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The extent of gender gaps in mathematics

Jesus Nolasco

THE EXTENT OF GENDER GAPS IN MATHEMATICS

A Thesis

Presented to the

Faculty of

California State University,

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In Partial Fulfillment

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Master of Arts

in

Educational Administration

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by

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ABSTRACT

This is a study on the extent of the gender gap in course taking patterns among secondary students in mathematics and what factors contribute to the gender gap. To address this, I have conducted a pilot study on the role of gender gaps in mathematics course taking patterns in an urban comprehensive high school. This is a mixed-method study using both quantitative and qualitative methods by collecting standardized testing data and classroom performance. Over one hundred students were surveyed on their perspectives on mathematics. Triangulation was used for this study for an in-depth exploration on how factors influence the framework of gender patterns. The utilization of qualitative/quantitative methods were used for an in-depth exploration on retaining a better understanding on how various factors impact student achievement. Some of the findings included a gender gap in mathematics. However, it is no longer females that are falling behind in mathematics but males. Implications include making males more aware of the importance of mathematics and offering males more academic support in order to close the gap in mathematics.

ACKNOWLEDGMENTS

I would like to recognize the assistance of the graduate advisory committee: Dr. Louie F. Rodriguez (Committee Chair), Dr. Susan Jindra (Second Reader), and Dr. Thelma Moore-Steward (Department Chair). It would not have been possible without your assistance.

DEDICATION

I would like to dedicate this to my parents and family for supporting me in my academic career. Lastly, I thank my Creator who has made it all possible for me in the first place.

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CHAPTER ONE

INTRODUCTION

Gender Disparity

Are females in the 21th century outperforming males in the field of mathematics? Researchers have shown that females are truly closing the gender gap in mathematics. Stereotypes that females always underperform in math are being brought into question. In a cross-sectional analysis scores from standardized math tests from 10 different states (California, Connecticut, Indiana, Kentucky, Minnesota, Missouri, New Jersey, New Mexico, West Virginia, and Wyoming), Hyde, Lindberg, Linn, Ellis, and Williams (2008) discovered a mean effect size of 0.0065, attesting to no gender difference in math performance.

There is this notion that men outperform women in math and science and organizations such as Women of TI Fund and AWM (Association of Women in Mathematics) both of which are non-profit organizations are trying to narrow the barrier between both worlds. I wanted to investigate the extent of the gender gap in mathematics in secondary school settings and what factors attribute to the promotion or hindrance of gender gap in mathematics.

In addition I want to increase research attention in understanding gender differences in mathematic achievement pertaining towards standardized testing, attitudes, and gender similarities/ differences in mathematics. To what extent is there a gender gap in mathematics achievement and what can be done to address this problem?

CHAPTER TWO

LITERATURE REVIEW

Literature Review

Since the launch of Sputnik in 1957, the United States shifted its priorities towards education. Resources and social reforms were invested in education targeting mathematics and science. In 2010, President Obama launched a $4 billion Race to the Top fund where states compete for funds. It has been over 50 years since our nation has made an effort to equalize the playing field by creating new courses to prepare our students to become effective citizens and become global competitors. In a 2007 speech, Obama stated, "In this kind of economy, countries who out-educate us today will out-compete us tomorrow." Obama also stated in 2005, "By twelfth grade, our children score lower on math and science tests than most other kids in the world. And we now have one of the highest high school dropout rates of any industrialized nation in the world." So much attention has been placed on the importance of mathematics that studies have been conducted on math achievement/stereotypes, attitudes, and standardized testing. This raises a question, to what extent is there a

gender gap in course taking patterns among secondary students in mathematics?

A long standing belief that boys outperform females is fading away with new studies. Researchers have found that parents, teachers, and even girls themselves hold stereotypes that boys are more capable in mathematics and math-related professions (Cavanagh, 2008). Such stereotypes have been feeding on one another for decades. Other researchers, such as Kimball (1989) cite many studies validating that boys at the secondary level still outperform females on standardized math tests. In a study with a sample size of 255 eighth graders (mean age 14.2) from an urban school district of Nicosia in Greece, students were given fifteen minutes to finish a math test. Researchers concluded no significant difference between the boys mean score = 4.07 and girls mean score = 3.82 (Georgiou, Kalavana, & Stavrinides, 2007, p. 336). A similar study conducted by Frenzel, Goetz, & Pekrun who compared males and females from 42 different schools in the state of Bavaria, Germany. Their results indicated a mean score of 3.90 for males and a mean score of 3.88 for females pertaining to math achievement (Frenzel. et al., 2007,p.504). More and more studies suggest a paradigm shift

in math achievement that females are proficient in mathematics.

Another study conducted by Else-Quest, Hide, & Linn used the data from the 2003 Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) dataset. This included more than 493,495 students 14-16 years of age with more than 69 nations participating in this assessment. The study included questions relating to mathematics achievement and attitudes. Empirical data stated only a small difference of 0.15 ($d < 0.15$) in mathematics achievement by gender not only in the United States but in many other countries. In fact, females showed an advantage in math performance. For example, in a meta-analysis in 1990 (Fennema, Hyde, & Lamon., 1990) found an effect size of $d = -0.05$ for the gender difference in math performance among the general population, indicating a negligible female advantage (Else-Quest et al., 2010, p.104). Furthermore, a study administered between 2005 and 2007 from the 2^{nd} grade through the 11^{th} grade found $d = 0.0065$, indicating no gender gap in young adolescence (Fennema et al., 2008).

Additional Studies

More and more studies are being conducted and replicated in different settings. The explanation for the gender gap in mathematics is complex and includes factors such as attitudes and perceptions. For many decades research on learning mathematics were cognitively oriented and emphasized intra-personal factors such as ability and talent (Georgiou et al., 2007). Such factors were used as a measuring tool to assess growth and stablity. In recent decades new factors under consideration include affective and interpersonal factors. Other researchers have included other variables such as socioeconomic status, student ability, attitudes and preceptions (Leder, Pehkonen, & Torner, 2002). All of these factors add to our understanding of math achievement. Two of the most important attributions are attitudes and preceptions in mathematics. Such factors can progress or regress a students ability to do well in mathematics.

Campbell and Evans (1997) compared a single-sex ninth grade algebra class compared to a coed algebra class. This study gave us insight on how high school girls perceive themselves in mathematics. In their study, the researchers randomly selected students that were not enrolled in an

accelerated program such as honors or Advanced Placement but in college preparatory courses. The range of the class size was 25-30 students and both classes (single-sex/coed) were taught by the same instructor. Subjects completed a pretest in the beginning of the year and a posttest at the end of the year. In their findings females thrived in a single-sex classroom. Mathematics anxiety among females decreased in a single-sex class, while mathematics anxiety among females increased in a coed class. The researchers also concluded that females in a single-sex class are more likely to enroll in advanced math classes such as trigonometry and calculus as opposed to their male counterparts (Campbell& Evans, 1997).

In a more recent study, Shapka (2009) formulated a longitudinal study with ninth graders and/ or tenth graders. Twenty-six females participated in a single-sex class, 42 girls and 50 boys were placed in a coed class (Shapka, 2009). It has been stated that females tend to do well in a single- sex school environment rather than females placed in a regular co-educational program. Females tend to develop a higher perception of their cognitive ability and efficacy (Campbell, 1997; Hoffman, 2002; Thompson, 2003). As educators we must learn to foster those

skills and nurture them from preconceived notions that have been lingering for decades. Some of the attitudes that need to be addressed are how girls attribute their success to external factors (e.g. low expectations from teachers, help from family members, and an easy examination).

The researchers stated that beliefs among educators, parents, students, and even girls themselves believe girls and mathematics are a "bad fit…girls are expected to judge their mathematics competence as being relatively low and the subject of mathematics as being unattractive, while being aware of the importance of attaining good grades in this subject" (Frenzel et al.,2007). Such expectations and notions are setting up our children for failure. Frenzel gave us three reasons why studying emotions in learning and achievement is important. Their first reason was important dependent variables (attitudes and perceptions). The second reason was the impact of emotions on students' achievement. Lastly, emotions influence learning by changing dopamine levels in the brain.

If we strip away the self confidence of girls and discourage them from challenging themselves in taking higher math courses, then it is a self fulfilling prophecy in which males will outperform females since we are setting

the stage for their failure. Then how do we assess our students? How do we compare their academic achievement? The most significant tool we use today as a means to study gender gaps are standardized testing.

Standardized Testing

According to recent research in a cross-sectional analysis of standardized math tests from grade levels ranging from 2nd grade through 11th grade across ten different states, researchers concluded a mean effect size of 0.0065, which implicated no gender difference in math performance (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Scafidi and Bui (2010) have also replicated Hyde et al. (2008) using data from 9,813 students from the National Education Longitudinal Study (NELS), in which 51% were female and the mean age was 14.38 (Bui & Scafidi, 2010, p.253). They found no real significant difference by gender. In another study comparing China to the United States, Chinese males mean score was 67.9 and females mean score was 67.0 score. There were no significant gender differences for those eight graders who scored above the 50th percentile (Tsui, 2007). An additional study was conducted by Liu who compared gender differences between United States and Hong Kong 15 year olds. In her findings

Liu reported, significantly higher levels of interest, confidence, and lower levels of anxiety about math learning and testing than females (Liu, 2009). There is also a notion of the importance of performing well on standardized tests which would further their career or get them into a prestigious school.

Although it seems the gender gap has been decreasing over the past decade, data on the Scholastic Aptitude Test (SAT) indicates that males are still outperforming females for over the past four decades. "The score difference has remained somewhere constant between 33 to 40 points from 1972 to 2005…the male advantage is small, but consistent" (Liu & Wilson, 2009, p.165).

The extent of the gender gap in course taking patterns among secondary students in mathematics is not fully tangible because so many factors come into play such as intra/interpersonal skills, stereotypes, attitudes, assessments, and so on. However, we can make educational predictions. Data has been collected by many researches which point out that the gender gap is closing. In future research it would be interesting to be able to replicate the analyses with data from PISA, questionnaires, and surveys in a school setting with a diverse population.

Attitudes

Another factor that contributes to the gender gap is the perception of math achievement by gender. Males and females have different perceptions of mathematics due to peer and adult influences (Hyde et al., 1990). It appears adults and peers are a socializing agent that influence and shape students attitudes towards mathematics and a number of researchers support the notion that attitudes towards mathematics have a strong relationship with social influences (Singh, Granville, & Dika, 2002). Attitudes have been shaped and molded by stereotypes held by society, stereotypes held by parents, teachers, and even girls themselves that boys are more capable in mathematics and professions (Cavanagh, 2008). As students buy into the system, it becomes a self fulfilling prophecy where girls start to believe that boys are better in math and start to change their attitudes and perceptions of mathematics. In the long run, stereotypes can impair math test performance and have an impact on students' self-confidence, and satisfaction in math (Blascovich, Spencer, Quinn, & Steele, 2001).

Researchers have suggested that some of the strongest predictors of math achievement are students' attitudes

towards mathematics (Ercikan, McCreith, & Lapointe, 2005). Other researchers have also made claims that poor achievement results in negative attitudes in mathematics (Ma & Xu, 2004). Yet, improving attitudes cannot improve math achievement. Furthermore, researchers have found evidence indicating females have obtained higher grades than males in the classroom (Hedges and Nowell, 1995). This research shows how influential attitudes have impacted students' perceptions of mathematics.

In order to further examine the gender gap in mathematics, we must first analyze the gender similarities and differences of students. Researchers have found an interesting gender difference in how males and females attribute their successes and failures in mathematics. For example, males attribute their success in mathematics to ability whereas girls attribute their success to effort. Likewise, males attribute their failure to lack of effort whereas girls attribute their failure to lack of ability (Georgiou et al., 2007). Gender difference in the elementary level is non-existent in mathematics, yet appears in high school. This can be attributed to how attitudes and perceptions have largely impacted to what is socially acceptable in our society. Social outlets have

exaggerated the gender differences on how boys tend to outperform females. Such perceptions have impacted adults, peers, and teachers' views of girls and have had a negative impact on girl's motivation and perceptions (Helwig, Anderson, & Tindal, 2001).

Researchers have also pointed out during the performance of standardized testing gender similarities were not moderated by race (Scafidi & Bui, 2010). Scafidi and Bui compared Caucasians to minorities and found no significant differences in gender similarities. In addition, boys and girls showed similar interest in mathematics and as the years progress boys tend to be more interested in learning math than girls (Liu, 2009).

Historically, math has been portrayed as male domain and is socially accepted and affirmed in our society. Notions such as these have discouraged females from reaching their full potential in mathematics and females who are gifted underestimate their competence in mathematics (Reis & Park, 2001). Boys' confidence in mathematics is being fostered and nurtured as the years progress. Therefore, boys tend to be more interested in math than girls.

CHAPTER THREE

FRAMEWORK LENSES

Methodology

According to the research, factors such as attitudes, standardized testing, and gender similarities/differences in mathematics form and shape gender gaps in math achievement by gender. If we dissect such components, subfactors will begin to emerge such as classroom performance, self-efficacy, and test anxiety. These subfactors are the infrastructure that support and nourish the factors responsible for the gender gap in math achievement.

It is also important for students to be more autonomous with having skill sets in number sense to promote self-efficacy and reduce text anxiety. There is a correlation that students perform better when they have a sound grasp of mathematics. Affective elements can promote or hinder the ability level of a student when undergoing math assessments.

In a classroom setting, if fostered correctly, students can be enriched in content and context and be on their way of reaching their full potential in mathematics.

I believe gender equity will and should be our goal to breach gender gaps in mathematics but as well as to provide stability for both genders. I am going to analyze the data through the lenses of standardized testing, attitudes, and gender similarities/differences.

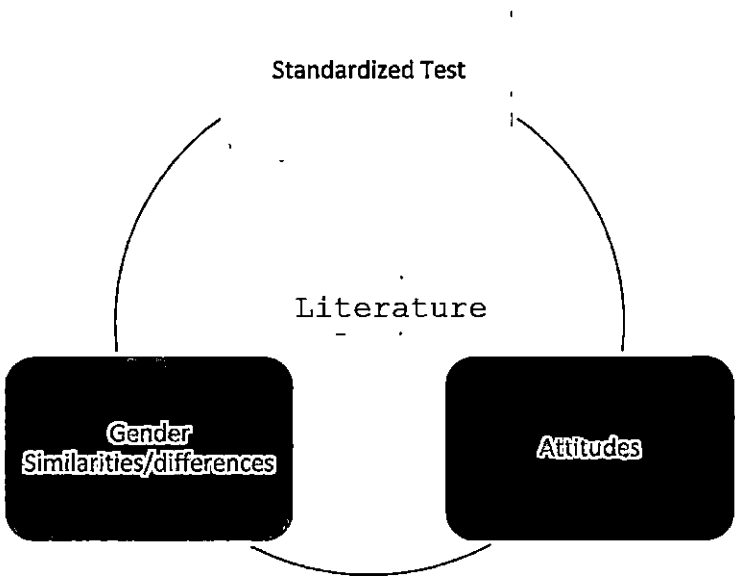

Figure 1. Bodies of Research

Research Methodology

In this study, I expanded and conducted an in-depth study of gaps in mathematics of course-taking patterns in

an urban Southern California comprehensive senior high school. Such factors (stereotypes, self-efficacy, test anxiety, etc) were found to narrow or broaden the gender gap in a secondary level school context. While research shows females are performing better in classroom settings, males are still outperforming females on standardized assessments.

In this study I assessed gender gap by accessing a dataset, surveys/questionnaires, and grades as tools to measure gender gaps in a high school context. Exploring gender gaps in mathematics will give me an insight into how the gender gap in mathematics influences students' perception in math. The knowledge acquired from this study will help districts, schools, and the research community better understand the role of gender at the high school level.

I initially explored the idea of ascertaining data from standardized testing and classroom performance. After going over the research literature many reoccurring themes started to stand out such as test anxiety and affective characteristics. The data allowed me to broaden my research on factors that hinder or promote gender gaps. Moreover, I wanted to explore the concept of gender similarities/

differences in mathematics and focus more on the stereotypes that promote the gender gap.

In addition, attitudes play a huge factor on gender gaps in mathematics such as classroom performance and how students comport themselves during class and outside of the classroom. I developed a questionnaire for the students to complete as a way to learn about their experiences in mathematics. Finally, I wanted to focus on standardized testing and how it correlates with test anxiety.

While some studies have considered standardized testing as their focal point on analyzing the gender gap (Scafidi & Bui, 2010; Cambell & Evans, 1997; Liu & Wilson 2009; Liu, 2009; Tsui, 2007) more empirical studies from students' perspective are needed. Henceforth, my research question is what drove my study and established my parameters on gender gap.

Validity

All data collected was via means of educational and ethical pursuits. To minimize any researcher bias all data was randomly selected. Therefore, preferential treatment was not given towards any ethnic group or gender. In order to strengthen the data, similar studies must be conducted in similar settings. Students' voices were quoted verbatim.

Limitations

This study was design to measure the cognitive/affective ability of males and females in a high school setting. Some of the limitations of this study were the small sample size that was conducted. To further improve this study, we will need a larger sample size replicated in a similar setting. Another limitation was the time span of 10 weeks to produce results. In addition, students may or may not have taken the surveys and questionnaires seriously.

Positionality

I am a secondary math instructor and the reason why I have selected this topic is because I have found it to be an interesting topic. I used to struggle in math as a secondary student. Once I was able to overcome emotional barriers (fear of math) I was able to learn and retain math skills that have helped me be successful in math. I have found math much more enjoyable and practical.

Research Question

To what extent is there a gender gap in course taking patterns among secondary students in mathematics and what factors influence the gender gap?

Research Design

Triangulation was used for this study for an in-depth examination on how various factors influence gender patterns. The utilization of qualitative/quantitative methodology was used for an in-depth exploration on acquiring a better understanding on how minute or vast affective factors impact student achievement. One way of measurement was through the use of surveying. I used a four-point Likert type scale; students were able to respond on a scale that indicated "strongly agree," "agree," "Strongly disagree," and "disagree" (See Appendix A). In this survey, I eliminated the neutral response component so that I can get a better read on the students' responses. The survey was designed to measure student's attitudes and future expectations of math. Another data collection tool included a set of open ended questions (See Appendix B). This tool was designed to extract students' prior experiences with math and their perspectives towards math. I have also selected their standards-based test and their summative grades as a means to measure math achievement.

Demographics

The school site in which the study was conducted was from a comprehensive senior high school in the San

Bernardino City Unified School District. Over 86% of the student population was economically disadvantaged. Over 67% of the school population was Hispanic, 19% of the school population were African American, 12% white (not Hispanic), 1% American Indian, and 1% Pacific Islander. English Learners made up 25% of the school population and 10% were identified as students with disabilities. The school is categorized as a PI (program improvement) school and is receiving Title I school improvement grants (SIG). The school site is considered a low performing school and was selected to undergo the transformational model in which the principal is replaced and the school needs to implement comprehensive instructional reform strategies. The students who participated in the pilot study are as follows; 3% African American, 17% Asian, 61% Hispanic, and 19% white. These are some of the factors that shape and define the school environment/culture.

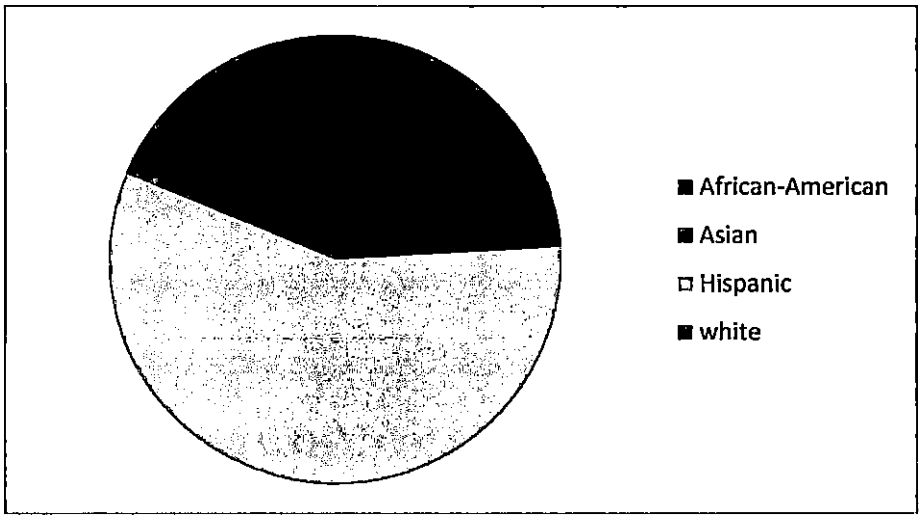

Figure 2. Sample Demographics of Participants

Participants

Ten students were chosen to participate in the interview questionnaire—5 students were males and 5 students were females. One hundred students who are currently taking trigonometry or calculus classes participated in the surveys. Over two hundred students' standardized test scores and their current math G.P.A's were included in the study. Before data collection was conducted for this study, parent permission was granted upon describing the nature of the study. In addition, the district and principal's approval was also granted for this study. Moreover, a child assent form was also provided and

read aloud. All students who participated were 11th and 12th graders from a comprehensive senior high school from Southern California in an urban setting. The racial distribution included 7% African American; 17% Asian; 58% Hispanic; and 18% White.

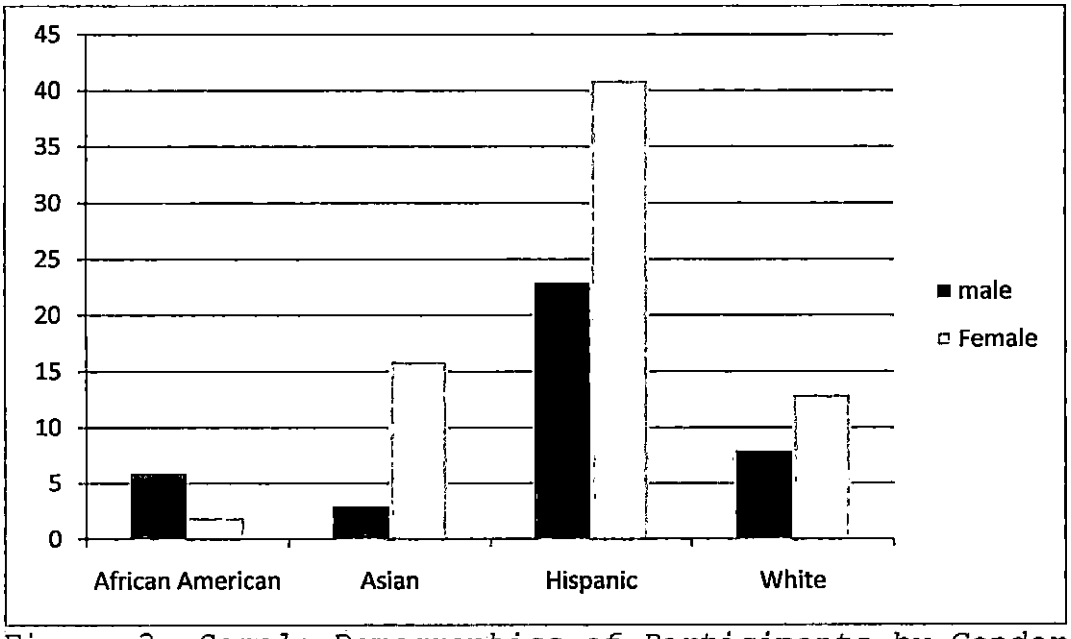

Figure 3. *Sample Demographics of Participants by Gender*

Data Collection

Three data collection techniques were implemented in order to gather information pertaining to students' achievement and attitudes towards mathematics. I will discuss each data collection method.

Participant Survey

After acquiring consent forms from all parents/ guardians, students were given the choice to fill out the survey (See Appendix A) at their own leisure during non-instructional time and the students were required to submit the survey to me within 48 hours. The survey would last approximately ten to fifteen minutes to complete.

Participant Questionnaire

An open-ended questionnaire format was employed to ten students who were randomly selected. The questionnaire forms was also conducted during non-instructional time and lasted approximately about 20 minutes (See Appendix B). Categories pertaining to the questionnaire included: attitudes towards mathematics, gender perspectives, and experiences from prior math classes. The qualitative data collected provided a deep understanding of students' experiences with mathematics.

Dataset

Data was collected through the use of DataDirector which supplied me with the scores for the past three years of standardized testing. The data collected provided me with the information to measure students' academic

performance on testing. In addition, I was able to access student's first semester's grades as a means to measure classroom performance. All three forms of data collected provided me with a powerful tool of data triangulation.

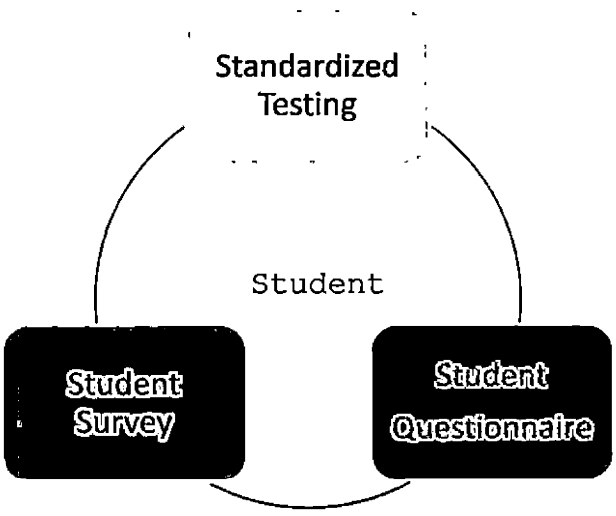

Figure 4. Triangulation

CHAPTER FOUR

DATA ANALYSIS

Analysis

Are To address the research question, three major analyses were conducted in this study: (a) an analysis of standardized testing data, (b) analysis of classroom performance, and (c) analysis of student surveys. The objective of this study was to investigate course taking patterns of the gender gap in mathematics. This section will be organized by the various types of data I collected

Standardized Testing Data

Data was collected from the past three years of mathematics (Algebra I, Geometry, and Algebra II) from the same pool of students.

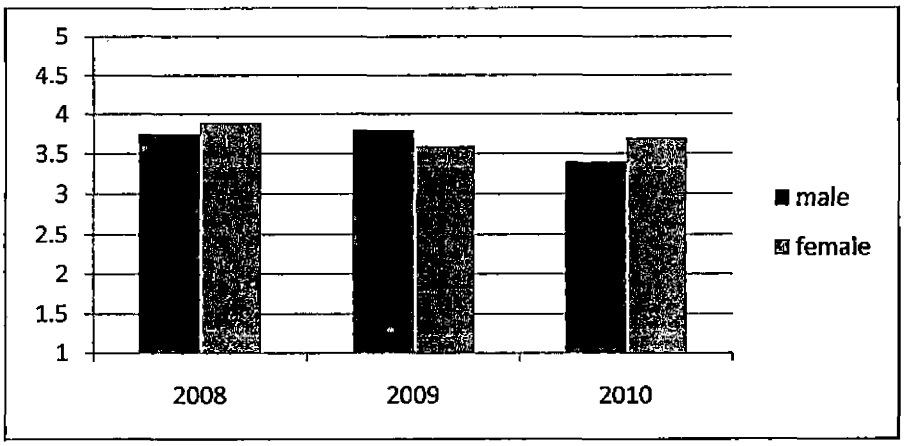

Figure 5. California Standardized Test

An average score was obtained from over 200 students' test scores from the California Standardized Test. The score ranged from 1= Far below Basic to 5= Advanced Proficient (See Figure 5). In 2008, students took the algebra I strand of the CST; males mean score was 3.4 and females mean score was 3.9. In 2009, students took the geometry strand of the CST; males mean score was 3.8 and females mean score was 3.6. In 2010, students took the Algebra 2 strand of the CST and the males mean score was 3.4 and females mean score was 3.7. After finding the mean score for the past three years, males mean score was 3.683 and females mean score was 3.723. Results from the analysis shows that the performance difference between boys and girls are considered small (d= 0.04) (See Figure 6). The current trend that males score higher on major standardized math test over the past three decades has made a shift. Females are not only taking higher level math courses but, they have been able to compete academically with their male counterparts. This data suggest that females are taking a more aggressive initiative in mathematics causing a significant shift in the gender gap in math achievement.

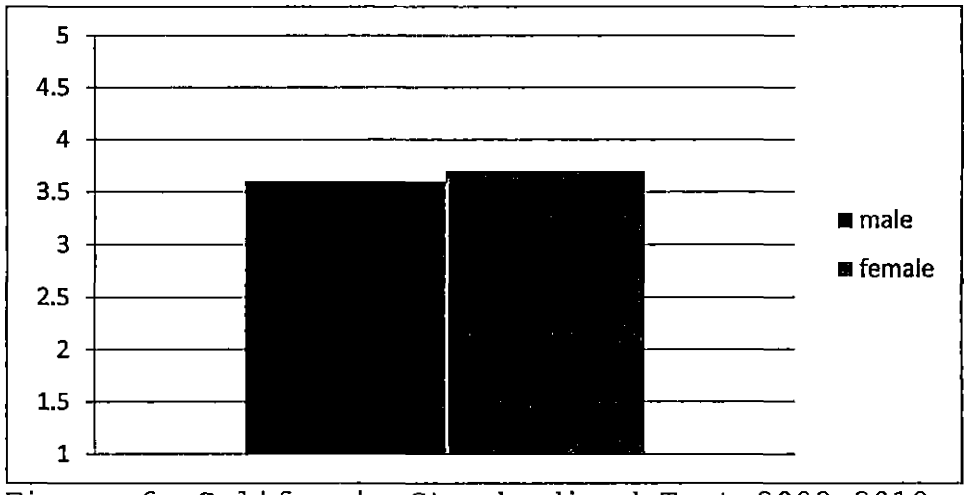

Figure 6. California Standardized Test 2008-2010

Classroom Performance

Another component that was also considered besides standardized testing was classroom performance. Eighty-one males are currently taking a trigonometry math class or a calculus math class. One hundred and twenty-three females are currently taking a trigonometry math class or a calculus math class. Sixty percent of females are taking upper division math classes. With that in mind, not only are females able to compete with the males on standardized testing but they are also challenging themselves by taking more rigorous math courses. In a change of events females are outperforming males in classroom performance. Females earn more than twice the amount of A's than their male counterparts. Over eighty percent of females registered in

a trigonometry class or a calculus class are passing with a C or better. Over sixty-seven percent of males registered in a trigonometry class or a calculus class are passing with a C or better. This suggests that females are outperforming males in the classroom.

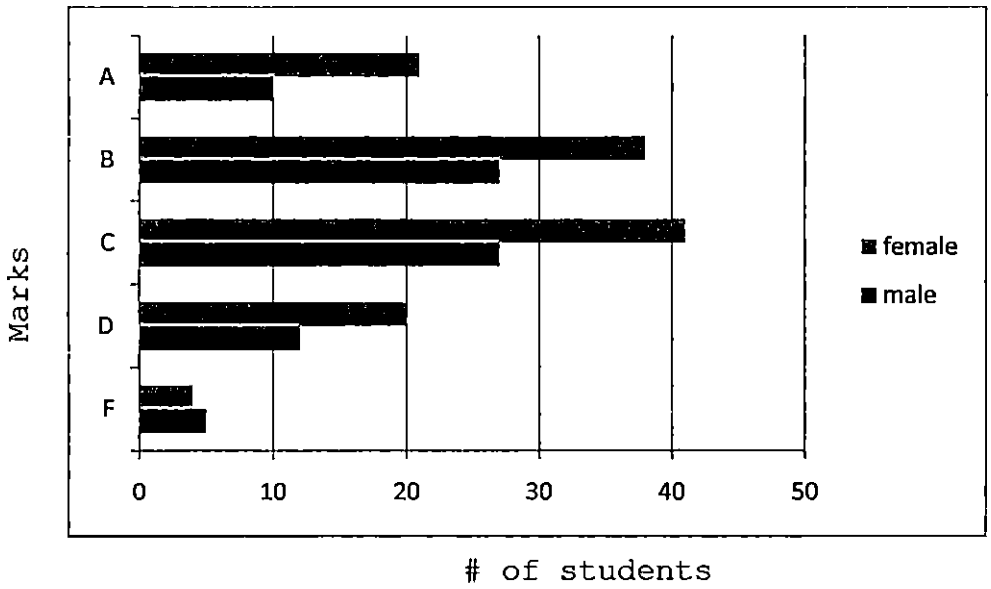

Figure 7. Classroom Performance

Student Interview Questionnaire

Data collected from the surveys (See Appendix A) also produced powerful results in understanding the attitudes that males and females perceive in mathematics. Three main

themes were produced from the survey: attitudes, effort, and gender. In one of the questions: "I struggle in math but I wish to excel", 70% of the females agreed/strongly agreed. Fifty-two percent of the males also agreed/ strongly agreed (See table 1). Although females are proficient in mathematics they still struggle and wish to do better. In another question: "I see myself working in a field of math or science", both males (73%) and females (75%) wish to explore those fields in mathematics. When questioned about whether they had role models to look up to, 65% of the males agreed and 83% of the females agreed. To my surprise, females can associate themselves with more female role models as opposed to male role models. Ninety-two percent of the females feel encouraged in taking higher level math classes as oppose to males who feel 83% who feel encourage in taking higher level math classes. Due to the lack of motivation for males, 76% feel they will take rigorous math classes in college as oppose to females 90% who feel they will take rigorous math classes in college. If this trend continues to grow, males will need remediation, encouragement, and support in mathematics.

Attitudes

Eighty-six percent of the females responded under the theme of attitudes in agreeing with several of the statements in the survey. As opposed to the males which is seventy-nine percent who agreed with several of the statements in the survey. Results from the survey suggest that females believe that mathematics is an accepted domain and area of interest to pursue. The survey also suggested that females experience more enjoyment and find learning new concepts of math fulfilling.

Effort

Under the theme of effort, 63% of the females agreed and 56% of the males agreed to be willing to challenge themselves in taking higher level math classes and show interest in mathematics. Females have expressed to be willing to take rigorous math classes when they go to college. This might be due to the fact that there have been more positive female role models that have impacted them. (See Table 1)

Gender

Under the theme of gender, 92% females agreed with most of the statements and 75% males agreed. Females are showing a more positive attraction towards mathematics.

Table 1

Student Survey

Agreement	Male	Female
I struggle in math but I wish to excel.	52%	72%
I have role models of my gender to look up to.	65%	83%
Learning new concepts in math is fun for me.	81%	90%
I will take rigorous math classes in college.	76%	90%
I see many more people of my gender being successful in math.	70%	96%

In the student interviews (5 females and 5 males were randomly selected from a calculus class), most of the math teachers were predominately females. Since teachers are considered role models, the high presence of female teachers in the classroom had a positive impact on the female population.

Girls still consider math as a difficult subject to comprehend. It might be due to the vicious cycles created by existing stereotypes that males are better at math. One of the female students stated, "Well our year of 2012 females dominate, but when I think of math I think male"

(Participant 1, personal communication, April 2011). There is still an association that math is a male trait.

Furthermore, both genders have expressed in the questionnaire to have positive experiences in high school. For example, a female participant said, "I love the challenge and how there are patterns to know how things are solved" (Participant 2, personal communication, April 2011). A male participant said, "It has been an overall positive experience because since freshmen year, I have gained knowledge in many new areas" (Participant 3, personal communication, April 2011). Yet, some females who participated in the questionnaire found it more difficult to comprehend mathematics than males. For example a female participant said, "I believe that math is one of the most difficult subjects although with hard work I can achieve" (Participant 4, personal communication, April 2011). When asked why they chose to take higher level math classes, 80% of the females wanted a challenge versus 90% of males who experienced a sense of enjoyment and satisfaction.

These findings suggest that females are no longer accepting the social norm that males dominate the field of mathematics in the high school. According to my findings, females are outperforming males in the classroom,

standardized testing, and show a higher interest and engagement towards mathematics.

CHAPTER FIVE

CONCLUSION

Summary and Implications

Considerable progress has been made in order to close the gender gap in mathematics. In addition, there have been great strides towards gender equity in regards to cognitive performance. Females in the high schools are challenging the norms and challenging themselves in mathematics.

From the pilot study, I have discovered that females are outperforming males in the classroom setting. Teachers should maintain high expectations and career aspirations for males as well as females. Teachers need to develop innovative strategies that will motivate, captivate, and empower all students to believe they can also be successful in mathematics. Classroom teachers should maintain high expectations for all of their students.

Despite the efforts made to reach gender equality in the mathematics, gender disparities and stereotypes still exist. Many researchers have shown males have reported significant higher confidence in mathematics. This clearly sends out a message to our community that we must promote female interest and confidence in mathematics.

Surprisingly, attitudes and perceptions have largely contributed to the gender gap. Social outlets, peers, adults, and teachers should all collaborate and work together in order to close the gender gap since they have a huge impact on how males and females perceive themselves in mathematics. It is the cultural not biological genes that make genders superior/inferior than the other. Research has shown that single-sex schools have found success in keeping girls engaged in mathematics and have higher efficacy and motivation than a co-educational school (Shapka, 2009). Further research needs to explore single-sex settings where, according to some researchers, (Campbell & Evans; 1997) have show some progress of increasing female's efficacy in mathematics.

Implications

In order to accommodate student's needs, classroom teachers should implement equitable teaching practices. An example of this is ensuring teachers are giving both genders equitable opportunities in the classroom by answering questions, given students opportunity to enhance their natural talent, and given students a voice in the classroom.

Research

Further research needs to be conducted in a single-sex classroom and confirm that females do thrive in that type of environment. In addition, more research should investigate students' awareness and perception of gender stereotyped practices. Future studies need to include a more diverse group of students and need to include other variables to explain the gender gap over time.

Practice in the Classroom

Teachers should change the climate in the classroom to promote equity. Teachers should use language that is gender neutral. Equal opportunities should be given to boys and girls and in cooperative learning boys and girls should be mixed.

Policy

Districts should formulate policies that would address gender equality. Teachers should receive training on how to effectively implement gender neutral practices. Cultural practices that promote gender-stereotype should be discouraged.

In conclusion, my research demonstrated the gender gap in mathematics still exist, however males are no longer outperforming females in math. Females have demonstrated in

various assessments to be outperforming males in the classroom, standardized testing, attending higher math classes, and have a stronger desire to challenge themselves in math. I learned that the gender gap in mathematics is a social factor rather than a function of ability. Until the education system implements equity-based policies and practices there will continue to be inequity in mathematics achievement.

APPENDIX A

STUDENT SURVEY

STUDENT SURVEY

Gender: Ethnicity: Age: Current math class:

	Disagree	Strongly Disagree	*Agree*	*Strongly Agree*
I feel that I have a voice in my math class.				
I struggle in math but I wish to excel.				
I see myself working in a field of math or science.				
Peers of the opposite gender respect me in my math class.				
I feel competent when the teacher calls on me to solve a math problem.				
I have role models of my gender to look up to.				
I feel encouraged in taking higher level math classes.				
Learning new things in math is fun for me.				
I feel discouraged in taking higher level math classes.				
I will take rigorous math classes in college.				
I find math boring.				
I found this survey to be useful.				
I see many more people of my gender being successful in math.				
Additional comments:				

* Developed by Jesus Nolasco April *2011*

APPENDIX B

INTERVIEW QUESTIONNAIRE

INTERVIEW QUESTIONNAIRE

Gender: Ethnicity: Age: Current math class:

Interview Protocol

1. How do you feel about the math classes you have taken in school?

2. Has your overall experience in math been positive or negative? Why? Or why not?

3. Do you feel that your classmates of the opposite gender take you seriously in a math class? Why or why not?

4. When you work in groups or at home do you work with boys or girls? Why?

5. Do you find math to be a difficult subject to comprehend? If so, explain.

6. Why have you chosen to take a higher math class?

7. Have your math teachers been predominately males or females? Explain

* Developed by Jesus Nolasco April *2011*

APPENDIX C

IRB APPROVAL LETTER

CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO

Academic Affairs
Office of Academic Research • Institutional Review Board

March 28, 2011

CSUSB INSTITUTIONAL REVIEW BOARD
Administrative Review
IRB# 10062
Status
APPROVED

Mr. Jesus Nolasco
c/o: Prof. Louie Rodriguez
Department of Leadership and Curriculum
California State University
5500 University Parkway
San Bernardino, California 92407

Dear Mr. Nolasco:

Your application to use human subjects, titled, "Exploring Gender Gaps in Course – Taking Patterns of High School Students" has been reviewed and approved by the Chair of the Institutional Review Board (IRB) of California State University, San Bernardino and concurs that your application meets the requirements for exemption from IRB review Federal requirements under 45 CFR 46. As the researcher under the exempt category you do not have to follow the requirements under 45 CFR 46 which requires annual renewal and documentation of written informed consent which are not required for the exempt review category. However, exempt status still requires you to attain consent from participants before conducting your research.

The CSUSB IRB has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval notice does not replace any departmental or additional approvals which may be required.

Although exempt from federal regulatory requirements under 45 CFR 46, the CSUSB Federal Wide Assurance does commit all research conducted by members of CSUSB to adhere to the Belmont Commission's ethical principles of respect, beneficence and justice. You must, therefore, still assure that a process of informed consent takes place, that the benefits of doing the research outweigh the risks, that risks are minimized, and that the burden, risks, and benefits of your research have been justly distributed.

You are required to do the following:

1) Protocol changes must be submitted to the IRB for approval (no matter how minor) before implementing in your prospectus/protocol. Protocol Change Form is on the IRB website.
2) If any adverse events/serious adverse/unanticipated events are experienced by subjects during your research. Form is on the IRB website.
3) And, when your project has ended.

Failure to notify the IRB of the above, emphasizing items 1 and 2, may result in administrative disciplinary action.

If you have any questions regarding the IRB decision, please contact Michael Gillespie, IRB Compliance Coordinator. Mr. Michael Gillespie can be reached by phone at (909) 537-7588, by fax at (909) 537-7028, or by email at mgillesp@csusb.edu. Please include your application identification number (above) in all correspondence.

Best of luck with your research.

Sincerely,

Sharon L Ward, Ph.D.

Sharon Ward, Ph.D, Chair
Institutional Review Board

SW/mg

cc: Prof. Louie Rodriguez, Department of Leadership and Curriculum

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5500 UNIVERSITY PARKWAY, SAN BERNARDINO, CA 92407-2393

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