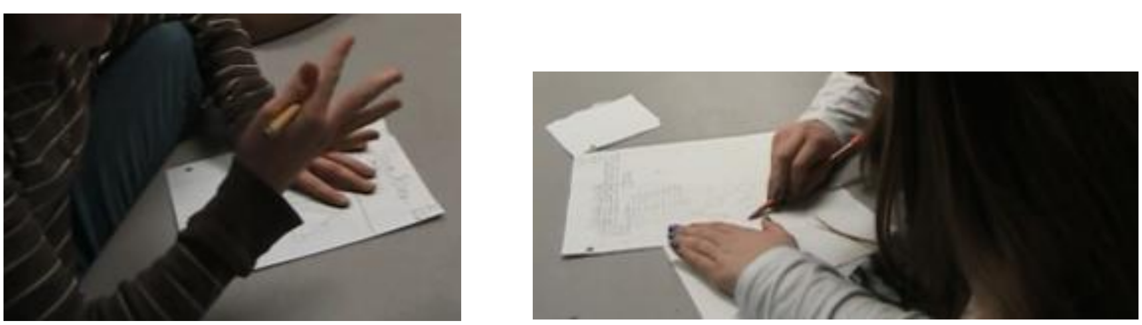


FIGURE 11: Stella and Arianna counting with their fingers

Inclusion and Exclusion of a Non-Working Member

One of most fascinating findings was the social inclusion or exclusion of a non-working member in the boys' class given a competitive group work task. Boys displayed different work patterns in cooperative and competitive learning contexts. The boys tried to work with a non-working member in a cooperative setting, yet they left the member behind in a competitive group setting. The non-working member was attentive to his work during the cooperative activities. During both the individual and group competitions, the non-working member would not stay focused on his work. Since time was a factor during competitive events, group members chose to concentrate on the mathematical activity instead of the boy's non-working behaviors. Jeremy, a member of the boys' group mostly led by Christopher or Zander, was a clear evidence for this interesting finding.

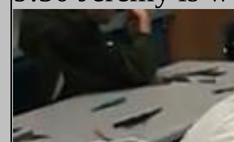
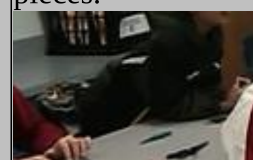
November was the first month data were collected; the work habits of that month vary somewhat from the rest of the data. In November the novelty of being videotaped and the excitement of being in a research study may have caused the students to be on their best behavior and be more earnest in their work. Therefore the November data had more positive records of student behaviors and outcomes. Accordingly, as the school year progressed the students became more accustomed to the routine of data collection days.

In November during the cooperative activity, Jeremy's group worked in a quiet and serious manner compared to other groups that injected humor into their work environment. Christopher experienced moments of frustration in his group. At one point during the video, Christopher took Benjamin's paper to look at his work; later on Jeremy was copying from Christopher's paper. This group shared answers and work, but also struggled to finish creating the integer puzzle on time. During the competitive activity of solving an integer puzzle, the whole group worked together and Jeremy was very attentive and on task. At one point Christopher explained a problem to Jeremy. Towards the end of the competition all the group members worked together to finish the puzzle. The group did not win the competition, although they finished well before the time was up. During November all group members shared the work load of creating and solving an integer puzzle.

Work habits changed within the group during December's activities. Table 8 shows Jeremy's contrasting behavior or patterns of engagement in the two learning contexts. Jeremy was not focused at the beginning of the cooperative activity of creating an equation puzzle. Since Jeremy did not listen to the teacher's directions he had no idea what to do. His group members had to explain the directions that they were making a 2-step equation puzzle. Next, his group members started solving equations. Jeremy worked at a slower pace than his group members. At one point Christopher directed Jeremy to copy his puzzle grid, since Jeremy had nothing in his puzzle grid so far. While the group was working, they decided to take turns creating new equations. When it was Jeremy's turn to create an equation, it took him a while, but he did come up with an equation. Christopher gave these words of encouragement, "That's a good idea." The group was very patient with Jeremy as they worked together in a cooperative learning context.

TABLE 8: Jeremy's Group Working in Cooperative and Competitive Setting

Month	Cooperative	Competitive
November	Jeremy's group was a serious group with all group members working together. At one point Jeremy is copying from Christopher's paper.	Jeremy is very attentive during the activity. 4:50 Christopher explains a problem to Jeremy. 8:25 Jeremy and Christopher are working together. 12:00 All group members are working together to finish the integer puzzle
December	3:50 Jeremy doesn't know what to do 4:00 Zander, "Where you paying attention?" 4:15 Christopher and Zander are explaining to Jeremy that the group is making a 2 step equation puzzle. 7:10 Zander and Benjamin are working problems on paper. 7:25 Jeremy has 2 problems worked out on paper, but nothing in his puzzle. 7:40 Christopher tells Jeremy to copy 8:10 Christopher's puzzle grid. Christopher has 2 problems/answers on his puzzle grid. 15:15 Jeremy is trying to come up with an equation. – taking him a while. Christopher says, "That's a good idea." 15:55Anthony has a new problem. 17:35 Christopher, Zander, & Benjamin are trying to agree on an answer. 18:23 Jeremy is writing down a problem and starts working it out.	2:30 Christopher is looking at an answer Jeremy has worked out on his paper. 15:10 Jeremy is not working and is playing with the puzzle plastic bag. Jeremy's group is quietly and seriously working, except for Jeremy.
January	Jeremy is working with his group members. Jeremy is using a calculator and writing with his pencil during the whole activity. Group members are helping and explaining problems to Jeremy. During a video clip Zander said, "Help him out Christopher." Zander asks Jeremy, "Do you know how to do any of this?" Jeremy replies, "Yes, let me see the (index) card. Yes."	Tangrams are an individual competition. 3:50 – 4:20 Jeremy is not working very much. He is looking at the camcorder. Holding up a tangram shape. Rearranging sitting position so he is more comfortable.

Month	Cooperative	Competitive
January (cont.)		 9:50 Jeremy is working.  24:28 Jeremy is in his own world examining tangram pieces.  25:10 – 25:57 Jeremy is not working 26:53 Jeremy is zoned out again.
March	Jeremy is working with his group member during the irregular shape stations. He is copying down the shapes at each station. Working with group members to find the answers.  4:44 Jeremy is working in his group.  6:46 Jeremy (bottom left) is still working after the rest of his group members are finished.	Jeremy's inattentive behavior and staring off into the classroom.  6:00 – 6:24 Jeremy continues to look around the room – not writing on his paper.

Month	Cooperative	Competitive
March (cont.)	 7:56 Jeremy is copying down the irregular shape.  8:12 Jeremy is using the calculator to figure out the area and then writes down his answer.  8:24 Jeremy asks his group a question, “What number is that?”  9:24 Jeremy is continuing to work out the problem, while his group members discuss it.  15:12 Jeremy (bottom right) is continuing to work.	 9:41 Christopher raises his hand, “Ms. Rohn we really got it.” Jeremy is staring off in the classroom.  27:48 Jeremy is not working. He is looking around the room and at the camcorder.

During December’s competitive activity of solving an equation puzzle, Christopher and Jeremy’s group was a quiet and seriously working group, except for Jeremy. At the beginning of the competition, Jeremy solved a problem and Christopher was looking at an answer Jeremy had worked out on his paper. Shortly thereafter Benjamin, Christopher, and Zander were the only group members working on solving the puzzle. Jeremy stopped solving the puzzle and was playing with the puzzle bag, while looking around the room. Jeremy's group members would have welcomed any help Jeremy could have given during the competition, since solving the puzzle pieces would have allowed the group to finish more quickly. Unfortunately, Jeremy was not concentrating on the equation puzzle. The group members did not ask him questions or assign problems to him to keep him on task because they were in a hurry to solve the puzzle. Thus Jeremy was left out of the process of solving equations during this competitive learning context.

In January, during the cooperative activity of taxes, discounts, and tips, Jeremy and his group members kept to task. Jeremy was solving problems and looking through the sale ads. He wrote down problems and solved them with the aid of his calculator. While the group was working, Jeremy had an incorrect answer which his group members tried to help him with by explaining the problem. Jeremy's group members seemed to be concerned with Jeremy's comprehension of the problems and slowed down to include him in the discussion and the work. When Jeremy's answer to a problem was incorrect, Zander asked Jeremy if he understood how to work out the problem. Zander asked Christopher to help Jeremy out, but Jeremy answered that he knew how to work out the problem. The competitive activity in January was an individual challenge of solving tangrams. Jeremy spent much of his time examining the tangram shapes, daydreaming in his own world, and watching his fellow classmates. During the competitive activity which was an individual tangram competition, the group members could not help each other which caused Jeremy to veer off-task once again.

In March during the cooperative activity of the irregular shape stations, Jeremy was working very hard to solve the problems. He copied down each station's questions and used his calculator to help find the answer. Jeremy asked questions of his group members, such as the measurement on a shape. Jeremy worked very hard even after all of his group members had finished. Similar to the previous two months, Jeremy and his group members were all working and attentive to answering each others' questions. They made sure to include all group members in solving the irregular geometric shapes. During the competitive problem solving activity, Jeremy was once again inattentive and staring off into space. As shown in the previous months, the group members were all working hard, except for Jeremy. The group members did not have the time to make sure Jeremy understood each problem. Additionally, Jeremy did not stay focused or ask his group members for help.

With the exception of November, Jeremy was attentive to his work during the cooperative activities, but not during the competitions. Jeremy and his group may have been attentive during the first month of videotaping, since the concept of videotaping was new to the classroom. During the next three months of data collection, regardless of if it was a group or individual competition, Jeremy did not focus on his work. If his group members did not help him along, he was daydreaming, playing with plastic bags, or tangram pieces. Christopher summarized his group's interaction with Jeremy during the interview:

R: Are there people in your group that hindered your ability to understand the math concepts?

C: Uhm. Jeremy, he didn't really pay attention. We had to go back and help him a lot. He was just sitting there. Yeah, we had to help him a lot.

R: Okay. Did he ask questions or did you just give your..?

C: We would ask him like 'do you know what the answer is?' and he would just be sitting in outer space. He would be like 'No, sorry' and we would tell him how to do the problem and then eventually if he didn't get the answer, we would tell him the answer.

This group did their best to keep Jeremy focused, on task, and to help him; however, this created a frustrating situation for them. The group may have been able to work at a faster rate, if they did not have to explain the problem to their unfocused group member. Consequently, the boys left out a non-working member during competitive lessons, but they continued to work with the member in a cooperative setting.

Stress Management in Individual Competitions

Students utilized a variety of strategies to manage their stress during the session that promoted individual competition. The boys used comedy in their discussions as they worked to lighten the mood of the classroom. This eased their frustrations of trying to solve challenging problems. The girls also experienced frustrations in solving problems, but were more likely to keep their frustrations to themselves. Both the boys and girls revealed that solving challenging mathematical problems was psychologically frustrating, while they conversed with other students. This finding describes the social and psychological aspects of how the all-boys and all-girls classrooms demonstrated stress management in individual competitions. This thought-provoking finding reveals the social and psychological aspects of how the boys and the girls dealt with their emotions in an individual competitive learning context.

There were also noteworthy differences in the ways the boys and the girls worked on the tangram activity. Both classes worked diligently to solve the tangram shapes. The girls worked in quiet concentration. In contrast, the boys were quite loud at times and verbally expressed their frustrations; some used comedy to lighten the mood. The boys also had more difficulty in determining if their tangram model was the same as the shape shown on the projection screen. The boys expressed their frustrations verbally, while the girls tried to keep their problem-solving frustrations to themselves. It is hard to determine if boys experienced more stress than the girls, yet it was clear that boys chose to express their stress in a more verbal or social manner than the girls.

The all-girls class worked very quietly during the tangram activity. During the first ten minutes of the competitive activity not one of the girls said a word as they worked independently. I walked around the room and monitored the girls' progress as they tried to form their seven tangram shapes into a shape of a swan, duck, etc. The girls worked quite diligently to solve the shapes. Four minutes after the activity commenced, Jasmine was trying to make her pieces form the shape of a swan. She turned some of her pieces to the white side, even though most of the shapes as the teacher directed used all the black sides. Although Jasmine quietly clenched her fists as shown in Figure 12, which indicated her frustration, she continued to work. Jasmine held up and examined two tangram pieces more closely and then rearranged all her pieces. Arianna whose table was behind Jasmine's looked at Jasmine's clenched fists and continued trying to solve the puzzle by herself. Andrea was seated beside Arianna and was showing her own frustration in solving the puzzle by momentarily placing her head on her hand.

FIGURE 12: Jasmine expressing frustration with her hands

Occasionally a girl would ask the teacher a question or would pose a question to a girl sitting beside them. Two of the girls talked quietly to themselves as they were rearranging their tangram pieces. About 30 minutes after the activity started, Rachel was having difficulty solving the bunny. I critiqued Rachel's bunny at her desk by saying that the behind of the bunny should be curved a little bit. Rachel tilted her head to the right and rested it on her hand in frustration and looked at the projection screen. I said, "Good try though." Rachel replied, "This is hard." Similar to other girls Rachel rested her head in her hand to relieve the tension of not solving the shape correctly as shown in Figure 13. Rachel's bunny was missing a tail and the hand was incorrect. The only other verbal sign of frustration by the girls was a couple saying, "Oh, man."

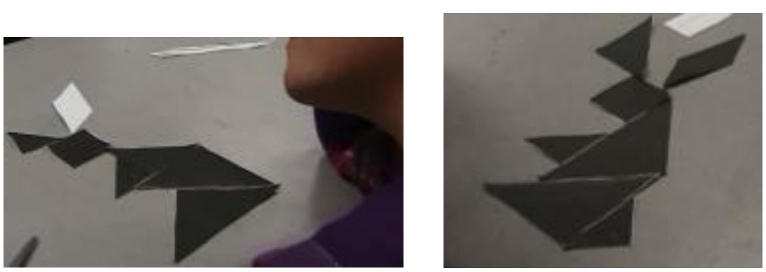


FIGURE 13: Rachel's incorrect bunny and Julia's correctly solved bunny

Jasmine had another episode of frustration while trying to solve for the shape of a capital letter E and turned all of her pieces to the white side. She persevered and a couple minutes later solved the shape and won candy for her efforts. As explained above, the girls utilized geometric tangram models in quiet concentration.

The boys socialized with completely different behavior than the girls during the tangram activity. About five seconds after the first shape was shown, the boys started talking. After approximately two minutes had passed, Christopher said, “Okay this is harder than I thought.” Andy replied in a laughing tone, “I know.” Another student also said, “This is harder than I thought.” Andy stated, “I got the body.” About ten seconds later Andy said, “Anybody got it yet?” A boy replied, “Why would you ask that?” Gabriel, “This looks nothing like it.” At this point, I gave words of encouragement, “Keep trying.” Gabriel, Michael, and Robbie looked at each other’s progress and laughed. In the previous conversation Christopher and Andy both expressed that solving for tangram shapes was more difficult than they first believed. Another student mimicked their surprise of the difficulty of the challenge. Andy said he had the body, even though he was not done with the shape. Robbie’s group looked at each other’s progress and laughed at the shapes they had created, since none were anywhere near correct. Robbie’s group continued to do this at different times throughout the activity to point out their progress, or lack thereof. Dylan said, “This is like hard. Is this 7th grade stuff?” Dylan found this activity so challenging that he was even questioning whether tangrams were a 7th grade objective. Shortly thereafter Gabriel put his hands to his face in frustration and looked at the projection screen. There was constant talking among the boys in the room during the activity and from time to time somebody would say, “This is hard.” The boys liked to say that they had solved the tangram activity, even though they were not even close to doing so.

The boys also became very comedic as they worked, besides looking at each other's shapes or creations and laughing. At one point Henry said, "Need more pieces. I need eight to do this." A couple of the boys also tried to take each other's pieces and then jokingly gave them back. Rule-breaking behaviors were exhibited by some of the boys as they tried to exchange or hide tangram pieces in their joking behaviors. The rest of the class was diligently working by moving their tangram pieces. Humorous remarks and behaviors provided a momentary break from the boys' stress of trying to create the different shapes. All of the joking was light-hearted; none of the boys were offended by the comedic remarks. About 16 minutes after the video started, Zander started to sing to himself to help entertain himself and others. This was very unusual for Zander, since he is typically a quiet and serious worker. The light-heartedness of the room seemed to be contagious with Robbie laughing. Henry exclaimed, "Then I must have lost my head." Andy gave a joking reply in return, "You lost your head a long time ago." Andy stated, "This is possible, just not for us." Earlier somebody asked if making these shapes was possible, so Andy joked that making the shapes was possible, but just not for the boys in this classroom. Andy then decided to stand his pieces on their sides up like playing cards. Shortly thereafter he returned to making the actual shapes. Andy asked later on, "Can we cut this out and make a cow?" Andy then was frustrated and returned to standing pieces on their sides. Later Zander was singing again as he was moving shapes around. Zander then joked and made a capital letter E with his fingers, which caused Benjamin and Zander to laugh together. At one point during the activity, somebody called out, "Whatever you do, don't do the goldfish." This comical remark was also a warning that the fish was a difficult shape to solve.

The boys also had difficulty in determining the correctness of their tangram models as compared to the shape on the projection screen. Jeremy raised his hand, when he believed he had the first shape of the swan. When I came over to look at his shape, I explained that all seven tangram pieces had to be used to make each shape. After working diligently, Benjamin raised his hand because he believed he had the shape of the cat as shown in Figure 14.

Figure 14 – Benjamin's incorrect cat and correct tangram cat

I came over and said, "Good try, but it should have a flat bottom." As shown in the picture, the cat at the lower left comes to a sharp point, but Benjamin was not able to recognize that his shape was incorrect. A couple boys also asked each other if their shape looked like the cat. Later on Michael believed he had the fish and said, "Did I get it? Did I seriously just get it?" Gabriel looked and laughed and then Michael raised his hand because he believed his shape was correct. I came by and told Michael it was a good try, but the bottom of the fish should be flat. The picture on the left in Figure 12 clearly shows that the bottom of the fish is not flat, but Michael believed his shape was the same as shown on the projection screen. Also the tail of Michael's fish was incorrect as compared to the diagram on the right. Several of the boys also raised their hand to have me come over, when they clearly did not have the shape and were still rearranging the pieces. Towards the end of the activity, many boys showed their frustrations jokingly, "I give up. I retire.” Robbie joked that he made an arrow with four shapes as shown in Figure 15. I advised him that the point of the arrow is a right angle, which Robbie’s shape is lacking. Overall the boys had difficulty diserning the correctness of their tangram models and also used comedy to lighten the mood of the classroom and to ease their frustrations in solving the challenging activity.

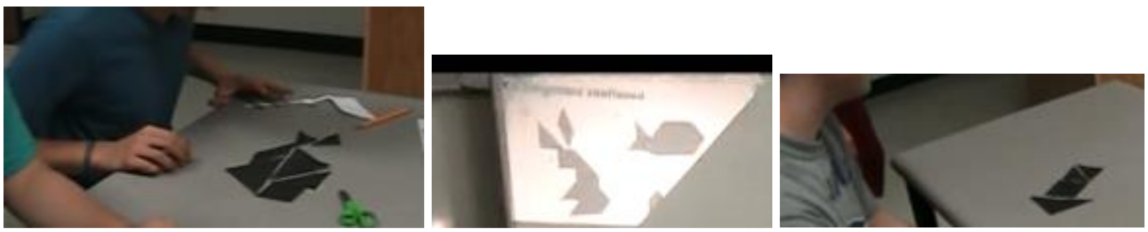


FIGURE 15: Michael’s incorrect fish, projected tangram fish, and Robbie’s incorrect arrow

In contast, as the girls worked quietly by themselves and rarely called the teacher over to observe an incorrect construction of their tangram models. As the girls worked, they looked repeatedly back and forth at the projection screen and their tangram shapes. They moved their shapes around to closely match the projection screen models. Some of the girls used the white side of the paper, when they became frustrated with the black side which was assigned. The girls were better able to discern that their tangram models were correct and seldom raised their hand for the teacher to examine their incorrect constructions.

The boys also interjected comedic lines as they worked together on “Floating Family” and the “Brenda the Brave” problems. This helped to lighten the mood and ease the frustration of trying to solve the problems. Isaac, Carter, and Robert discussed different possibilities for crossing the river in the “Floating Family.” The group states, “It is impossible.” Isaac says, “I did it though. I don’t remember how I did it.” Isaac jokingly comments, “Swim kids.” Isaac believed he had been able to move the pieces to get the family across the river, but unfortunately the steps had not been written down. He was showing frustration that he could not remember the steps and could not move the pieces a second time in order to show his group members. Isaac then joked that the rest of the family could swim across the river instead of having to deal with the restrictions of using the boat.

In Gabriel and Robbie’s group they are also used comic relief. Dylan tried moving the paper pieces and declared, “That’s cool. I got it,” then added, “He kicked him out and he drives away.” The whole group laughed at Dylan’s remark. Gabriel then added lightheartedly, “I’m sorry mom and dad and brother or sister. I guess there are just three now.” Dylan’s group had solved the river problem. Then to help in his understanding, Dylan decided to move the puzzle pieces.

For the “Brenda the Brave” problem, the same group also injected humor after figuring out the T-table for the increase and decrease in elevations. Gabriel said, “Dude, look.” Smiling, Gabriel showed the table written on his paper. Michael said in jest, “Brenda was really a survivor man.” Dylan added, “She must be really sleepy.” The boys joked around that Brenda was a real survivor since she descended down the mountain 2,000 feet during the night due to the mischievous spirit and then climbed up the mountain 3,000 feet during each day. Dylan also said she was really sleepy, since the spirit never woke her as she descended the mountain slope nine nights in a row.

In summary, the boys used comedy in their discussions to lighten the mood of the classroom and to ease their frustrations of trying to solve the challenging problems. The girls also experienced frustrations in solving perplexing problems, but they were more likely to keep their frustrations to themselves. Instead of using comedic relief the girls clenched their fists, held their heads, readjusted their glasses, took a deep breath, or offered words of encouragement to others. Solving mathematical problems was a stressful situation at times; however the students managed their stress differently in the all-boys and all-girls classrooms.

My Observations of Implementing Single-Sex Classrooms

The phenomenon of my experience with implementing single-sex classrooms will be explained in this section. At the beginning of the 2012-13 school year many of the parents and students were quite excited that they would have the opportunity to experience single-sex classrooms. During the school's Open House, many of the mothers shared that they were quite eager to have their daughters learn mathematics in an all-girls classroom. Some of the mothers and daughters shared their thoughts about being shy or being too embarrassed to ask questions with boys in the classroom. Some of the girls expressed their turmoil about being teased by boys in the past. With excitement and eagerness, I began the school year with all-boys and all-girls mathematics classes.

From the very beginning of the school year, both the boys and the girls were very protective of the single-gender environment. For instance, if a boy walked into the all-girls class or a girl walked into the all-boys class, the whole class would get quiet and wonder or ask why that person was in their classroom. The male principal even felt he had to ask permission to enter the all-girls classroom. The single gender classroom was considered a safe zone where the students knew they could be themselves while they were learning mathematics.

The girls created very strong bonds of friendship with each other both personally and while working and learning together. The girls were very focused on their work and the aspect of learning. They felt very comfortable asking questions when they needed to fully comprehend a mathematical objective. At times, the girls even asked too many questions and made some topics seem more challenging than they actually were. The girls took full advantage of the open learning environment with many preferring to work in pairs of small groups. The girls utilized all of their learning resources while becoming closer friends in the all-girls classroom.

The boys were also very hard workers and became friends within the all-boys classroom. Some of the boys preferred to work by themselves at their own pace, whether faster or slower than their peers. Some of the boys liked to joke around, which created a fun atmosphere and learning environment. They were very polite and courteous to me as their female teacher. They would help me whenever possible and were very protective of me acting like big brothers. The boys were also very respectful of the girls on the team when they interacted during mixed gender class, Healthy Active Child time, and class changes. Overall the boys behaved and worked in a respectful manner during the entire school year.

There were also other notable discoveries that occurred between the girls and the boys. During lunchtime the boys and the girls preferred to have all-girls tables and all-boys tables. There were two boys' tables and then two girls' tables. Chairs were added to the girls tables as new students were added onto the team. The girls especially were very adamant about sitting at all-girls tables. A couple of times, the boys arrived at the lunchroom first and sat at different tables. The girls would get upset and express their frustrations and even wanted me to leave earlier for lunch the next day. The boys eventually saw that the girls preferred the separate lunch tables and quit in their attempts to modify the seating arrangements. Only during the last month of the school year did some students start to sit mixed-gender for lunch. Another finding was that there were no dating dramas during the school year. Since the boys and the girls were only in mixed classes for half of the day, they did not get to know the opposite gender as well. Also with the strong bonds the girls created with each other, the girls did not seem to need additional support from the boys. I did not observe any dating drama, break-ups, or emotional days among the students in my single-sex classes as compared to previous years. The students also had less discipline referrals as compared to past years. This all contributed to the respectful manner of the students and the strong friendships, which resulted in a very hard-working learning environment throughout the school year.

Summary

There were five major findings that emerged from the seven types of data collected. The first finding was gender differences in group cohesion, which appeared in a competitive learning context. The girls worked while maintaining and growing the group bonds, whereas the boys found it difficult at times to work together in their groups. Gender differences in the type of motivation was the second finding. This finding highlights how intrinsic and extrinsic motivations were displayed differently between the boys and the girls. The third finding was different patterns of engagement were displayed as the boys and girls solved mathematical problems. Fourthly, the boys included and excluded a non-working member of the group. The fifth and final finding examines stress management during individual competitions within the boys' and girls' classrooms.

The first three findings show gender differences in an all-boys and all-girls competitive environment. The first finding, gender differences in group cohesion, focuses on the social aspects of learning mathematics in an all-boys and all-girls classroom. The second finding, psychological, examines gender differences in intrinsic and extrinsic motivation while learning mathematics in an all-boys and all-girls classroom. The third finding, cognitive, reveals how boys and girls utilized the same solution methods, but differ in their patterns and how they showed they work. The fourth finding, social, compares how some boys worked in the different learning contexts of competitive and cooperative classes. The fifth finding, social and psychological, reveals how boys and girls manage their stress when faced with a challenging task or situation during individual competitions.

These findings reveal the emergence of gender differences in competitive groups yet not in cooperative groups in all-boys and all-girls classrooms. In this study, boys and girls exhibited similar behavior concerning the social, psychological, and cognitive aspects of learning mathematics in cooperative groups. Four out of the five findings occurred in competitive contexts of all-boys and all-girls mathematics classrooms, whereas the fifth finding compared social aspects between all-boys in both cooperative and competitive learning contexts. Therefore, there were more findings in the learning context of competitive groups in all-boys and all-girls mathematics classrooms.

CHAPTER 5: CONCLUSION

This qualitative case study was designed to examine the learning experiences of students enrolled in an all-girls and all-boys math class in a co-educational public school. The classroom interactions were analyzed focusing on the cognitive, psychological, and social aspects of students learning mathematics in the two single gender classes. Students' responses to the different pedagogical approaches of cooperative and competitive learning contexts were examined.

In this chapter, I examine the research question and the findings that emerged from the case study of students enrolled in an all-girls and all-boys math class in a co-educational public school. The major findings will be linked to other research in the field. The discussion will focus on answering the overarching research question: How do two different pedagogical approaches, cooperative and competitive learning contexts, shape students' learning experiences in an all-girls math class and an all-boys math class? Three sub-research questions were:

1. How do the two different learning contexts shape the cognitive processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?
2. How do the two different learning contexts shape the psychological processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?

3. How do the two different learning contexts shape the social processes and outcomes of students learning mathematics in an all-girls math class and an all-boys math class?

Next, the limitations of the study will be examined. Then, the implications for teacher education and areas of future research that would enhance this study are presented.

Summary of Findings

There were five major findings that emerged from the seven types of data collected. The first finding involves gender differences in group cohesiveness in a competitive learning context. In a cooperative learning context both the boys and the girls worked together with their peers to solve problems and produce a joint product. The boys and the girls relied on each other to assist with cognitive misconceptions and to finish the challenging task in a timely manner. While working in a competitive learning context, the girls continued their strong bonds of group cohesion and worked even harder with their group members to finish before other groups. The importance of teamwork and having fun was important to the girls as they worked in a competitive learning context. The boys expressed problems in the unity of their groups during competitions. The increased excitement of winning caused the voice-level of the classroom to rise, which in turn produced focus issues for some boys. Due to time constraints, some of the boys groups did not work closely together causing an uneven distribution of work. Only working members of some groups collaborated with each other on the task excluding a non-working group member. The inclusion and exclusion of a non-working member will be examined more closely in the fourth finding. Both the boys and the girls enjoyed competitions and wanted to win. The girls enhanced the strong bonds of friendship as they worked, while the boys found it difficult at times to work cohesively in their groups.

The second finding demonstrated gender differences in the type of motivation while in a competitive learning context. Intrinsic and extrinsic motivation was exhibited differently by the boys and the girls as they solved mathematical problems. A goal of lesson planning should be to design lessons to stimulate a certain kind of motivation. During competitions, the girls exhibited both intrinsic and extrinsic motivation. The girls valued the learning aspects of working with their friends as well as the extrinsic reward of the prize. Some of the girls thought it was fun and exciting working in their group with the fast pace of the competitions. However, the intrinsic reward was more important to the girls, since some of the girls did not rush and wanted to make sure all the group members understood the problems. Peer understanding and the importance of social relationships was a key aspect for the girls' motivation.

The boys' learning revolved around the extrinsic reward of brain food. This aspect became a disadvantage to some of the groups. Some of the boys groups worked diligently with their peers to solve the given tasks, although some students became isolated and passive during the competitive tasks. Two of the boys did not like the idea of working so hard and then not winning the extrinsic reward. Both the boys and the girls were concerned with balancing the fast pace of the competitions with the correctness of their answers. The boys and the girls found that despite the fact there were advantageous aspects of winning an extrinsic reward, there were also challenging features of competing against one another while maintaining positive peer relationships.

The third finding revealed diverse patterns of engagement in a competitive group environment during a problem-solving activity. The boys and girls held different perceptions on when they thought group work was completed. The girls needed to prove to themselves that they could solve the Floating Family problem, whereas some of the boys' groups were content when one member in the group solved the problem. While the boys worked on the Floating Family and Slippery Slope problems, they participated in dynamic discussions, while the girls preferred less discourse in order to concentrate on the problem. This behavior is uncommon among boys, since boys are usually quieter in groups and not as willing to discuss problems with their group members. While solving the Slippery Slope problem, the boys and the girls used the same solution strategy, but they showed their work differently. However, when working on the Magic Triangle problem where both the boys and the girls used the same solution strategy, some girls counted with their hands to help solve the problem. Their active engagement indicated the girls wanted to solve the problem and preferred to count with their fingers rather than using pencil and paper. This cognitive finding demonstrated different patterns of engagement between the all-boys and all-girls classes.

Boys displayed different work patterns in cooperative and competitive environments, which is the fourth finding. The boys left out a non-working member in competitive groups, but they still tried to work with him in a cooperative setting. This finding shows there was more active involvement and participation in boys' cooperative groups as compared to a competitive learning context. The passive worker was also a low-achiever that was less involved in competitive groups than were his high-achieving peers. Uninvolved, this student's off-task time was spent staring off into space, watching the classroom, or aimlessly playing with non-task objects. This finding is common with passive, low-achieving students in cooperative group; however, not in a competitive learning context as is this finding. In summary, the boys left out a non-working member during competitive lessons, but they still tried to work with and include the member in a cooperative learning context.

The fifth finding illustrated how boys' and girls' stress management strategies were different during individual competitions. The affective domain of learning in mathematics includes beliefs, attitudes, and emotions. This finding involves emotions, which may appear and disappear quickly such as the frustration of trying to solve a challenging problem and the joy of finding an answer. Affects also include a system of communication such as body language, eye movements, facial expressions, laughter, and exclamations. The boys used comedy in their discussions as they worked to lighten the mood of the classroom, as well as to ease frustrations of trying to solve challenging problems. The girls also experienced frustrations in solving problems, but kept their frustrations quietly to themselves. The girls' nonverbal communication with frustration was exhibited with clenched fists, deep sighs, and holding their heads. The boys were more vocal with exclamations of how challenging the problems were and some became class comedians. Some boys exclaimed the need for more tangram pieces, joked and took or hid other boys' pieces, and one soft-spoken boy even started singing. The boys and girls managed the stress of solving mathematical problems differently in the all-girls and all-boys mathematics classrooms.

The overall findings show that the girls behaved in a similar manner in cooperative and competitive classrooms, whereas the boys showed contrasting behaviors.

In the competitive classroom, there were gender differences in group cohesion and in the types of motivation. Gender differences were exhibited in patterns of engagement such as when group work was finished and the boys' groups had more discussions about the solution. Both the boys and the girls found ways to manage their stress and emotions while solving challenging problems during individual and group competitions. All of the findings occurred in a competitive learning environment. While the first three findings focused on gender differences, the fourth finding examined differences between the competitive and cooperative learning contexts solely in the boys' classroom. With the exception of the fourth finding, all of the findings occurred in both the all-boys and all-girls mathematics classrooms.

Discussions

Teaching and learning in mathematics is encountering dramatic change. In the United States, the *Common Core State Standards for Teaching Mathematics* (CCSSI-M, 2011) has described the content in addition to the mathematical practices students should learn in the K-12 curriculum in order to prepare them for success in higher education and the workplace. *The Standards for Mathematical Practice* follow the National Council of Teachers of Mathematics' (NCTM, 2000) Principles and Standards for School Mathematics. NCTM's vision of school mathematics calls for student-centered constructivist learning that will prepare students for the 21st century. These current reforms in mathematics education promote new strategies. This research study provides unique insight regarding a classroom context that utilized one possible strategy.

Boys' and girls' interactions and work habits in cooperative and competitive learning contexts were the focal point of this study. Discussions encourage new ideas, since the mere act of listening or looking at another's idea may ignite new thoughts that would not have occurred on their own. When discussion occurs in an informal setting of small learning groups, the result for the members can be thought-provoking and exhilarating. There are many factors to consider in small learning groups such as achievement levels, communication skills, groups leaders, different learning styles and personalities as was illustrated in this study. Skemp (1987) emphasizes, "Those who really understand mathematics is not uncommon; those who can communicate it less so; those who are also excellent group leaders, fewer still; while those who can also communicate this last ability are rare indeed" (p. 91). As was shown in the findings, girls and boys exhibited differences as they worked and discussed ideas in small groups, especially in a competitive setting.

The first finding demonstrated gender differences in group cohesiveness in a competitive learning context or during an intergroup competition, which Roseth, Johnson, and Johnson (2008) considered a cooperative learning context. Townsend and Hicks (1995) found in cooperative groups girls were more likely than boys to engage in taking turns, verbal organization, and helping their peers. In this study the girls and the boys acted similarly in cooperative groups. However, in competitive groups, the girls took more time to help other group members' mathematical comprehension and their verbal exchanges did not hinder other students from working in a productive manner. Mulyran (1994) found differences between boys and girls were minimal, but girls emphasized the importance of social variables over academic variables as compared to boys. This result was confirmed with my findings, since the girls wanted to preserve the group and value that they worked together and helped each other. The girls were also concerned with the social aspects of winning and the negative effect of losing with regard to their friends' self-esteem and confidence. Crockenberg, Bryant, and Wilce (1976) believed females may fear success because success means another student fails and success could be viewed as 'competitively aggressive' and consequently unfeminine. Student achievement correlated with the positive relationship the student(s) had in small groups. (Johnson, Johnson, & Roseth, 2010). Additionally, Shapka and Keating (2003) found more active participation in all-girls classes allowed girls to attain deeper cognitive processing by the creation of a task-focused cooperative learning environment. Streitmatter (1997) learned when girls were comfortable with female peers they had a tendency to focus on collaboration, rather than on competitive aspects. In Townsend and Hicks (1995), they found girls expressed a greater preference for working in small groups since the social satisfaction may be greater for girls than boys in a small group learning environments.

The second finding illustrated gender differences in the type of motivation in a competitive learning environment. Competitions can be an exciting challenge that increases the desire for students to do well; therefore, students may become more involved in an activity and increase intrinsic motivation (Sherman & Thomas, 1986). Intrinsic motivation displays high levels of task enjoyment, which helps students develop an interest in the activity (Tauer & Harackiewicz, 2004). The girls in this study displayed intrinsic motivation to solve the problem, as well as developing a strong social affiliation with group members. The competitive learning context can increase the desire to perform well and the excitement of the challenge, which can increase intrinsic motivation (Tauer & Harackiewicz, 2004). This positive effect can also cause students to become more involved in the activity. Increased extrinsic motivation by providing an extra incentive such as a reward during a competition may lead students to place more emphasis on performing at a high level (Tauer & Harackiewicz, 2004). Both the boys and the girls found they had to balance how fast they could work with the accuracy of solving the problems. Some of the boys became extremely motivated by the extrinsic reward which caused them to become highly aggressive in their groups, which ultimately lowered their performance level. Given that students were actively involved in constructing knowledge, their excitement level could have hindered their cognitive ability to solve mathematical problems. Thus, the short-term motivation of a prize is an extrinsic reward, but it does not guarantee mathematical comprehension.

The goal of the mathematics educator is to have one's students intrinsically motivated to lean mathematics in order to increase their cognitive understanding and becomes reflective learner of mathematics. When a student completes an activity that is personally worthwhile, the reward is immediate and favorable. Consequently, the student will want to prolong or continue doing the activity. Skemp (1987) describes this tendency towards growing and learning in mathematics as an intrinsic aspect of the mental organization called schema. When pleasure is derived from engaging in something student enjoys, that becomes a powerful incentive to incite mathematical learning inside and outside the classroom. According to McLeod (1992) and other researchers, the confidence and enjoyment of mathematics appears to decline as students move from elementary to secondary school. Until intrinsic motivation is more thoroughly understood, mathematics will be viewed as a subject to be tolerated, not appreciated, and the coursework will quickly be forgotten (Skemp).

In the third finding, students showed different patterns of engagement in a competitive group environment during a problem solving activity. Each gender held different perceptions on when they thought they were done working on the problem. As Schoenfeld (2012) emphasizes, a mathematical problem is never really done or solved, since there are a multitude of ways to solve and cognitively examine problems. This study of 7th grade students involved solving a magic triangle, whereas Schoenfeld engaged his college students in solving a magic square problem. My students solved for a solution by guess and test or, as Schoenfeld terms, trial and error. Most of them solved the triangle by working forward and looking for triples which add up to nine. In this study my students used the same solution strategy, but used different processes to solve the problem such as counting with their fingers or writing the solution on paper. Schoenfeld also challenged his college students to examine different ways to solve the problem such as working the problem backwards, which leads to a proof about the sum of each row. He extended the problem to various mathematical variations including if the magic number could be changed, which numbers would be possible. Students benefit from being challenged to their mathematical boundaries as they develop their mathematical understandings.

Similarly, Mulryan (1995) found that students can be exposed to more cognitively demanding content in a small group setting where they are assigned to work together with their peers. Students are able to engage in higher-order thinking and problem-solving in small groups in a way that is not is often possible in a whole group setting. Cooperative small groups at the elementary level have resulted in positive cognitive outcomes for student achievement (Mulyran, 1994). Open-ended mathematical tasks allow for meaningful engagement within groups. In this study, some of the boys took part in animated dynamic discussions while solving problems. Given an open-ended task, group members have to work together in order to negotiate how to solve the problem. Activities that encourage individual accountability and group rewards have been found to be effectively consistent (Esmonde, 2009).

In the fourth finding, the boys exhibited the social inclusion and exclusion of a non-working member in competitive learning contexts. This finding shows there was more active involvement and participation in boys' cooperative groups as compared to a competitive learning context. In contrast, Mulyran (1992) found that some low-achieving students exhibited high-levels of passive behaviors in a small group cooperative learning context. In this study, the low-achieving students exhibited pronounced passive behaviors only during competitive activities. Mulyran describes passive behaviors as a failure to ask questions, contribute to comments or suggestions, and respond to group members' questions. During student interviews after the group activities, Mulyran found that students mentioned names of students in their group that were uninvolved or passive during group work. This also happened during this study when I interviewed one group's members. High achievers also tend to interact more with their peers in a small group as compared to low achievers (Mulyran, 1994). The quality, rather than the quantity of interactions in contribution to solving the mathematical task is key to effective small groups. Receiving explanations can help students correct misconceptions, fill in gaps in their understanding, and help scaffold new information and ideas (Webb, Farivar, & Mastergeorge, 2002). It is critical that group members do not become frustrated with low achievers in their group and encourage students to copy their work instead of asking for help in solving mathematical problems. Students should also not be blamed or reprimanded for less content knowledge (Lavasani & Khandan, 2011). Small groups should be a supportive and safe environment for all students regardless of their ability level (Martinie, 2003).

The social aspects of group work are crucial to the creation of student identities in the mathematics classroom. Successful groups are more likely to be attentive to other group members' learning, respond to their ideas, and share group manipulatives (Esmonde, 2009). Differences in group achievement are a result of group organizational structure, instead of problems with mathematical content knowledge. As in this study, the groups that worked well together and spent more time on task were able to solve the problems accurately and efficiently. Group work and interactions are essential to prepare students for their future learning and for success in the workplace (Esmonde). Students have to negotiate ways of working together to lessen hierarchy and focus on teamwork and equity in the mathematics classroom.

The fifth finding showed how stress management manifested in individual problem solving competitions. The boys were more verbal and used comedic expressions in their discussions, whereas the girls kept their frustrations quietly to themselves. According to McLeod (1992), the affective domain or the emotional response to mathematics has never played a prominent role in mathematical research. This is mainly due to the lack of a theoretical framework in which to comprehend the role of emotions in learning mathematics, even though the constructivist perspective has been used previously. This study focuses on the emotions and frustrations of boys and girls during a problem solving episode as they constructively learn mathematics. As McLeod points out, “If research is going to help us understand the role of affect in mathematics learning and teaching, studies of affect must be integrated with studies of cognition” (p. 588). This study is one example of research that includes cognitive and affective aspects of learning mathematics in an all-boys and an all-girls classroom. The source of the students’ struggle was the challenge or cognitive block as students attempted to solve non-routine problems. While some students attempted to solve challenging problems, they showed a willingness to persist and persevere. Many students redirected their behavior and looked for alternative cognitive approaches in order to solve the problem. McLeod’s views highlight the importance of this study, since curriculum reform is emphasizing the importance of non-routine problems, mathematical discourse, and applying mathematics in new situations.

Key Points. A unique aspect of this study was that the girls talked less than their male counterparts while working in competitive groups. The girls took their work very seriously and stopped talking intermittently preferring to concentrate on solving problems. Mullholland & Kaminski (2004) also found the girls were able to concentrate more without the distraction of the other gender. The girls wanted to preserve the group and became closer with their group members. They were able to achieve this without excess or unnecessary talking. Streitmatter (1997) found the girls in a single-sex classroom had a sense of freedom to ask and answer questions without having to be correct. In this study, the girls also asked questions whenever they needed to in order to comprehend how to solve a problem.

The boys were also serious at times, especially if they wanted to win the competition. Not all of the boys’ discourse was thought-provoking, since sometimes they spoke just to discuss answers with group members. The boys voice-level also elevated as they became motivated in their groups. The boys conversed when they needed to talk through how to solve the problem and explore different ways to solve the task. Some of the talking was also to be funny and to tell jokes, while they were working on the problems. Martino, Mills, and Lingard (2005) found the boys socialized and worked on group projects. Similar to these researchers' study, the boys in the single-sex classroom socialized as they solved mathematical problems in their groups.

The key point of girls talking less and boys talking more differs in comparison to mixed-gender classes. Denith, (2008) found that to be taken seriously and regarded as smart girls feel they have to work harder than males. Consequently, the girls who are confident in their mathematical ability are more likely to speak out in class. Less confident or shy girls adopt a quieter demeanor a mixed-gender classroom since they do not want to appear ignorant in front of boys. Denith also found some girls had a challenge with their self-image and diminished confidence. Girls tend to have a civilizing effect on boys in the classroom (Jackson & Smith, 2000). The presence of girls in the classroom may calm some boys, but other boys in the mixed-gender classroom may feel they have to show off their confidence and masculinity. In whole group discussions, boys may be called on more often, allowed to speak more, given more praise, and useful and constructive criticism. Therefore, girls and boys vary in the type of and amount of discourse in mixed-gender classrooms. Girls may not engage as fully in mathematics classroom discussions; however this could be caused by lower confidence, shyness, boys, or teacher preference.

The second key point of this study was the boys' behavior. It was interesting to note the discovery that some groups left out a non-working member, but only during competitive learning contexts. Before videotapes and student work were thoroughly examined, my initial impression was that the boys just left out or ignored a group member. However, after further analysis, I discovered a pattern in how the boys discussed the different problems, and provided and received help to solve their group's tasks. It was also intriguing to ascertain the boys did not require the non-worker to do his fair share of the work. These boys were not shy, but they never denounced the fact that somebody was not working and should be on-task with his contribution to the group.

The boys' classroom in this study was a safe environment in which the boys felt secure since ground rules has already been established. The boys were respectful, partially due to the fact that a female teacher was present. Most boys were hard workers and wanted to excel in mathematics. There were occasions when their jokes lightened the mood, but nothing disruptive to tasks. This contradicts Van de gaer, Pustgens, Van Damme, and De Munter's (2004) finding that boys engaged more in roughness and getting into trouble. In Martino, Mills, and Lingard (2005) study, the all-boys classroom was designed to control a group of disruptive students. The teacher created a bond with the boys and became closer to them while gaining their trust. A similar outcome was found in this study where students in both classes and I formed strong bonds resulting in a stronger team as the year progressed.

Relationships Between Theoretical Frameworks and Major Findings. The constructivist student-centered problem solving classrooms in this study had the students working in a cooperative or competitive learning context. While the students worked cohesively in their groups they utilized the benefits of discussion, such as communicating their ideas to help clarify them into words or mathematical symbols. The boys in this study were more apt to use discussions to convey their thinking, while the girls created different models and symbols to convey their ideas. The girls used verbal communication to ask questions and explain their mathematical strategies as needed. Some boys became too excited and motivated, which became a detriment to their thinking processes. Overall the students were able to communicate their mathematical thinking clearly and coherently to their peers, while evaluating and analyzing others' mathematical strategies and thinking. The students created a constructivist, sense making, problem solving atmosphere in their all-boys and all-girls mathematics classrooms.

Feminist theory focuses on gaining equal rights and educational opportunities for both genders. In this study the boys and the girls were provided the same educational opportunities, expectations, and support regardless of their gender. Both the boys and the girls were given the same problems to solve, learning context, and pedagogical support. Feminist theory also takes into account internal diversity and difference. While students were in their groups, they discovered mathematics and problem solved together in a supportive environment where alternate solution methods were encouraged (Spielman, 2008). Girls especially need to feel a social connectedness, which was a key factor both the cooperative and competitive learning contexts. A positive learning environment was created in the all-boys and all-girls classrooms, which allowed them to value the importance of mathematics while they became confident in their ability to do mathematics. Single-sex education is an opportunity to improve education for both genders, while increasing equity and feminism in the mathematics classroom.

Limitations of the Study

A qualitative case study design is used to gain an in-depth understanding of a situation (Merriam, 1998). In this exploratory case study, there were two cases consisting of an all-girls and an all-boys mathematics class that were studied at length during the 2012-13 school year. The goal of case study research is to provide a thick, rich description, and analysis of a phenomenon (Merriam). Limitations include reliability, validity, and generalizability. Strategies used to enhance validity include: triangulation, long-term observation, member checks, and committee member examinations. This study utilized multiple data collection methods including seven different types of data: student interviews, teacher's reflective journal, post-lesson surveys, students' reflective journals, classroom observations, student attitude surveys, and student work samples to triangulate the data. On the topic of reliability, instead of assuming a repeated study will yield the same results, the objective is that the data make sense given the collected data and are dependable and consistent. By providing a thorough descriptive explanation, the findings are context based and as a result are transferrable. Generalization is always a concern with case study research, since just a few cases are studied, but generalization is not the goal of case study research. Yin (1994) points out that case studies "are generalizable to theoretical propositions and not to populations and universes" (p.10). Overall there should be uniqueness to the case to truly understanding the case itself.

A second limitation of this study is the dual role I undertook of being the teacher and the researcher. This limitation proved to be a positive aspect, since it allowed me to gain in-depth knowledge about the research participants. For instance, during interviews, the students may have felt comfortable sharing their thoughts since they knew me. Rather than a complete stranger interviewing them, the students were familiar with me through our daily interaction. In contrast, students may also have held back information based on the fact that I was their teacher. They were informed at the onset of this study that their grades would not be affected by their answers, but students could also have altered their answers depending on what they thought I wanted to hear or read. Participants may also have projected a more positive perspective of single-sex classes, since they knew I was in favor of this design. Since I was the teacher and researcher, I did not have the additional concern about being in another teacher's classroom to conduct a study on students with whom I was unfamiliar. In this study, the advantages of being the researcher far outweighed the potential disadvantages of the dual role of teacher and researcher.

The third limitation of this study is the low number of students of different ethnicities. The Caucasian majority in the all-boys classroom was 90%; and the all-girls classroom was 82% Caucasian. These percentages reflect the school demographics of being approximately 90% Caucasian. However, this study did not focus on ethnicity. A future study to discover how students of different ethnicities or SES embrace single-gender classrooms would be edifying.

Implications

Implications for Practice. The implications of this study suggest that small groups may be used more in the mathematics classroom to incorporate the use of small groups into their classrooms. This includes the use of cooperative groups and competitive groups as a strategy to create positive peer relationships. This study highlighted gender differences in group cohesion while students were in competitive groups. As a result, attention should be paid on how the cooperative and competitive goal structures are incorporated into the classroom in order for it to create a positive learning environment for the students as well as the teacher. This study highlighted gender differences in group cohesion while students were in competitive groups. Accordingly, the more successful the peer relationships, the more likely students are going to achieve in cooperative and competitive groups (Roseth, Johnson, & Johnson, 2008).

Johnson, Johnson, & Roseth (2010) suggest that schools deemphasize the use of competitive or individual work, but this study indicates some positive aspects of competitions, whether it be individual or group competitions. Individual competitions were employed as a successful learning context providing motivation and incentives for students in the mathematics classroom. The teaching methods could be a key factor in how the competitions are implemented in the classroom by creating an encouraging learning and social environment. In this study, students appreciated the individual and group competitions which motivated the majority of them to work at a quicker pace. This was shown by the finding of gender differences in types of motivation in a competitive learning context. When a student has a tendency to work to less than their full potential, they should be paired with a student that keeps him or her on task and engaged in their share of the group work. Another strategy would be to have a group of students that may not always challenge themselves work together. When they are in the same group, the students will have to change their previous work habits in order for the group to complete the task and remain in the competition.

Teaching students how to solve mathematics problems also implies that we teach them about how to deal with frustrations and how to cope with emotions especially when they are problem solving. Only by experiencing negative emotions will students have the opportunity to learn how to deal with them. A finding from this study was stress management in individual competitions. I encouraged my students to persevere and continue working even when the problems seemed quite challenging. For instance, during the tangram activity the boys and the girls became overwhelmed at times; some wanted to quit. When another student solved a tangram puzzle, it was helpful for other students to look at another student's correctly completed puzzle. All students need guidance and encouragement to work to their full potential and feel empowered to solve mathematical challenges.

The implications of this study suggest that it may be worthwhile for teachers to create a constructivist, sense making, and problem-solving mathematical culture within their classrooms. In keeping with the goals of the CCSSI-M and NCTM's Standards, students need to develop their understanding of mathematics and 'mathematical habits of mind' from the mathematical cultures inside the mathematics classrooms (Schoenfeld, 2012). The students should be held accountable for their mathematical understandings by the teacher as well as the other students in the classroom. Therefore, if students are having problems with their mathematical understanding, they need to verbalize their misconceptions to their peers or their teacher and create mathematical discussions. As shown in this study, students should be challenged with problem-solving mathematical problems. The students may have demonstrated their work or process differently as in the finding of patterns of engagement, but they arrived at the same solution for their thought-provoking tasks.

Implications for Teacher Education and Professional Development. Durick and Eccles (2006) found that new teachers were more likely to utilize cooperative groups in their classrooms, due to trends in teacher education programs. Additionally, teachers that have positive experiences teaching math are more likely to use competitive mathematical activities. All of the findings in this study examined the learning contexts of cooperative and competitive groups. As a result, professional development opportunities accentuating the positives of cooperative and competitive groups and how they can be incorporated into the classroom setting should be made available to all teachers. It would be worthwhile to explore professional development opportunities concerning mathematical pedagogy and content knowledge. When teachers are more knowledgeable about mathematics, they are more confident and comfortable with their mathematical abilities; thus, and more likely to utilize competitive activities in their classrooms.

It may be beneficial if teachers are comprehensively trained on different theoretical and pedagogical approaches, since that training will ultimately influence their success as teachers. Giving students open-ended challenging problems has been viewed as risky as students are socially constructing mathematical knowledge (Hills, 2007). Teachers make decisions on when and how to use particular educational approaches in their classroom. It is their choice when to provide students the opportunity to explore challenging mathematical problems designed to develop new insights into mathematical understanding. There are many variations in teaching styles due to subject, experience, and grade level. Some prefer constructivist approaches to teaching, while others may view constructivism as risky.

Best practices on gender differences in cooperative and competitive learning contexts should be offered in professional development. This study revealed that boys and girls reacted differently in the two learning contexts. Teachers need to recognize the gender differences in group cohesion in a competitive learning context. Girls intentionally work closely as a team, which strengthens their bonds of friendship. In contrast, boys are highly energized, talk excessively, and raise the volume of their discussions which present challenges. The types of motivation during competitions reflected gender differences. Both genders enjoyed the competitive aspects of winning a prize, but some boys became overly competitive which was a disadvantage to their group. In a cooperative learning context, boys and girls react similarly. Findings from this study suggest that educators may need to discern the best practices on how boys and girls respond in diverse learning situations. Since boys and girls have different learning preferences, the more educators understand about classroom dynamics, the better pedagogical decisions they will make.

The results of this study suggest there is a need for professional development opportunities on best practices to incorporate single-sex classroom in public school systems. Due to changes in NCLB, the incorporation of single-sex classrooms as a strategy for school improvement became a legal option. Before this study began, I had to discover the steps to proper implementation within my own school and county school system. Since commencing this exploratory case study, I have had the opportunity to present the information I discovered on implementation and the positives of single-sex classrooms to colleagues. Educators, school systems, and surrounding communities should be informed on the implementation, limitations, and positives of single-sex classrooms. The assignment of single-sex classrooms is a positive step in creating equity in the mathematics classroom; however proper implementation and accurate data are key to its success.

Implications for Research. There have been few research studies on single-sex mathematics classrooms in the United States; fewer still have examined single-sex classrooms within co-educational public school systems (Glasser, 2012; McFarland, Menson, & McFarland, 2011; Streitmatter, 1997). Most of the single-gender studies have been quantitative research and have compared achievement levels and performance of students' mathematical abilities. Quantitative research focuses on numbers in comparing students to one another. EOG scores are given at the end of the year and do not examine how do students' learn best in the classroom during the school year. This study found gender differences in group cohesion, types of motivation, and patterns of engagement while working in competitive groups. How students learn and prefer to learn cannot always be quantified. A thick description of seven different types of data was used to triangulate the data in this study. In general there needs to be more research on single-gender classrooms in the United States. Qualitative research would allow the researcher to gain a more thorough understanding of the social phenomenon of single-sex classrooms.

Overall there has been a limited number of studies on competitions in the mathematics classroom with even fewer containing intergroup competitions and/or middle school level (Tauer & Harackiewicz, 2004). The few practitioner journals containing examples of competitive games and puzzles are only a couple pages in length. As shown by the limited amount of information involving boys and girls in competitions, I recommend for more research involving gender in the mathematics classroom. Due to the overall positive impact of competitive grouping in this study, the lack of research concerning single-sex classrooms and cooperative and competitive learning contexts is accented. Research examining boys' and girls' collaborative and competitive group work in mixed gender classes is also recommended. One question to address is what would happen if the all-girls groups and all-boys groups competed against one another in a mixed-gender class? Would the students change their behaviors because it is a mixed gender class?

Conclusions

The CCSSI-M and NCTM's Standards clearly call for teachers to use a social constructivist model of teaching. Social constructivism reaches beyond learning theory. It is model of the culture within the mathematics classroom and the communication that takes place based on Vygotsky's social learning theory (White-Fredette, 2009). Social constructivism is a communicative process that people or students do in the classroom as their social interactions enhance them to make connections with ideas and reorganize their mathematical knowledge. By integrating problem solving experiences in their classroom, educators can stimulate further mathematical reasoning and learning (Hennessy, Higley, & Chesnut, 2011). In this study, the students were encouraged to connect with their prior knowledge and create different representations of mathematical problems as they strengthened their leaning experiences within a social context. Their use of mathematical communication allows the participants to make sense of other students' mathematical ideas while engaging in a dialogue of common knowledge. This social constructivist learning environment ultimately increased the participants' mathematical application and retention. Along with constructivist teaching approaches, my students and I reflected and discussed their learning experiences while thoughtfully promoting interactive mathematical communication, which is a key element of the learning process (NCTM, 2000).

White-Fredette (2009) states, “The social process of learning mathematics is intricately linked to society’s ideas of what is and is not mathematics” (p. 24). The role of mathematics as viewed by society has a major influence on the development of the mathematics curriculum and instruction. Gender differences in mathematics attitudes and achievement have changed over time from mathematics being a stereotypical male domain to mathematics not being appropriate for the female brain (Rohn, 2013). Recently there has been a focus on boys’ educational experiences in mathematics (Martino, Mills, & Lingard, 2005). The current feminist perspective positions the current problem with mathematics not with girls’ mathematical abilities, but how the subject is taught in schools (Spielman, 2008). In lieu of such concerns, various intervention programs have come to the forefront of mathematics education and research. Single-sex classrooms as illustrated in this study have become an accepted model of increasing equity, feminism, and social justice in the mathematics classroom. While the students discovered and socially constructed their mathematical knowledge, they became confident in their ability to do mathematics. Conclusively as a society, we need to rethink the role of mathematics to make it inclusive for all students regardless of gender, ethnicity, or socioeconomic status. “Together we can reconstruct common sense in mathematics education by tearing down tired disciplinary boundaries and building up a new mathematics education in the public interest that can inspire hope and change” (Spielman, p. 655).

REFERENCES

Anfara, V. A. & Mertens, S. B. (2008). Do single-sex classes and schools make a difference? *Middle School Journal*, 52-59.

Atweh, B., & Cooper, T. (1995). The construction of gender, social class and mathematics in the classroom. *Educational Studies in Mathematics, 28,* 293-310.

Becker, J.R. & Jacobs, J.E. (1983). Sex: Is it an issue in mathematics? *Educational Horizons, 63*(2), 60-67.

Bell, D. (1994). *Confronting authority: Reflections of an ardent protester.* Boston: Beacon Press.

Blickenstaff, J. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, *17*(4), 369-386.

Blum, R., Hart-Davis, A., Longe, B., & Niederman, D. (2002). *Classic mathemagic*. New York: Sterling Publishing Co., Inc.

Bishop, A. J., & Forgaz, H. J. (2007). Issues in access and equity in mathematics education. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 1145-1167). Charlotte, NC: Information Age Publishing.

Boaler, J. (2002). Paying the price for "sugar and spice": Shifting the analytical lens in equity research. *Mathematical Thinking and Learning, 4*(2&3), 127-144.

Boaler, J. (1997). Reclaiming school mathematics. *Gender and Education, 9*(3), 283-306.

Breakell, J. (2001). An analysis of mathematics textbooks and reference books in use in primary and secondary schools in England and Wales in the 1960s. Retrieved from http://faculty.education.illinois.edu/westbury/paradigm/breakell.pdf

Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning.* Portsmouth, NH: Heinemann.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis.* Thousand Oaks, CA: Sage Publication.

Che, M., Wiegert, E., & Threlkeld, K. (2012). Problem solving strategies of boys and girls in single-sex mathematics classrooms. *Educational Studies in Mathematics, 79,* 311-26. doi:10.1007/s10649-011-9346-x

Crockenberg, S. B., Bryant, B. K., & Wilce, L. S. (1976). The effects of cooperatively and competitively structured learning environments on inter- and intrapersonal behavior. *Child Development*, 47, 386-396.

Common Core State Standards Initiative (2011). *Common Core State Standards for Mathematics.* Retrieved from http://www.corestandards.org/read-the-standards/.

Curry, B. (2000). *Women in power: Pathways to leadership in education.* New York: Teachers College, Columbia University.

Dean, S. (1995). *Hands on Algebra*. Grand Rapids, MI: Instructional Fair, Inc.

DeMarrais, K. B. & LeCompte, M. (1998). *The way schools work: A sociological analysis of Education* (3rd edition). White Plains, NY: Longman.

Dentith, A. (2008). Smart girls, hard-working girls but not yet self-assured girls: The limits of gender equity politics. *Canadian Journal of Education, 31,* 145-166.

DiME Group. (2007). Culture, race, power, and mathematics education. In F. Lester (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (Second ed., pp. 405-433). Charlotte, NC: Information Age Publishing.

Durick, A. M. & Eccles, J. S. (2006). Classroom activities and reading in early, middle, and late elementary school. *Journal of Classroom Interaction, 41*(1), 33-41.

Edwards, D., & Mercer, N. (1987). *Common knowledge: The development of understanding in the classroom.* New York: Routledge.

Eisenhart, M. (1988). The ethnographic research tradition and mathematics education research. *Journal for Research in Mathematics Education*, *19* (2), 99-114.

Epstein, D., Mendick, H., & Moreau, M. (2010). Imagining the mathematician: Young people talking about popular representations of maths. *Discourse: Studies in the Cultural Politics of Education, 31*(3), 45-60.

Esmonde, I. (2009). Ideas and identities: Supporting equity in cooperative mathematics learning. *Review of Educational Research 29*(2), 1008-1043.

Ezzy, D. (2002). *Qualitative analysis: Practice and innovation.* London: Routledge.

Fennema, E. (1979). Women and girls in mathematics – equity in mathematics education. *Educational Studies in Mathematics 10*, 389-401.

Friend, J. (2007). Single-gender public education and federal policy. In *American Educational History Journal Volume 34 1 & 2* (pp. 55-67). Charlotte, NC: Information Age Publishing.

Gates, P., & Jorgenson (Zevenbergen), R. (2009). Foregrounding social justice in mathematics teacher education. *Journal of Mathematics Teacher Education, 12,* 161-170. doi:10.1007/s10857-009-9105-4

Geist, E. A., & King, M. (2008). Different, not better: Gender differences in mathematics learning and achievement. *Journal of Instructional Psychology, 35*(1), 43-52. Retrieved from http://www.projectinnovation.biz/jip_2006.html

Glasser, H. M. (2012). Hierarchical deficiencies: Constructed differences between adolescent boys and girls in a public school single-sex program in the United States. *Journal of Adolescent Research, 27*(3), 377-400. doi:10.1177/0743558411409933

Glesne, C. (2006). *Becoming qualitative researchers: An introduction*. New York: Pearson.

Griffiths, M. (2006). The feminization of teaching and the practice of teaching: Threat or opportunity. *Educational Theory 56*(4), 387-405.

Gurian, M. (2001). *Boys and girls learn differently: A guide for teachers and parents.* San Francisco: Jossey-Bass Publishers.

Gutiérrez, R. (2010). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education Special Equity Issue*. www.nctm.org/jrme/equity

Harker, R. (2000). Achievement, gender, and the single-sex/coed debate. *British Journal of Sociology and Education, 21,* 203-218.

Hennessey, M. N., Highley, K., & Chesnut, S. R. (2012). Persuasive pedagogy: A new paradigm for mathematics education. *Educational Psychological Review 24*, 187-204. doi:10.1007/s10648-011-9190-7

Hills, T. (2007). Is constructivism risky? Social anxiety, classroom participation, competitive game play and constructivist preferences in teacher development. *Teacher Development, 11*(3), 335-352.

Hochschild, A. (2003). *The second shift* [Arlie Russell Hochschild with Annie Machung]. New York: Penguin Books.

Jackson, C. (2002). Can single-sex classes in co-educational schools enhance the learning experiences of girls and/or boys? An exploration of pupils' perceptions. *British Educational Research Journal, 28*(1), 37-48. doi:10.1080/0141192012010973 9

Jackson, C., & Smith, I. (2000). Poles apart? An exploration of single-sex and mixed-sex educational environments in Australia and England. *Educational Studies, 26*(4), 409-422. doi:DOI:10.1080/03055690020003610

Johnson, D. W., Johnson, R. T., & Roseth, C. (2010). Cooperative learning in middle schools: Interrelationship of relationships and achievement. *Middle Grades Research Journal, 5*(1), 1-18.

Klein, P., Adi-Japha, E., & Hakak-Benizri, S. (2010). Mathematical thinking of kindergarten boys and girls: Similar achievement, different contributing processes. *Educational Studies in Mathematics, 73*(3), 233-246.

Kroll, D. (1985). Evidence from *The Mathematics Teacher* (1908-1920) on women and mathematics. *For the Learning of Mathematics, 5,* 7-10.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education, 28*(6), 697-708.

Lavasani, M. G., & Khandan, F. (2011). Mathematics anxiety, help seeking behavior and cooperative learning. *Cypriot Journal of Educational Sciences, 2*, 61-74.

Lawrie, L. & Brown, R. (1992). Sex stereotypes, school subject preferences and career aspirations as a function of single/mixed-sex schooling and presence/absence of an opposite sex sibling. *British Journal of Educational Psychology, 62*(1), 132-138.

Leder, G. C. (1992). Mathematics and gender: Changing perspectives. In D. Grouws, (Ed.), *Handbook of research on the teaching and learning of mathematics* (pp. 597-622). New York: Macmillan.

Leder, G.C., Forgasz, H.J. & Solar, C. (1996). Research and Intervention Programs in Mathematics Education: A Gendered Issue. In A. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), International Handbook of Mathematics Education (pp. 945-985). Dordrecht: Kluwer.

Leikin, R., & Zaslavsky, O. (1997). Facilitating student interactions in mathematics in a cooperative learning setting. *Journal for Research in Mathematics Education, 28*(3), 331-354.

Lerman, S. (2000). The social turn in mathematics education research. In J. Boaler (Ed), *Multiple perspectives on mathematics teaching and learning,* 19-44.

Lipman, P. (2004). *High stakes education: Inequality, globalization, and urban school reform.* New York: Routledge.

Lorde, A. (1984). *Sister outsider: Essays and speeches.* Freedom, CA: Crossing Press.

Lubienski, S. T. (2000). Problem solving as a means toward mathematics for all: An exploratory look through a class lens. *Journal for Research in Mathematics Education, 31*(4), 454-482.

Martinie, S. (2003). Families ask: Cooperative groups. *Mathematics Teaching in the Middle School, 9*(2), 106-7.

Martino, W., Mills, M., & Lingard, B. (2005). Interrogating single-sex classes as a strategy for addressing boys' educational and social needs. *Oxford Review of Education, 31,* 237-254.

McFarland, M., Benson, A. M., & McFarland, B. (2011). Comparing achievement scores of students in gender specific classrooms with students in traditional classrooms. *International Journal of Psychology: A Biopsychosocial Approach 8*, 99-111.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Eds.), *Handbook of Research in Mathematics Teaching and Learning: A Project of the National Council of Teachers of Mathematics* (pp.574-596). New York, NY: Macmillan Publishing Co.

Mendick, H. (2005a). A beautiful myth? The gendering of being/doing 'good at maths'. *Gender and Education 17*(2), 203-219.

Mendick, H. (2005b). Only connect: Troubling oppositions in gender and mathematics. *International Journal of Inclusive Education, 9*(2), 161-180.

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass Publishers.

Moll, L. C. Editor (1996). *Vygotsky and education: Instructional implications and applications of sociohistorical psychology.* New York: Cambridge University Press.

Mulholland, J., Hansen, P., & Kaminski, E. (2004). Do single-gender classrooms in coeducational settings address boys' underachievement? An Australian study. *Educational Studies, 30*(1), 19-32. doi:10/1080.0305569032000159714

Mulryan, C. M. (1992). Student passivity during cooperative small groups in mathematics. *Journal of Educational Research 85*(5), 261-273.

Mulryan, C.M. (1994). Perceptions of intermediate students' cooperative small-group work in mathematics. *Journal of Educational Research, 87*(5), 280-291.

Mulryan, C. M. (1995). Fifth and sixth graders' involvement and participation in cooperative small groups in mathematics. *The Elementary School Journal, 95*(4), 297-310.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics.* Reston, VA.

NC School Report Cards. (2013). *North Carolina School Report Cards.* Retrieved from http://www.ncreportcards.org/src/.

Parker, L. H., & Rennie, L. J. (2002). Teachers' implementation of gender-inclusive instructional strategies in single-sex and mixed-sex science classrooms. *International Journal of Science Education, 24*(9), 881-897. doi:10.1080/09500690110078860

Pedro, J. D., Wolleat, P., Fennema, E., & Becker, A. D. (1981). Election of high school mathematics by females and males: Attributions and attitudes. *American Educational Research Journal, 18*(2), 207-218.

Piro, J. S. (2002). *The pedagogical desires of an all-girl math class* (Doctoral dissertation). Retrieved from ProQuest Information and Learning Company. (3064641).

Rebel, M. & Wolfe, J. (2008). *Moving every child ahead: From NCLB hype to meaningful educational opportunity.* New York: Teacher College Press.

Reid, P., & Roberts, S. (2006). Gaining options: A mathematics program for potentially talented at-risk adolescent girls. *Merrill-Palmer Quarterly, 52*(2), 288.

Rohn, D. (2013). Equity in education: The relationship between race, class, and gender in mathematics for diverse learners. *Urban Education Research and Policy Annuals, 1(1),* 12-22.

Roseth, C. J., Johnson, D. W., & Johnson, R. T. (2008). Promoting early adolescents' achievement and peer relationships: The effects of cooperative, competitive, and individualistic goal structure. *Psychological Bulletin, 134*(2), 223-246. doi:10.1037/0033-2909.134.2.223

Sax, L. (2005). *Why gender matters.* New York: Broadway Books.

Shapka, J. D., & Keating, D. P. (2003). Effects of a girls-only curriculum during adolescence: Performance, persistence, and engagement in mathematics and science. *American Educational Research Journal, 40,* 929-960.

Sherman, L. W., & Thomas, M. (1986). Mathematics achievement in cooperative versus individualistic goal-structured high school classrooms. *Journal of Educational Research, 79*(3), 169-72.

Schoenfeld, A. H. (2008). Research methods in (mathematics) education. In L. D. English (Ed.), *Handbook of International Research in Mathematics Education* (467-519). New York: Routledge.

Schoenfeld, A. H. (2012). Problematizing the didactic traingle. *ZDM Mathematics Education, 44*, 587-99. doi:10.1007/s11858-012-0395-0

Skemp, R. (1987). *The psychology of learning mathematics.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Spielman, L. J. (2008). Equity in mathematics education: unions and intersections of feminist and social justice literature. *ZDM Mathematics Education, 40*, 647-657. doi:10.1007/s11858-008-0113-0

Stake, R. E. (1995). *The art of case study research.* Thousand Oaks, CA: Sage.

Stinson, D. (2010). Negotiating the "white male math myth": African American male students and success in school mathematics. *Journal for Research in Mathematics Education Special Equity Issue*. www.nctm.org/jrme/equity

Stone, M. (1976). *When God was a woman.* Orlando, FL: Harcourt.

Streitmatter, J. (1997). An exploratory study of risk-taking and attitudes in a girls-only middle school math class. *Elementary School Journal, 98*(1), 15-26.

Tauer, J. M., & Harackiewicz, J. M. (2004). The effects of cooperation and competition on intrinsic motivation and performance. *Journal of Personality and Social Psychology, 86*(8), 849-61.

Tirosh, D., & Graeber, A. O. (2003). Challenging and changing mathematics teaching classroom practices. In A. J. Bishop, M. A. Clements, C. Keitel, J. Kilpatrick, & F. K. S. Leung (Eds.), *Second international handbook of mathematics education* (pp. 643-687). The Netherlands: Klumer.

Townsend, M. A., & Hicks, L. (1997). Classroom goal structures, social satisfaction and the perceived value of academic tasks. *British Journal of Educational Psychology, 67*, 1-12.

Tyack, D. & Cuban, L. (1995). *Tinkering to utopia: A century of public school reform.* Cambridge, MA: Harvard University Press.

U.S. Department of Education (2006). Press Release: Secretary Spellings announces more choices in single sex education amended regulations give communities more flexibility to offer single sex schools and classes. Retrieved from http://www2.ed.gov/news/pressreleases/2006/10/10242006.html

U.S. Department of Education, National Center for Education Statistics (2011). Retrieved from http://nces.ed.gov/fastfacts/display.asp?id=514 on July, 11, 2012.

Valenzuela, A. (1999). *Subtractive schooling: U.S.-Mexican youth and the politics of caring.* Albany, NY: State University of New York Press.

Van de gaer, E., Pustjens, H., Van Damme, J., & De Munter, A. (2004). Effects of single-sex versus co-educational classes and schools on gender differences in progress in language and mathematics achievement. *British Journal of Sociology of Education, 25,* 307-322.

Webb, N. M., Farivar, S. H., & Mastergeorge, A. M. (2002). Productive helping in cooperative groups. *Theory Into Practice*, *41*(1), 13-20.

Wertsch, J. V. (1985). Vygotsky and the social formation of the mind. Cambridge, MA: Harvard University Press.

White-Fredette, K. (2009). Why not philosophy? Problematizing the philosophy of mathematics in a time of curriculum reform. *The Mathematics Educator, 19*(2), 21-31.

Wikipedia (2012) Demographic information for location of research study. Retrieved from http://en.wikipedia.org/wiki/Wikipedia

Yates, L. (1997). Gender equity and the boys' debate: What sort of challenge is it? *British Journal of Sociology of Education, 18*(3), 337- 347.

Younger, M., & Warrington, M. (2002). Single-sex teaching in a co-educational comprehensive school in England: An evaluation based upon students' performance and classroom interactions. *British Educational Research Journal 3,* 353-74. doi:10.1080/0141192022013744 9

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.) Thousand Oaks, CA: Sage.

APPENDIX A: LESSON PLANS

Lesson Plan – 1st Month – Cooperative
Making Integer Puzzle

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. No calculators. Students are given a blank puzzle sheet (a 3 x 3 square) and are to make an integer puzzle utilizing the rules of order of operations. They are to work in cooperative groups to create their puzzle pieces. Where the puzzle pieces meet, an integer problem and its answer should join.

The students will turn in notebook paper showing their work & problems solved to create the puzzle.
The teacher will act as a facilitator as the students create their puzzle.
Students that finish early will work on another assignment.

Lesson Plan – 1st Month – Competitive & Cooperative
Solving Integer Puzzle

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. No calculators
Students are given a puzzle created by the other class from the previous day. The groups are all given the same puzzle so one puzzle will not be easier to solve than others. Students will be in competition with other groups. The first two groups that complete their puzzle correctly will receive brain food (candy).

The students will turn in notebook paper showing their work & problems solved to solve the puzzle.
The teacher will act as a facilitator as the students solve their puzzle.
Students that finish early will work on another assignment.

Lesson Plan – 2nd Month – Cooperative
Making Equation Puzzle

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. Two Students pass out calculators. Students are given a blank puzzle sheet (a 3 x square) and are to make a two-step or multi-step equation puzzle. They are to work in cooperative groups to create their puzzle pieces. Where the puzzle pieces meet, an equation and its answer should join.

The students will turn in notebook paper showing their work & problems solved to create the puzzle.
The teacher will act as a facilitator as the students create their puzzle.
Students that finish early will work on another assignment.

Lesson Plan – 2nd Month – Competitive
Solving Equation Puzzle

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. Two Students pass out calculators. Students are given a puzzle created by the other class from the previous day. The groups are all given the same puzzle so one puzzle will not be easier to solve than others. Students will be in competition with other groups. The first two groups that complete their puzzle correctly will receive brain food (candy).

The students will turn in notebook paper showing their work & problems solved to solve the puzzle.
The teacher will act as a facilitator as the students solve their puzzle.
Students that finish early will work on another assignment.

Lesson Plan – 3rd Month – Cooperative
Taxes, Discounts, Tips

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. Two Students pass out calculators. Students will get out notebook paper and clear their desks. Each stations will have an index card containing the questions as well as sale ads or menus. Students will have 5 minutes to solve for the tax, discount, and tip problems given at the station. Students have to write down the problem and show their work on how they solved their problem. At the end of 5 minutes students will move to the next station and solve the problem. There are 7 stations total.

The students will turn in notebook paper showing how they solved the problems.
The teacher will act as a facilitator as the students solve their puzzle.

Lesson Plan – 3rd Month – Competitive
Tangrams

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students will be given a copy of the tangram shapes. Two students will pass out scissors. Students will cut out the 7 tangram shapes. Extra paper will be recycled.
The directions to the tangram game will be given:
Students are to work independently.
They have to use all seven pieces to form the shape shown on the board.
No pieces can overlap.
When students think they have solved the shape, they are to raise their hand and the teacher will examine the shape for correctness. If the students have solved correctly, they can get a piece of candy from the brain food bucket.
Once a shape is solved another will be shown for the next competition.

The teacher will act as a facilitator and judge as the students solve their tangrams.

Lesson Plan – 4^{th} Month – Cooperative
Irregular Shape Stations

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students move desks into co-ed cooperative groups of 3-4 students. Two Students pass out calculators. Students will get out notebook paper and clear their desks. Students will have 5 minutes to solve for the area of the irregular shape given at the station. Students have to write down the problem and show their work on how they solved their problem. At the end of 5 minutes students will move to the next station and solve the problem. There are 7 stations total.

The students will turn in notebook paper showing how they solved the problems.
The teacher will act as a facilitator as the students solve their puzzle.

Lesson Plan – 4^{th} Month – Competitive
Problem-Solving

I. Warm-Up – 5 review problems from any previously covered topics
Students work quietly & individually for 5 minutes to solve problems.
The problems are graded and a score of 1-5 is orally given to the teacher.

II. Activity – Students will get out notebook paper. Two students will pass out calculators. The teacher will show 4 different problems on the board that the students have to solve. After the students have solved or attempted each problem, an explanation on how to solve each problem will be given by the by the students and the teacher.

The students will turn in work showing how they solved the problems.
The teacher will act as a facilitator as the students solve their problems.

APPENDIX B: POST-LESSON STUDENT SURVEY

Name: ____________________

Post-Lesson Student Survey

1. What did you learn about math during the lesson?

2. How did you work with other students during the lesson?

3. Did other students help your ability to learn math? Explain.

4. Did other students get in the way of your ability to learn math? Explain.

5. What did you enjoy most about the lesson?

6. How do you think the lesson could be improved?

APPENDIX C: INTERVIEW QUESTIONS

Post-Lesson, Post-Survey Interview Questions

1. Do you have a better understanding of (math concept) since the lesson?

2. Looking at question #3 on the Student survey, how did (other students name) help you to better understand (math concept)?

3. Looking at question #4 on the Student survey, how did (other students name) hinder your ability to understand (math concept)? Why do you think they acted that way?

4. What did you enjoy (response to question #5) about the lesson? Will it help you in the future? Explain.

5. What do you want to improve (response to question #6)? How will that help? Why?

6. Explain your thoughts about learning math in single-sex classrooms.

APPENDIX D: PARENTAL PERMISSION FOR SINGLE-SEX CLASSROOMS

Dolphin Middle School

Dear Seventh Grade Parents and Guardians,

Your child is invited to participate in a research study being conducted by Debra Rohn, a doctoral student in Curriculum and Instruction at the University of North Carolina at Charlotte and a 7th grade math and science teacher at Dolphin Middle School. For her dissertation, she will be conducting research in the classroom during the 2012-2013 school year to determine the impact of teaching mathematics in single-gender classes.

To be involved in Ms. Rohn's dissertation research study, your child will be in either an all-girls or all-boys classroom for mathematics and language arts instruction. Science and social studies classrooms will remain mixed with both boys and girls in the same classroom. Ms. Rohn plans to examine how the students are learning mathematics, their interactions with other students, as well as their experiences in single-gender classrooms. This research will be based on observations collected by Ms. Rohn with your child participating in normal classroom activities and class work. There will be no risks to your child. All data collected regarding student learning and interactions will be kept confidential and all students' names will be replaced with pseudonyms to maintain anonymity. This research will be conducted under the direction of Ms. Rohn's dissertation committee and the University's Research Compliance Office.

As many of you know Dolphin Middle School was recently recognized as a *School to Watch*, having received this distinction from the National Forum to Accelerate Middle Grades Reform. In her May 17th letter to NC Public School Principals, State Superintendent June Atkinson stated, "Dolphin Middle was designated a school to watch because of its emphasis on strong academics, sensitivity to young adolescents' needs and interests, and commitment to equal access to high-quality education." This research study illustrates yet another way that Dolphin Middle School is dedicated to learning more about how to best meet the emotional, social, and intellectual needs of young adolescents.

I will try to place as many students as possible into the single-gender math and language arts classrooms. Ms. Rohn and I appreciate your support as she continues to look for ways to improve her teaching and instructional practices. Ms. Rohn is looking forward to completing this project so that she will have more information about the best ways to help your child learn.

Sincerely,
Principal

Please respond no later than August 8, 2012.

---Cut and Return--

Please indicate below if your child will or will not be permitted to participate in the study.

______Yes, my child may be scheduled in single-gender mathematics and language arts classes and be included in Ms. Rohn's dissertation research.

______No, my child may not be scheduled in single-gender mathematics and language arts classes or included in Ms. Rohn's dissertation research.

Student's
Name____

Parent Signature
____

OR

You may e-mail your response to me at principal@dolphinmiddleschool or call me with your response at (XXX) XXX-XXXX.

APPENDIX E: STUDENT ASSENT & PARENTAL CONSENT LETTER

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223-0001

Student Assent for Dissertation

Dear Students,

As many of you know, I am a doctoral student in Curriculum and Instruction at the University of North Carolina at Charlotte. For my dissertation, I will be conducting research in the classroom during the months of October through March. I am doing a study to see how you are learning math and interacting with other students. You will participate in normal math classroom activities and class work. Twice a month a lesson will be videotaped, audiotaped, and post-lesson surveys will be given. Selected students will take part in short audiotaped interviews about the lessons. I also will need access to your End-of-Grade scores in mathematics from the two previous years. The information collected by me will not affect your daily schedule or grades.

You can ask questions at any time as in normal math classroom activities and class work. You do not have to be in the study. If you start the study, you can stop at any time you want and no one will be angry or disappointed in your decision and it will not affect your grades in any way.

When I am done with my study, I will write a report. I will not use your name in the report.

As always, I appreciate your support and eagerness to learn. As a teacher, I am always looking for ways to improve my practice. I look forward to completing this project so that I will have more information about the best ways to help you learn.

Sincerely,

Ms. Debra Rohn

---cut and return ---

Please show below if you want to participate in the study.

______ Yes, ______________________ wants to be included in Ms. Rohn’s dissertation.
______ No, ________________ does not want to be included in Ms. Rohn’s dissertation.

Student Signature ____

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223-0001

Parental Informed Consent for Dissertation

Dear Parents,

As many of you know, I am a doctoral student in Curriculum and Instruction at the University of North Carolina at Charlotte. For my dissertation, I will be conducting research in the classroom during the months of October through March. I plan to examine how the students are learning math and their interactions with other students in single-sex mathematics classrooms. This research will be based on observations collected by me and will not affect your child's daily schedule or grades. Your child will simply participate in normal classroom activities and class work. There are no risks to the students. All data will be kept confidential and all student names will be replaced with pseudonyms to maintain anonymity. I will be conducting this research under the direction of Dr. Jae Hoon Lim in the Department of Educational Leadership at UNCC and have permission of the Lincoln County School district.

If you have any questions or concerns about the research I will be conducting, please feel free to contact me. Your child's participation in this study is strictly voluntary. The decision to participate in this study is completely up to you and your child. Your child will take part in normal class activities and twice a month a lesson will be videotaped, audiotaped, and post-lesson surveys will be given. Selected students will take part in short audiotaped/digitally recorded interviews about the lessons. Students will also write in journals about their experiences as needed. I also will need access to your child's End-of-Grade scores in mathematics from the two previous years. If you prefer your child not take part in the study, he or she will continue to participate in the normal classroom activities and class work and your child's work will not be included in the research study. Students that do not wish to participate in the study will not be videotaped and will work in separate groups from the students being videotaped.

UNC Charlotte is strongly committed to making sure that all research participants are treated in a fair and respectful manner. Please contact the University's Research Compliance Office (704-687-3309) if you have any questions or concerns about your child's treatment as a study participant.

As always, I appreciate your support. I am looking forward to conducting this project to have more information on how students are learning math and their interactions with other students in single-sex mathematics classrooms.

Sincerely,

Ms. Debra Rohn

---cut and return --

Please indicate below if your child will or will not be permitted to participate in the study.

______ Yes, my child ___________________ may be included in Ms. Rohn's dissertation.
______ No, my child ________________ may not be included in Ms. Rohn's dissertation.
Parent Signature ____

APPENDIX F: NAME CHANGE RECORD

2nd Math Block – Boys

Original name All Info Deleted	Pseudonym Given	Gender
	Jeremy	M
	Andy	M
	Zander	M
	Robbie	M
	Josh	M
	Aiden	M
	Isaac	M
	Robert	M
	Thomas	M
	Benjamin	M
	Anthony	M
	David	M
	Carter	M
	Michael	M
	Elijah	M
	Kevin	M
	Gabriel	M
	Brian	M
	Henry	M
	Christopher	M
	Logan	M
	Dylan	M

3rd Math Block – Girls

Original name All Info Deleted	Pseudonym Given	Gender
	Arianna	F
	Hailey	F
	Brooklyn	F
	Heather	F
	Jasmine	F
	Amelia	F
	Andrea	F
	Bella	F
	Julia	F
	Lauren	F
	Sydney	F
	Ashley	F
	Ava	F
	Leah	F
	Anna	F
	Kylie	F
	Sophia	F
	Rachel	F
	Stella	F
	Kim	F
	Claire	F
	Hallie	F
	Khloe	F
	Polly	F
	Savannah	F
	Charlotte	F
	Emily	F

APPENDIX G: SEATING CHARTS

Seating Chart w/Pseudonyms – 2nd Block - Boys

Teacher's Desk	Henry Group 7 Logan Kevin	Anthony Group 6 Andy Josh
	Elijah Thomas Group 4 David Aiden	Benjamin Christopher Group 5 Zander Jeremy
Not in study Group 3		
	Carter Isaac Group 2 Brian Robert	Gabriel Michael Group 1 Dylan Robbie

---

Seating Chart w/Pseudonyms – 3rd Block - Girls

Teacher's Desk	Emily Brooklyn Group 7 Sydney Kylie	Hallie Savannah Group 6 Ashley Leah
	Lauren Heather Group 4 Amelia Charlotte	Bella Rachel Group 5 Hailey Claire
Khloe Group 3 Polly Kim		
	Anna Ava Group 2 Sophia Julia	Jasmine Andrea Group 1 Stella Arianna

APPENDIX H: STUDENT ATTITUDE SURVEY

Student Survey

1. What interests you most in mathematics and/or what do you like doing best? (Circle at most 2.)
   - Life applications
   - Geometry problems
   - Algebraic problems
   - Problem-solving

2. Which themes from the social and natural environment would you like to consider in mathematics lessons? (Circle at most 3.)
   - Ecology (pollution, recycling)
   - Biology/medicine (epidemics, genetics)
   - Economy (markets, taxation)
   - Physics (mechanics, astronomy)
   - Geography (cartography)
   - Technology (building construction)
   - Sports (pool, tennis, baseball)
   - Art (painting and drawing)
   - Other (please specify)

3. How do you prefer to work in math class? Explain if needed.
   - Group Work
   - Individual Work
   - Work in Pairs
   - Class discussion
   - Other methods (Explain)

Below is a list of statements dealing with your general feelings about yourself. If you Strongly Agree circle SA. If you Agree with the statement, circle A. If you Disagree circle D. If you Strongly Disagree, circle SD.

		Strongly Agree	Agree	Disagree	Strongly Disagree
4.	I feel it is important to be good at math, more than other subjects.	SA	A	D	SD
5.	I feel that everyone willing to learn can be good at math.	SA	A	D	SD
6.	I believe math is for people with a special talent and people with 'average' intelligence cannot master math.	SA	A	D	SD

7. Do you think there are benefits of being in a class with a mixture of girls and boys? Explain.

8. Do you think there are disadvantages of being in a class with a mixture of girls and boys? Explain.

9. Do you think there are benefits to being in an all-girls or all-boys class? Explain.

10. Do you think there are disadvantages to being in an all-girls or all-boys class? Explain.

11. Think of all the math information you have learned through the years. Are there real-life problems in which you can use the information? Explain

12. Has anyone in school encouraged you to persevere in math? Explain.

13. Has anyone in school discouraged you from persevering in math? Explain.

14. In your opinion, why or how is mathematics is important in our society?

15. Do you think mathematics is important to what you will do in the future? Explain why it is important or not important.