The Relationship Between Gender Gaps in Income and Gender Gaps in Academic Achievement

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Abstract

The purpose of this research was to determine the relationship between the gender gap in income and the gender gap in mathematic academic achievement, as measured by scores on the math sections of the SAT and NAEP. Data on the gender gap in income from 1971 to 2015 were collected from the The National Committee on Pay Equity, while data on the gender gap in mathematic academic achievement were collected from SAT tests and the NAEP. As such, the sample included all high school students who completed the NAEP or SAT. The data for each category were converted into an expression of the gender gap for each year, as expressed by the percentage of the average male score achieved by the average female. A Pearson product-moment correlation coefficient test was conducted, comparing the income gender gap with the gender gap in academic achievement on the mathematics sections of the NAEP and SAT. The results indicated that there was a significant correlation between the gender gap in income and the gender gap in mathematic academic achievement. These results suggest that, as the gender gap in income narrows, female academic achievement in mathematics improves.

Keywords: gender, gap, math, boys, girls, STEM, SAT, NAEP, equality, education.

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Table of Contents

Contents

Chapter 1

Introduction

Up until recently, the discussion of gender gaps in academic performance was mainly focused on women. Women, who have historically had fewer opportunities to receive education and prospects to use it to their economic benefit, lagged behind men academically, especially in Mathematics.

This gender gap was incredibly pronounced. In 1980, Benbow and Stanley conducted a study of gendered performance in Mathematics that found that boys scored, on average, about 50% higher than girls on tests. This difference was so significant that the researchers concluded that the gap could only be caused by a naturally "superior male Mathematical ability" that could not be remedied.

Benbow and Stanley couldn't have expected just how quickly and drastically that gender gap would change. Today, the situation is very different. Girls' Math scores have almost completely caught up to boys. On NAEP tests, high school girls currently only trail boys in Mathematics by 3 points, a difference of 2.9%. This is a significant change from Benbow and Stanley's difference of 50%. Middle-school girls, meanwhile, show no significant gap in performance on the Mathematics section of the NAEP at all (NAEP, 2015).

Moreover, in the classroom girls are actually outperforming men in every subject, including Math. At the middle-school level, women outperform men at a 0.23 d and, at the high school level, at a 0.11 d (Voyer & Voyer, 2014).

Outside of Mathematics, women are outperforming men altogether. Middle-school boys currently trail girls in NAEP Reading tests by 9 points and by 10 points at the high school level (NAEP, 2015).

More women are graduating from college than men, as well. In 1980, when Benbow and Stanley conducted their study, the majority of undergraduate degrees were conferred to men. Within two years, though, men and women reached parity and graduated at equal rates. Since then, women have only continued to improve, and, today, the gap significantly favors women. In fact, in 2004, 58% of bachelor's degrees were conferred to girls (Goldin, 2006).

Clearly, women are doing better. The gender gap is shifting. Where once men outperformed women so drastically that it was accepted as a "natural superiority", today women are excelling – so much so that the focus of studies on the gender gap is starting to shift toward the problems with boys (Whitmire, 2010).

It seems, then, that we did it. We set out to fix the gender gap and we actually succeeded. This an amazing accomplishment that should be a model for future problems. The problem now, though, is that no one is quite sure just how we pulled it off.

The first study on how women managed to close the academic gender gap was conducted by Claudia Buchmann and Thomas A. DiPrete in 2006. However, rather than looking at the accomplishments of women, they focused on the failures of men. Their study concluded that male performance dropped dramatically in families where boys did not have a father figure present.

This is certainly an interesting an illuminating correlation. However, it is unlikely that this is the only reason that women have made it over to the winning side of the academic gender gap. Given the social changes of the past century, it's reasonable to assume that the growing rate of female academic success is probably connected to their growing rights and freedoms. Rather than purely being a failure of male students, it's logical to assume that women are actually doing better in school and that this likely correlates to their growing equality in society.

There are some major signs that women are gaining equality. For example, the median wage for women in the workplace is currently equal to 80% the median wage of men. It's true that women aren't earning as much as men and that there is still a long way to go toward total equality, but it should not be discounted that this is a major improvement. In 1980, women only earned 59% the median wage of men, (Hill, 2016) meaning that a woman's employment prospects and her chances to gain gainful employment have drastically increased over the last 36 years.

There are signs that this may have changed women's attitudes, as well. Up until 1990, men had always enrolled in more Math and science classes than women. Since then, however, that has changed, and, today, there is actually a higher ratio of women in high school Math classes than men (Goldin, 2006).

Statement of the Problem

Up until recently, the discussion of gender gaps in academic performance was mainly focused on why women lagged behind men in Mathematics. This difference was so significant that, at this point, researchers believed the gap could only be caused by a naturally "superior male Mathematical ability" (Benbow and Stanley, 1980) that could not be remedied. Today, however, women's Math scores are nearly identical to men's, and there is actually a higher ratio of women in high school Math classes than men (Goldin, 2006).

It remains unclear why women's academic performances are improving. During the same period, however, women's career opportunities were improving, and it is possible that these two events are correlated. Therefore, for this study, the problem was to determine if there is a correlation between the gender gap in income and the gender gap in academics.

Purpose of the Study

The purpose of this study was to determine if there is a correlation between the gender gap in wages and the gender gap in academic achievement.

Significance of the Study

Finding a correlation between the academic gender gap and the income gender gap would suggest that women's academic achievement may have improved because of their enhanced opportunities. It would open the door for further and broader studies into this question that could determine whether improving the economic opportunities for women in all cultures might lead to improved female academic performances, as well. This could further present an avenue through which governments can meaningfully address issues in female achievement as they arise.

Further, this is a rare opportunity to conduct a study that celebrates a success rather than condemning a problem. The number of studies that probe crises and difficulties in our lives vastly outweighs those that look at how we have succeeded, and it would be useful for us to take the time to look at what social changes have successfully improved education.

Limitations

The following limitations were encountered:

1. The population of this study was limited to citizens of the United States of America, due to our decision to focus on changes in the United States as a country over time rather than on the varied cultures of the world.

2. The population of this study was further limited to students in the 4th, 8th and 12th grade, as these are the only grades that take the NAEP test.
3. The timeframe for the study was limited to a review of NAEP scores from 1969 to the present time as records before 1969 do not exist.
4. This study exclusively evaluates academic performance based on standardized testing rather than taking into account intelligent quotient tests or in-class performance. This is due to the lack of steady, regularly recorded data available in these other fields.

Definitions

The following were important operational definitions used in this study:

1. "Academic Achievement" in the study is defined as achievement on the NAEP tests, with a specific emphasis on Mathematics and Reading.
2. "Academic gender gap" is defined as the difference in median scores on the NAEP for men and women in a given category.
3. "Income gender gap" is defined as the difference in median annual salary between men and women.
4. "Elementary school students" are defined as students taking the 4th-grade NAEP test.
5. "Middle-school students" are defined as students taking the 8th-grade NAEP test.
6. "High school students" are defined as students taking the 12th-grade NAEP test.

Overview Of The Study

This study is made up of five chapters. Chapter one gives an introduction to the study; offers a statement of its problem, purpose, and significance; describes its limitations; presents

definitions for important terms and concepts, and offers an overview of the study. Chapter two include a critical review of the literature relevant to the study. Chapter three includes the research question and methodology of how information was obtained. The findings of the study are presented in chapter four. Chapter five contains a review of the study including the purpose, research questions, and methods, a summary of the findings, conclusions drawn from the findings and discussions, as well as recommendations for future study.

Chapter 2

Literature Review

Introduction

Research on the gender gap in academic achievement tends to focus on the negative. In the past, when girls were falling behind boys in certain areas of academic achievement, research always focused on what girls were doing wrong or what educators were doing wrong for their female students (Sadker, Sadker & Steindam, 1989; Orse, Palomino & Peyrache, 2013; LeFevre, Kulak & Heymans, 1992; Benbow & Stanley, 1980). The focus was always on a perceived deficiency and the question always how to overcome that deficiency.

Today, the landscape is changing. Girls are starting to improve and boys are no longer leading in Math and standardized test scores. The focus of the new studies, though, is still on what we are doing wrong. The question now is why boys are falling behind and how we might be failing them (Whitmire, 2010; Buchmann & Diprete, 2006). Our conception is still that there is a deficiency at play that is causing a problem.

A limited number of studies have looked at this as a success story. The theory that gender gaps in income and education might be correlated has been discussed and tested as a generalized theory (Green, Preston & Sabates, 2003; Dollar & Gatti 1999, Weichselbaumer & Winter-Ebmer, 2005; Stoet & Geary, 2014; Else-Quest & Hyde, 2010), but whether this correlation actually played a role in the academic change we see in the United States between 1969 and the present has yet to be tested.

The existence literature does, however, provide a lot of guidance to help focus our study. The work of other researchers can help us identify how girl's grades actually changed, where our

study should focus and how significant a correlation between gender gaps in income and academic achievement actually is.

Changes in the Academic Achievement of Girls

Up until recently, the focus of popular discussion about gender roles in education has predominately focused on women (Whitmire, 2010). The question of how to help girls succeed at school has been at the forefront of education, with questions about male success only really emerging recently.

The question bore with an implication that girls were doing particularly badly at school and that they needed some kind of help, but this implication does not accurately reflect the real situation that was at hand. Girls have actually always been ahead of boys in some respects, and so we need to be aware of what content areas and forms of education specifically merit investigation.

Girls have always outperformed boys in the classroom. A meta-analysis conducted by Daniel and Susan Voyer in 2014 reviewed 308 separate studies from as far back as 1914 proved that there has been no significant change in the gap between boys and girls' academic achievement in the classroom for the past 100 years. Their analysis found that girls have always outperformed boys in-class. In Language Arts classes, the achievement gap is consistently significant in favor of girls, although the gap in Math classes is small enough to be statistically insignificant.

However, just because girls outperform boys in the classroom does not mean that they have been ahead in every subject. More focused studies showed that, although girls outperform boys in-class, they typically perform less well than boys on standardized tests. For example,

(Sadker, Sadker & Steindam, 1989). At the time of that study, girls obtained only 36% of all national merit scholarships, which were based on PSAT scores, went to girls. Likewise, men typically outperformed girls on all sections of the SAT, ACT, GRE, MCAT and GMAT.

The gap in these scores was particularly significant in Math classes (Hyde, Fennema & Lamon, 1990). While girls typically performed well in Language Arts sections of tests, they lagged behind boys in Math. Before 1973, the gap in Math scores on standardized tests was very significant, with a mean difference of $d = -0.31$ against girls.

Over time, though, that gap between girls and boys has changed. Between 1974 and 1990, girls Math scores caught up to boys, lagging behind only with a mean variance of $d = -0.15$. Afterward, the gap continued to lessen, and a recent meta-analysis of studies since 1990 has found that the difference between male and female performance on the Math section of standardized tests is now small enough to be called negligible (Linberg, Hyde & Petersen, 2011).

This is definitely a global phenomenon, but it is supported within the specific context of the United States, as well. American boys are still outperforming girls on the Math section of the SAT by 31 points, but this is a small smaller gap than the one that existed in 1972. Moreover, Math is the only section of the SAT in which the academic performance of girls has significantly changed over the past 45 years. Although that gap has decreased, the gap between boys and girls has remained more or less consistent in Reading and Writing (SAT Total Group Profile Report, 2015).

Clearly, then, the key area of focus for any discussion about changes in the gender gap in academic achievement should be on standardized testing on Math, as this is the only area in which a significant change has recently taken place in the United States. Gender gaps in

classroom performance and Language Arts scores, according to the research, have remained essentially consistent.

Explanations for the Gender Gap

A number of studies have explored why these gender gaps exist. It is clear from the data that girls and boys do not perform equally in an academic setting. Boys consistently show an improved ability to perform on standardized tests, while girls consistently excel in the classroom. Boys consistently show more impressive scores in Math and Science subjects, while girls consistently excel in Language Arts.

There are two major approaches to the question of why these gaps exist. One is to view the components of the academic gender gap as an inherent characteristic difference between the sexes, while the other is to view it as the effect of the structure and functions of society. Different researchers take different approaches to this question, although it should be noted that these theories are not diametrically opposed. It is possible and, indeed, likely that both factors have an influence.

Inherent Gender Qualities

Research based on the premise that there is an inherent difference between boys and girls academic abilities suggests that boys may naturally do better than girls on standardized tests because they thrive when there is a competitive element to the test. One study compared the success of men and women on standardized tests used for admission to post-secondary schools and their academic performance within the schools themselves. They found that, when men complete a high-stakes standardized test that they need to succeed at to enter a prestigious school,

they outperform women. In the schools themselves, though, where the stakes are lower, the women outperform men (Ors, Palomino & Peyrache, 2013). Based their data, the researchers concluded that the boys' higher scores on standardized tests can be credited to the competitive nature of the tests, which seems to boost male academic performance.

The higher male performance on Math tests has been attributed to boys simply being more interested in Math classes than girls. Earlier studies have noted that boys are many times more likely to select majors with high math content and that when girls do enroll in Math classes they drop out at a significantly higher rate (LeFevre, Kulak & Heymans, 1992).

The suggestion is that male performance in math class is directly linked to interest has some support. Since LeFevre, Kulak and Heymans' 1992 study, women have started showing an increased interest in Math classes. Though girls in high school enrolled in fewer Math classes than men in 1990, female interest in Math classes has since increased and, currently, girls actually enroll in an average 20% more Math and Science classes than boys (Hill, Corbett & St. Rose, 2010).

There is evidence to suggest that interest levels in Math classes actually play a significant role in academic performance. Studies have shown that a student's belief in his or her ability to succeed in a class is strongly correlated with their actual ability to achieve (Ceci & Williams, 2007), suggesting that a growing interest in Math classes might truly be correlated with improving female academic performance. However, there does not appear to have been any study conducted so far on the correlation between the interest of girls in Math subjects and their academic performance in Math subjects in the United States.

It should also be noted that, though girls are starting to take a larger interest in Mathematics classes at the high school level, this has not reached parity at the post-secondary

level. Currently, only 20% of STEM bachelor's degrees are issued to women (Hill, Corbett & St. Rose, 2010) despite girls having an overall majority of total bachelor's degrees (Goldin, 2006), meaning that girls continue to show a lower interest in Math and Science classes at the post-secondary level.

Female Math Anxiety

A number of studies have looked into the reasons why women, historically, earn lower scores in Math class than their male counterparts. A myriad of different factors seem to influence girls' ability to confident learn and apply the knowledge they learn in Mathematics, but they are not exclusively biological or unchangeable.

One major factor is the differences in male and female attitudes toward the subject. Studies have found that female students typically express less favorable opinions of Math and Science classes than males students do. In part, this is believed to be because of group identification. Women develop a concept of self that establishes and defines them as members of the female group. This self-identification attaches them not only to the biological characteristics of their sex, but also to the stereotypes. In particular, it causes women to associated with the stereotypical preconception that they are less capable in Math classes and a disassociation between women's concepts of themselves and the ability to succeed in mathematics. This gap is reflected in their selections for majors and courses at both the secondary and post-secondary levels (Nosek, Banaji & Greenwald, 2002).

That initial anxiety and those stereotypical perceptions of womanhood are established and fostered in elementary school. The overwhelming majority (>90%) of elementary school teachers in the United States are female, and these female teachers are expected and counted

upon to teach Math class. These women, however, carry with them an anxiety toward the subject, learned in part through a stereotypical conception of their own gender and in part through the legacy of an education system that, historically, denied female students equal opportunities for mathematical success. These anxieties affect their students. Teachers who feel discomfort with their own ability and understanding of mathematics express their anxiety in subtle and subconscious ways. These anxieties affect the students, but mainly affect the performance of the female students. In part, failure of teacher instruction exemplifies an already pre-existing stereotype that men are more capable at Math and Science subjects than women are. By the end of an experience with an anxious, female Math teacher, female students express a greatly strengthened belief in the maxim that boys are good at Math and girls are good at reading (Smith, 2009). This belief in a harmful stereotypical self-perception exacerbates their own anxiety about Math class, leading to lower performances scores and the continuation of the cycle that produces female math anxiety in the first place.

The social anxiety explanation could be a factor in the decreasing academic achievement gap between men and women that has been observed over the past few decades. Female Math anxiety has been found to be decreasing significantly since the 1970s, the point that appears to no longer have a significant impact on female performance. While Math anxiety, in the past, has been shown to significantly affect course participation, grades, and drop-out rates, some more studies have charted the differences in math anxiety as being nearly completely non-existent today (Holden, 2016). There are, undoubtedly, a myriad of different factors that have influenced women's Math scores over the past 50 years. Existing studies suggest that one of these factors is very likely decreasing female math anxiety.

The Rise Of Dual-Income Households

Social expectations of women also seem to have had a major impact on female performance in their scholastic subjects. This is a factor worth noting, as these social expectations – in particular, the rise of the dual-income household – are indisputably and irrevocably linked with the male-female wage gap.

As the American economy and social system has evolved, women's expectations for their own futures have significantly changed. In 1968, the National Longitudinal Survey of Young Women surveyed fourteen to twenty-four-year-old female students, ask the respondents whether that they believed that they would be "married, at home, with family" or "at work" when they were 36 years old. In 1968, the overwhelming majority of women believed that they would grow up to be housewives. In fact, less than 35% of the respondents indicated that they expected to be employed. This survey, however, was repeated year after year, and as women grew up and found themselves, contrary to their expectations, thoroughly thrust into the workforce with the expectation that a family will no longer be able to survive on a single income, women adjusted their expectations. By 1984, the last year the survey was conducted, approximately 82% of women believed that they would be contributing members of the workforce by the time that they reached the age of 35 (Golden, Katz and Kuziemko, 2006).

It is reasonable to assume that this change in expectations would affect women's academic performances. In 1968, nearly two-thirds of women did not believe that they would be expected to use their educations anywhere outside of the household and outside of their roles as mothers and wives. By 1984, this attitude had clearly changed. Girls, from the moment they entered elementary schools, knew that they would be expected to financially contribute to their

household through the labor force. Education was no longer just an exercise in literacy – now it was preparation for the workforce.

While I have been unable to locate any study that has correlated this change in mentality to women's academic achievement in mathematics prior to this one, this phenomenon has been correlated to women's interest in post-secondary education. Studies have shown that women's increased expectations about their role in the workforce can be directly correlated to their rates of college application, acceptance, and graduation (Hock, 2004). In addition, this factor also appears to have an impact on their future incomes, marrying age, age at first birth, and labor force participation (Goldin and Katz, 2002).

Social Factors

The other explanation presented for the gender gap in academic achievement is social equality, which is the focus of this study. This idea has been studied in a number of different contexts, with largely affirmative if sometimes conflicting results.

In 2010, Else-Quest and Hyde conducted an analysis of male and female academic performance in 69 different nations on the PISA and TIMSS standardized tests. They compared the scores of male and female students to the social equality in effect in that country based on four separate measurements of gender equity, intending to test whether there was a correlation between social equality and the small academic achievement gaps. Their study concluded that there was a clear correlation between PISA scores and equality. In countries with a high rate of social equality, girls scores improved by a mean difference of $d = +0.14$. Notably, they found no significant correlation with TIMSS scores. Their results, however, still strongly suggested that social equality and academic gender gaps are significantly linked.

Their results, however, are still contentious. Stoet and Geary reviewed their study in 2014 and retested their data by looking at the past 10 years of PISA scores instead of just looking at one year. With their wider range, they found no significant correlation between social equality and academic gender gaps, contradicting Else-Quest and Hyde.

Clearly, then, the question of whether social equality affects academic achievement still requires further research. There does not appear to be any academic consensus for this question, and different studies posit different results.

While no study has yet looked at this correlation specifically in the context of the United States, it is notable that one study commissioned by Statistics Canada did review the correlation between gender gaps in income and academic achievement in a Canadian context. This study did find a correlation between academic achievement and income. Between 1990 and 2008, the gender gap in income closed by more than 5 percentage points, while the percentage of women aged 25-54 with a university degree rose 13.6 points at the same time (Drolet, 2011). This shows that, at least in Canada, there is a significant correlation between gender equality in academics and income.

Social Changes in the United States

The United States has definitely undergone changes and improvement in the equality of men and women over the last. The Global Gender Gap Report currently rates the United States at an overall score of 0.826 equity in all categories, a significantly increased ranking from past scores. Specifically, they gave America a 0.999 equity score in education, indicating that any differences between the opportunities for men and women in education are currently statistically

insignificant. Their economic equity score is currently 0.826, meaning that women earn an average of 82.6% of the wage of their male counterparts.

Obviously, equality in income still has a long way to go, but this is a significant improvement from the past. The first Global Gender Gap Report was conducted in 2006, and since that time income equality in the United States has improved by a significant rate of 6.8 percentage points.

To go further back than 2006, we have to use a different system of measurement that might not be entirely compatible. Fortunately, in 2005, Weichselbaumer and Winter-Ebmer conducted a meta-analysis of 788 studies on gender wage gaps from 1957 to 2005, which provides a useful reference for the data before 2006. Their study found that the United States had a mean gender income gap of 0.51 during the 1960s, compares to a mean gender income gap of 0.26 from 2000 to 2005. This shows a major and significant improvement to the equality of women over the past 50 years.

The Significance of Improving the Academic Achievement Gap

Improving the academic achievement gap has a major impact on society on the whole. Several studies have looked into the correlated and reciprocal relationship between educational equality and social equality and consistently show that improving the academic achievement gap improves several aspects of society on the whole.

Improving the academic achievement gap improves wages. Several studies have shown that income gender gaps are more pronounced in jobs that do not require a post-secondary education, whereas jobs that require a degree typically have a less pronounced gap (Mussida & Picchio, 2014; Livanos & Nunez, 2012).

Reducing the achievement gap between men and women also improves the economy on the whole. A direct correlation has been found between the gender equality in a country and the success of their economy (Dollar & Gatti, 1999), although it is difficult to determine whether the cause in this correlation is gender equality or economic success.

Studies also show that income equality is correlated with overall equality. Countries with lower levels of income equality also suffer from lower scores in other measures of equality, while countries with more income equality have higher scores in other measures (Dollar & Gatti, 1999). Therefore, there does seem to be a connection between improving income equality and improving the equality of society on a whole, suggesting that focusing on fair wages might be a key component to ensuring an equal society.

Finally, there are also studies that show that both income and education equality affect the involvement of women in the political arena. Women in countries with equal opportunities to learn and earn money show higher rates of involvement, trust and engagement in politics than women in unequal countries (Green, Preston & Sabates, 2003).

Achieving equality in education and income, then, seems to have a larger effect. It has a significant effect on the whole arena of society, improving the overall success of a country. Therefore, equality in education and income are significant topics of discussion with far-reaching implications.

The Significance of Math Scores

While gender equality in education is an admirable goal in general, there is a body of research to suggest that the specific area of gender equality in Math is of special importance. The literature,

on the whole, seems to indicate that Math has an especially significant role in the future success of a student, and particularly on their later economic opportunities.

First, studies show a direct correlation between achievement on Math tests and income later in life. In fact, a student's Math test scores can reliably be used as an effective predictor of their future income (Niederle & Vesterlund, 2010).

The influence of Math scores on future income is not a small one. For male high school seniors, an improvement of 2 percentage points from the mean on a Math test can be correlated with a 1% increase in annual earning income later in life (Murnane et. al, 2000).

Math scores are also connected the interest levels in STEM careers. Ceci and Williams' 2007 study reveals that both male and female occupational aspirates are primarily mediated by their expectancy beliefs, which are influenced by their performance on academic tests. In other words, improved academic achievement in Math classes gives girls a girl sense of ability in math in general, resulting in a higher rate of girls enrolling in STEM classes.

This has a significant impact on women's economic opportunities. Even today, men and women enroll in very different courses at both the high school and post-secondary levels. These course selections are significantly correlated with their future incomes. The courses that correlate with a higher income, however, are all courses that are stereotypically perceived as male majors, particularly STEM subjects. Other subjects that are still viewed as stereotypically female majors correlate with much lower incomes. Therefore, the differences in course selections and the lack of female interest in STEM subjects account for a significant part of the male-female wage gap. (Brown, Corcoran, 1997) Connecting more women with STEM jobs would go a long way in shrinking that gap.

Clearly, then, Math scores are a significant indicator of a girl's economic success later in life. Math performance affects success in a way that Language Arts does not, making a special focus on Math scores of particular significance.

Conclusion

The existing literature makes it clear that the academic achievement of girls has changed, as popularly believed, but that this change has not occurred in every measure of education. Instead, girl's achievement has specifically improved on Math scores on standardized tests. This gives us the focus of our study, as it lets us know that we should specifically be reviewing Math performance and that we should be using the SAT and NAEP as measurements of academic achievement.

The literature also reveals that there is no clear consensus on what has caused this improvement. Most studies have looked at correlations between social circumstances and academic achievement generally rather than in the specific context of the United States. On the general level, however, there is no consensus as to whether a correlation between social equity and equity in academic achievement exists. Different studies have come to different conclusions, and there are many questions still left to answer.

The literature does make it clear that male outperformance of women in Math and in standardized tests is a norm that appears in most cultures. However, this only makes the increasing success of women in Math more interesting. This suggests that a major increase has been made in an area where we are usually deficient, and so this a great example of an educational success that warrants study.

Finally, the literature makes it clear that the success of women in Math classes has far-reaching impacts. Achieving equality in Math score affects the equality of a society on the whole, improving female political involvement, income equality and economic success on the whole.

Chapter 3

Methodology and Procedure

The purpose of this study was to determine whether there is a correlation between the decreasing gender gap in average income and the gender gap in academic achievement in the United States.

This chapter discusses the population, sample, data collection methods, procedures, and research questions used.

Population

The population for this study comes from archival data for all students grade 4 and 12, all across the United States. The racial demographic of American students 18 and under ("POP 3 Race", 2015) is as follows:

- 51.3% White
- 24.9% Hispanic
- 13.7% Black
- 4.9% Asian
- 1% Native American
- 4.1% two or more races

Sample

The sample from this NAEP archival data includes every student who has completed either the NAEP or SAT test. The students taking these tests are 9-years-old, 13-years-old and 17-years-old

respectively. The demographic breakdown for the most recent NAEP test (NAEP, 2015) is as follows:

- 55% White
- 22% Hispanic
- 14% Black
- 6% Asian
- 1% Native American
- 2% two or more races

The students who completed the SAT in the 11th grade were as follows:

- 50% White
- 9% Hispanic
- 13% Black
- 12% Asian
- 1% Native American, (*2013 College-bound seniors*, 2013)

Data Collection

Data were collected through publically available documents. NAEP scores from the year 1969 to 2015 were retrieved from the NAEP website. SAT scores from the years 1972 to 2015 were retrieved from the SAT website.

Information on the gender income gaps from 1963 to 2015 were obtained from the National Committee on Pay Equity.

Procedure

The data used for this study were archival. Therefore, no permission was required to use the data.

The data were collected through the NAEP, SAT, and National Committee on Pay Equity.

To ensure a consistent and comparable measurement of all four sources of data, all data were expressed as a percentage. Specifically, data for each year's income gender gap was expressed as the percentage of the average male income that is earned by the average female worker. Data for each year's academic gender gap was expressed as the percentage of the average male score on each test that was achieved by the average female student.

These data were plotted on a chart showing the variations in gender gap over time, measured annually. Specifically, the chart included the percentage of the gender gap in the following categories:

- Average incomes
- Total NAEP scores
- NAEP Math scores
- Total SAT scores
- SAT Math scores

Research Questions

Research Question 1:	Is there a relationship between the gender gap and academic achievement on the mathematics section of the SAT?
Research Hypothesis 1:	There is a positive relationship between the gender gap and academic achievement on the mathematics section of the SAT.
Null Hypothesis 1:	There is no relationship between the gender gap and academic achievement on the mathematics section of the SAT.
Research Question 2:	Is there a relationship between the gender gap in wages and academic achievement on the mathematics section of the NAEP for 17-year-olds?
Research Hypothesis 2:	There is no relationship between the gender gap in wages and academic achievement on the mathematics section of the NAEP for 17-year-olds.
Null Hypothesis 2:	There is a positive relationship between the gender gap in wages academic achievement on the mathematics section of the NAEP for 17-year-olds.

Chapter 4

Data Analysis

The purpose of this study was to determine the relationship between the gender gap in wages and the gender gap in academic achievement, as measured by student performance on the NAEP and SAT tests.

Collection of Data

The data for this research were collected from reports by the National Committee on Pay Equity, The CollegeBoard's SAT Total Group Profile Report, and the National Center for Education Statistics.

The National Committee on Pay Equity, which supplied data on the average male and female incomes from 1960 to 2015, acquired its data from the Census Bureau. Their sample included every reporting male and female worker in the United States aged 15 and up. The demographics profile from the 2015 United States census is displayed in Table 1.

Table 1

Demographic Profile of the 2010 United States Census

Gender	Frequency (*f*)	Percent (%)
Male	151,781,326	49.2
Total	156,964,212	50.8

The CollegeBoard's SAT Total Group Profile, which provided the average male and female scores on both the mathematics and reading categories of the SAT. Their sample included

every male and female student who completed the SAT between 1972 and 2015. The demographics profile for the participants in the 2015 SAT is displayed in Table 2.

Table 2

Demographic Profile of 2015 SAT Test-Takes

Gender	Frequency (*f*)	Percent (%)
Male	794,802	46.8
Female	903,719	53.2
Total	1,698,521	100.0

The National Center for Education Statistics' reports, "NAEP 2012: Trends in Academic Progress" and "2015: Mathematics & Reading Assessments", provided the average scores for every male and female student who completed either the NAEP Mathematics Assessment and the NAEP Reading Assessment for the years 1971 to 2015. The ages of the test-takers were 17-years-old. The demographics profile for the participants in the 2015 NAEP tests is displayed in Table 3.

Demographic Profile of 2015 NAEP Test-Takes

Gender	Frequency (*f*)	Percent (%)
Male	*Data not disclosed*	51
Female	*Data not disclosed*	49
Total	*N/A*	100.0

To reduce possible confounds, the data collected were then converted into an expression of the gap between average male and female scores, expressed as the percentage of the average male score achieved by the average woman. This was done to reduce possible confounds. The NAEP and SAT tests have undergone numerous changes since 1971, which can be reasonably assumed to have artificially inflated and decreased student scores for reasons unrelated to gender. Likewise, economic booms, recessions, and other factors have caused increases and decreases in the average income that, again, are unrelated to gender. As my only interest is in the gaps in academic achievement and income between men and women, I have analyzed the data as a percentage point instead of from the raw data, which provide a more stable and meaningful figure to compare the data.

The average income gender gap for each was compared for statistical significance to the average gender gap in academic achievement in SAT math and reading scores, respectively. The income gender gap was also compared for statistical significance to the NAEP results of 17-year-olds, 13-years-olds, and 9-year-olds in both mathematics and reading.

Research Question 1

Research Question 1: Is there a relationship between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the SAT? To answer research question one, the data from the SAT mathematics test and the average male and female income for each year were converted into a percentage representing the gender gap in each category and compared.

The mean gender gap in academic achievement on the SAT mathematics test was 0.9289 and the mean gender gap in income was 0.6815. The two means were compared for a relationship.

Research Hypothesis 1: There is a relationship between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the SAT.

In order to determine whether there was a significant relationship, a Pearson Product-moment Correlation Coefficient test was administered. Results indicated there was a significant correlation ($r = 0.476$, $p = 0.001$) between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the SAT.

The coefficient of determination (r^2) revealed that 22.66% of academic achievement on the SAT mathematics test can be explained the gender gap in income. That means that 77.34% could be attributed to other variables.

Therefore, the null hypothesis was rejected and I state with 95% confidence that there is a relationship between the income gender gap and the gender gap in academic performance on the SAT mathematics test. The results are displayed in Table 4.

Table 4

Correlation Between the Gender Gap In Academic Achievement on the SAT Mathematics Test and the Income Gender Gap

	Mean	SD	r	r^2	Sig.
SAT Math Gender Gap	0.9289	0.00860	0.476	0.227	0.001

Income Gender Gap	0.681	0.11908

Research Question 2

Research Question 2: Is there a relationship between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the NAEP for 17-year-olds? To answer research question one, the data from the mathematics section of the NAEP for 17-year-olds and the average male and female income for each year were converted into a percentage representing the gender gap in each category and compared.

The mean gender gap in academic achievement on the mathematics section of the NAEP for 17-year-olds was 0.9840 and the mean gender gap in income was 0.6815. The two means were compared for a relationship.

Research Hypothesis 2: There is a relationship between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the NAEP for 17-year-olds.

In order to determine whether there was a significant relationship a Pearson Product-moment Correlation Coefficient test was administered. Results indicated there was a significant correlation ($r = 0.710$ $p = 0.010$) between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the NAEP for 17-year-olds.

The coefficient of determination (r^2) revealed that 50.41% of the gender gap in academic achievement on the NAEP mathematics test for 17-year-olds can be explained by the gender gap in income. That means that 49.59% could be attributed to other variables.

Therefore, the null hypothesis was rejected and I state with 95% confidence that there is a relationship between the income gender gap and the gender gap in academic performance on the NAEP mathematics test for 17-year-old. The results are displayed in Table 5.

Table 5

Correlation Between the Gender Gap On The NAEP Math Test and the Income Gender Gap

	Mean	SD	r	r^2	Sig.
NAEP Math Gender Gap	0.9840	0.00530	0.710	0.504	0.010
Income Gender Gap	0.6815	0.11908			

Chapter 5

This chapter contains a summary of findings, conclusions, recommendations for future study, and implications for practice based on the research examining the relationship between the income gender gap and the academic gender gap.

Summary of Findings

In regards to research question 1, "Is there a relationship between the income gender gap and academic achievement on the mathematics section of the SAT?", a Person product moment correlation test was conducted. The results indicated there was a positive correlation ($r = 0.476$, $p=0.001$) between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the SAT. The coefficient of determination ($r2$) revealed that 22.66% of academic achievement on the SAT mathematics test can be explained by the gender gap in income and 77.34% could be attributed to other variables.

The income gender gap steadily narrowed from 1971 to 2015, with women consistently improving their income in comparison to their male counterparts. Likewise, the performance gap on the math section of the SAT also steadily narrowed over the same period. This relationship suggests that, as the income gender gap decreased, the academic gender gap on the math section of the SAT decreased, as well. As women's income opportunities became more equal, their academic performance in mathematics on the SAT improved. Due to the significance of the correlation in this study, the null hypothesis was rejected.

In regards to research question 2, "Is there a relationship between the income gender gap and academic achievement on the mathematics section of the NAEP?", a Person product moment

correlation test was conducted. The results indicated there was a positive correlation ($r = 0.710$, $p=0.010$) between the gender gap in wages, as measured through US census reports, and academic achievement, as measured on the mathematics section of the NAEP. The coefficient of determination (r^2) revealed that 50.41% of academic achievement on the NAEP mathematics test can be explained by the gender gap in income and 49.59% could be attributed to other variables.

As with the gender gap in academic performance on the SAT mathematics test, the gender gap in academic performance on the NAEP mathematics steadily narrowed from 1971 to 2015.

It is noteworthy, however, that this correlation was more pronounced. The income gender gap proved a better predictor of the gender gap on the NAEP test than the SAT. This is consistent with past findings that suggest that male test performance improves on high-stakes tests. (Ors, Palomino & Peyrache, 2013). Performance on the SAT directly affects a participant's opportunities for post-secondary education and their future career prospects, whereas performance on the NAEP has a smaller and more indirect effect on test taker's future career prospects. As such, it is reasonable to assume that this additional pressure is a factor in the results. Due to the significance of the correlation in this study, the null hypothesis was rejected.

These results, combined with the results of past studies, suggest that the correlation between the income gender gap and the gender gap in academic achievement may not be a phenomenon restricted to a single culture. These findings are consistent with findings in the literature which suggested there was a correlation between female academic achievement on the PISA and social equity (Else-Quest, Hyde & Linn, 2010). They are also consistent with the results of similar studies comparing the income gender gap and the gender gap in university completion that have been conducted in Canada (Drolet, 2011) and the United States (Goldin,

Katz & Kuziemko, 2006). As these studies have consistently found significant correlations between the income gender gap and academic achievement through various different metrics and in different cultures, it seems likely that this correlation may exist across cultures. However, further testing would need to be conducted to confirm how strong this relationship is and how heavily it is influenced by culture.

Conclusions

The purpose of this study was to determine the relationship between the income gender gap and the gender gap in academic achievement, as measured on the mathematics section of the SAT and NAEP standardized tests. This study showed that there was a significant relationship between the income gender gap and the gender gap in academic achievement.

Therefore, the inference can be made that, as the income gender gap narrows, the gender gap in academic achievement on the mathematics section of the SAT and NAEP also narrows.

Recommendations

1. To better illuminate whether this effect still exists in children who are too young to be affected by the prospect of a future career, research into the gender gaps in income and academic achievement should examine the academic gender gap at multiple age levels instead focusing solely on pre-collegiate students
2. To develop a better understanding of whether career prospects might be affecting female performance in mathematics, a correlations study into the relationship between the academic gender gap in mathematics and the prevalence of women in STEM profession should be considered.

3. When combined, the findings of this study and the findings of Drolet's 2011 study suggest that these results may occur cross-culturally. Future research into the gender gaps in academic achievement and income should expand the sample to include statistics from multiple different countries to see whether the same results can be reached outside of the United States.
4. The NAEP and SAT tests used in this study both test the student's ability to succeed on a test that will affect their future opportunities in both college and employment. To better illuminate how heavily these results are influenced by growing female concern over future employment prospects, future studies should also correlate the income gender gap with a non-essential mathematics aptitude test to see whether female academic performance is as strong when there are no career prospects on the line.

Implications

The gender gap in income can be significantly correlated with the gender gap in academic achievement in mathematics. The implications of this research project are as follows:

1. The past gender gap in male and female mathematical achievement can be assumed to have been influenced by the limited career expectations previously held by the average woman.
2. Improvements in female academic achievement on both standardized tests and academic achievement in mathematics can be, at least in part, attributed to improved job prospects for women.
3. As income equality grows and women feel more confident in their opportunities in achievement equal incomes and job opportunities, we can predict that the gender gap in academic achievement will likely continue to narrow.

4. As a social policy, women should be encouraged to feel confident in their ability to achieve equal occupational success as their male counterparts to further improve female academic achievement.

References

2013 College-bound seniors: Total group profile report (Rep.). (2013).

Aud, S., Fox, M., & KewalRamani, A. (2010, July). Status and trends in the education of racial and ethnic groups. *Institute of Education Sciences*. Retrieved from http://nces.ed.gov/pubs2010/2010015.pdf

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2009). Female teachers' math anxiety impacts girls' math achievement. *PsycEXTRA Dataset*. doi:10.1037/e634112013-097

Benbow, C., & Stanley, J. (1980). Sex differences in Mathematical ability: Fact or artifact? Science, 210(4475), 1262-1264. doi:10.1126/science.7434028

Brown, C., & Corcoran, M. (1996). Sex-Based Differences in School Content and the Male/Female Wage Gap. *Journal of Labor Economics*, 15(3). doi:10.3386/w5580

Buchmann, C., & Diprete, T. A. (2006). The Growing Female Advantage in College Completion: The Role of Family Background and Academic Achievement. American Sociological Review, 71(4), 515-541. doi:10.1177/000312240607100401

Eccles, J. S. (2007). Why Aren't More Women in Science? Top Researchers Debate the Evidence (S. J. Ceci & W. M. Williams, Eds.). Washington, DC: American Psychological Association.

Dollar, D., & Gatti, R. (1999, May). Gender inequality, income, and growth: Are good times good for women? Policy Research Report on Gender and Development, 1. Retrieved October 25, 2016, from http://darp.lse.ac.uk/frankweb/courses/EC501/DG.pdf

Drolet, M. (2011). Why has the gender wage gap narrowed? (pp. 3-13, Rep.).

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in Mathematics: A meta-analysis. Psychological Bulletin, 136(1), 103-127. doi:10.1037/a0018053

Global Gender Gap Report: United States (Rep.). (2015). Retrieved October 25, 2016, from http://reports.weforum.org/global-gender-gap-report-2015/economies/#economy=USA

Goldin, C., & Katz, L. (2000). The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions. doi:10.3386/w7527

Goldin, C., Katz, L., & Kuziemko, I. (2006). The Homecoming of American College Women: The Reversal of the College Gender Gap. doi:10.3386/w12139

Green, A., Preston, J., & Sabates, R. (2003, March). Education equity and social cohesion: A distributional model. Wider Benefits of Learning Research Report, 7, 1-48. Retrieved from http://eprints.ioe.ac.uk/5502/1/Green2003Education.pdf

Hill, C., Corbett, C., & St. Rose, A. (2010). Why So Few? Women in Science, Technology, Engineering, and Mathematics (Rep.). AAUW. (ERIC Document Reproduction Service No. ED509653)

Hock, H. (2004). The Pill and the College Attainment of American Women and Men. *SSRN Electronic Journal*. doi:10.2139/ssrn.1023042

Holden, C. (2016). Female Math Anxiety on the Wane: But data from standardized achievement tests in math and science still show male superiority, particularly among the highest scorers. *Science, 236*(4802), 660-661. doi:10.1126/science.236.4802.660

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in Mathematics performance: A meta-analysis. Psychological Bulletin, 107(2), 139-155. doi:10.1037//0033-2909.107.2.139

Lefevre, J., Kulak, A. G., & Heymans, S. L. (1992). Factors influencing the selection of university majors varying in Mathematical content. Canadian Journal of Behavioural Science/Revue Canadienne Des Sciences Du Comportement, 24(3), 276-289. doi:10.1037/h0078742

Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and Mathematics performance: A meta-analysis. Psychological Bulletin, 136(6), 1123-1135. doi:10.1037/a0021276

Livanos, I., & Núñez, I. (2012). The effect of higher education on the gender wage gap. International Journal of Education Economics and Development, 3(1), 33. doi:10.1504/ijeed.2012.044952

Murnane, R. J., Willett, J. B., Duhaldeborde, Y., & Tyler, J. H. (2000). How important are the cognitive skills of teenagers in predicting subsequent earnings? Journal of Policy Analysis and Management, 19(4), 547-568. doi:10.1002/1520-6688(200023)19:43.0.co;2-#

Mussida, C., & Picchio, M. (2013). The gender wage gap by education in Italy. The Journal of Economic Inequality J Econ Inequal, 12(1), 117-147. doi:10.1007/s10888-013-9242-y

NAEP - 2015 Mathematics & Reading Assessments. (2015). Retrieved October 25, 2016, from http://www.nationsreportcard.gov/reading_Math_g12_2015/

Niederle, M., & Vesterlund, L. (2010). Explaining the Gender Gap in Math Test Scores: The Role of Competition. Journal of Economic Perspectives, 24(2), 129-144. doi:10.1257/jep.24.2.129

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology*, 83(1), 44-59. doi:10.1037//0022-3514.83.1.44

Ors, E., Palomino, F., & Peyrache, E. (2013). Performance gender gap: Does competition matter? Journal of Labor Economics, 31(3), 443-499. doi:10.1086/669331

POP3 Race and Hispanic origin composition: Percentage of U.S. children ages 0–17 by race and Hispanic origin, 1980–2015 and projected 2016–2050. (2015). *Child Stats*. Retrieved November 17, 2016, from http://www.childstats.gov/AMERICASCHILDREN/tables/pop3.asp

Sadker, M., Sadker, D., & Steindam, S. (1989, March). Gender equity and educational reform. Educational Leadership, 44-47. Retrieved from http://ascd.com/ASCD/pdf/journals/ed_lead/el_198903_sadker.pdf

SAT Total Group Profile Report (Rep.). (2015). CollegeBoard.

Stoet, G., & Geary, D. C. (2015). Sex differences in academic achievement are not related to political, economic, or social equality. Intelligence, 48, 137-151. doi:10.1016/j.intell.2014.11.006

Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: A meta-analysis. Psychological Bulletin, 140(4), 1174-1204. doi:10.1037/a0036620

Weichselbaumer, D., & Winter-Ebmer, R. (2005). A Meta-Analysis of the International Gender Wage Gap. Journal of Economic Surveys, 19(3), 479-511. doi:10.1111/j.0950-0804.2005.00256.x

Whitmire, R., & Rhee, M. (2010). Why Boys Fail: Saving Our Sons from an Educational System That's Leaving Them Behind. New York: American Management Association.