Gender Stereotypes and Mathematics Anxiety: Contributing Factors to the Deficit of Women in STEM Fields

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Introduction

STEM is an acronym used to describe a profession in the fields of science, technology, engineering, or mathematics. Examples of STEM jobs include, but are not limited to: scientists, mathematics teachers, doctors, nurses, software developers, psychologists, construction managers, architects, machinists, chemists, aerospace engineers, civil engineers, and many more. These jobs require special training or college degrees with heavy focus on advanced level subjects that make up the acronym. The population of people in the STEM work force is predominantly male. Minnesota State College and Universities (2015) offers a statistic showing that just 17 percent of chemical engineers and 22 percent of environmental scientists are women. Though STEM fields include female workers, there is a lack of women seeking STEM jobs. This lack of a female presence in the STEM fields then brings about the following questions: (1) Do females not receive enough encouragement to pursue a STEM career? (2) If females have pre-existing stereotypes about STEM careers, do these deter them from pursuing a job in a STEM field? (3) Does mathematics or science anxiety deter females from thinking about pursuing a STEM career?

Review of Literature

In a study that examined the results from the Early Childhood Longitudinal Study of the Kindergarten class of 1998–1999, inequity in mathematics based on gender begins as early as elementary school, and may be partially the fault of the teachers (Robinson-Cimpian, Lubienski, Ganley, Copur-Gencturk, 2014). The researchers found that teachers rate girls lower in

mathematics than boys by one tenth of a standard deviation. The researchers also found that girls do not receive as much acknowledgment for intellectual work compared to boys. Teachers are encouraging the gender gap in mathematics rather than preventing it by not encouraging girls to try more difficult mathematics problems. It is equally important to challenge female students as it is to challenge male students to excel in math. The researchers further found that perceived behavior of students by teachers has also been a force in broadening the gender gap in math. Girls have a tendency to exhibit better behavior than boys, which is known as the "good girl" effect. These good behavior traits included behaviors such as having a longer attention span and not fidgeting. The study also found that girls have to work harder than boys to be rated as well as boys. This means that girls are not getting an accurate representation how well they are doing in mathematics due to their teachers' misconceptions. This suggests that teachers misconceptions and stereotypes about students' behavior predetermines how well their students will do in their mathematics classrooms, thus dooming the female students for failure before they even enter the classroom.

Robinson-Cimpian, et al. (2014) also questioned that because the elementary education work force is predominantly female, it could be the case that these same female teachers' fears about mathematics shape how they rate their own female students. Once again, female students are doomed to failure before they even step foot in the classroom. If elementary school teachers continue to rate their female students lower than their male students due to their own misconceptions, will it affect their female students' confidence in math? Will it lead to those same girls entering middle school, high school, and perhaps even college with lesser mathematics confidence and a higher mathematics anxiety due to the incorrect information that they received on how well they did in the subject? The article, *The Role of Anxiety and Working*

Memory in Gender Differences in Mathematics (Ganley & Vasilyeva, 2014), suggests that this could be a possibility. The differences between male and female students in mathematical abilities increase as the students move into high school and college. As girls mature and become more aware of the stereotypes related to girls and mathematical abilities they can become more anxious about mathematics, which in turn can affect their grades. Females have a higher tendency to drop out of the mathematics pipeline compared to boys, which could very well be due to anxiety about the topic. This contributes to the lack of a female presence in STEM careers.

Mathematics anxiety as defined in Chapter 4 of the book *Social Issues: A Mathematician Comes of Age* (Krantz, 2012) is an "inability by an otherwise intelligent person to cope with quantification, and more generally, with mathematics" (Krantz, 2012, p. 64). The author provided an example of a person with mathematic anxiety. This person was a businessman who was unable to calculate a tip. Symptoms of mathematics anxiety include sweaty palms, nausea, pounding heart, and a clogged thought process. Krantz suggests that mathematics anxiety comes about because mathematics is than different from any other subject. For example, in English a student may spell things incorrectly or put words in a different order in a sentence, but the reader can usually understand what the student meant to say. In comparison, in mathematics a problem is either right or wrong after it is solved. After a student has constant failure in trying to solve mathematics problems, his mathematics confidence could decrease along with an increased anxiety about the subject. A student, especially a female student, may not be able to help but compare herself to her succeeding classmates.

Female students have a tendency to compare themselves to others, which makes them give themselves low expectations (Whitcher, 2011). Ursula Whitcher, a professor of mathematics at the University of Wisconsin- Eau Claire, writes about her about own difficulties in comparing herself to others in her article *Math Anxiety and Gym Class*. She explains that though she didn't struggle in mathematics, she struggled in her gym class, which made her compare herself to others and set low expectations for herself from elementary school through some of her college years. She did not fall victim to the stereotype that "girls are bad at math," (Whitcher, 2011, p. 17) but allowed herself to fall into a different stereotype-- that "nerds are bad at sports" (Whitcher, 2011, p. 17). Once females fall into the stereotype and believe that they are incapable of excelling in mathematics due to their gender, they become "distracted by negative mental cataloging," (Whitcher, 2011, p. 16) or the tracking of failures, which add up over time and decrease their interest and confidence in the subject. She also comments that girls get frustrated when they do not understand certain mathematical topics right away and cannot "evoke flexibility and balance" (Whitcher, 2011, p. 17) to overcome the trial and error stage of learning mathematics to a point where they can master a topic. These debilitating thoughts can increase a female's anxiety towards mathematics. Whitcher did, however, find strengths within her weakness in gym. She realized that she was bad at sports, not because she wasn't fit, but because she wasn't trained in them. Her gym class would only practice baseball two weeks out of the year, which didn't give her enough time to master the sport. She argued that the same theory can apply to a mathematics class, in which students do not apply themselves to the subject. This in turn increases their likelihood to not do well in the subject and to build negative feelings and anxiety towards mathematics. It is essential that students learn not to compare themselves to others because each individual student has his/her own individual strengths and weaknesses.

Instead, students should find confidence in their own abilities, build on those abilities to do well in mathematics, and look up to role models.

The media, however, has not done a good job in providing many role models for young girls to look up to as a source of inspiration to do well in STEM fields. The media plays a huge role in our society today and especially in the lives of young adults and children. Children look towards the media for information and role models; but the information and role models may not be the type of positive influence that girls need to be inspired to like STEM fields (Kitzinger, Haran, Chimba, & Boyce, 2013). The researchers found that media can influence a child's occupational knowledge and role identification, which can negatively impact a child's likelihood of liking STEM fields if they are not portrayed positively in the media, especially for young girls. In a study in which female scientists were asked about their opinions about the media, the general response from the participants was that the media has done a poor job in highlighting the importance of STEM fields and lacks female role models in those fields. When children think of a scientist from a movie or TV show, they will usually think of a mad scientist who is most likely a male. Such a portrayal of science in a young girl's mind would definitely deter her from viewing science in a positive way. Media has even gone as far as using females to show how easy it is to use piece of technology is to use. Branding different forms of technology in this way changes young girls' views on how much they are able to understand technology, which in this case means very little. A specific example of media that has portrayed STEM fields as a "man's world" and are not fields women typically enter is the movie, *Cloudy with a Chance of Meat Balls* (Marsden, 2009).

In the movie *Cloudy with a Chance of Meat Balls* (Marsden, 2009), the main character and "mad scientist," Flint Lockwood, sets out on a very noble task on ending world hunger. He

was ridiculed for his failure by society and even his father who wished he would give up being a scientist. But after much failure, Flint created a machine that made food fall from the sky. His work gained national attention and was tracked by the local news reporter Sam Sparks. After an interview with Ms. Sparks, Flint fell in love with her and decided to create a castle of her favorite food, Jell-O. In the Jell-O castle, Sam pours her heart out to Flint about how all she wanted as a child was a Doppler weather radar 2000 turbo. She was obsessed with the science of weather, but was forced to give it up due to the bullying she received from her peers for being "a nerd." She then decided it was easier to be given merit due to her looks rather than on how smart she was. Sam then gave up her glasses, pony tail, and dreams of getting a Doppler Weather Radar 2000 Turbo, to become a news reporter. This type of negative portrayal of females in STEM fields is what can change young girl's mind view about them. A young girl watching this scene between Sam and Flint may identify with Sam and might also in the future forgo pursuing a STEM career. Though this short three minute clip would not be a life altering moment for a young girl, repeated subliminal media messages about gender inequalities eventually may change her views on whom she is to become to fit into society.

It is clear that there is an obvious lack of women entering STEM careers, which may due to girls not receiving enough encouragement in the areas of mathematics and science, knowledge of stereotypes about mathematics and science, and having mathematics or science anxiety. If female students need to work harder to be rated as well as male students and are not asked enough intellectual questions by teachers, they are not being encouraged to do well in the subjects of mathematics and science (Robinson-Cimpian, et al., 2014). If female students are also receiving an incorrect picture on how well they are performing in the subjects of mathematics and science due to their teachers' misconceptions on how well female students can excel in those

areas, teachers are encouraging gender stereotypes in the subject areas of mathematics and science rather than preventing them (Ganley & Vasilyeva, 2014). Girls are sensitive to stereotypes, which can lead to lower their abilities and confidence in mathematics and science, especially when they hear the stereotypes continually repeated. This contributes to females dropping out of the mathematics pipeline.

Mathematics is a difficult subject because it builds upon previously mastered skills and there are only correct answers or wrong answers (Krantz, 2012). As students continually solve mathematics problems incorrectly, anxiety about the subject will increase. After much failure, students, especially female students, will compare themselves to their classmates, which may again, decreases their confidence in mathematics (Whitcher, 2011). Once female students believe the stereotype that they will never be good at mathematics, it is hard for them to break that stereotype. It should be the goal of teachers to break gender stereotypes about abilities in mathematics and science by providing accurate representations of how females are doing in the realms of mathematics and science. They should also encourage young female students to pursue STEM careers since the media has done a poor job of doing so (Kitzinger, et al., 2013 and Marsden, 2009).

Purpose

As a future mathematics teacher, I have noticed much of what I have researched in my observations in and out of classrooms. Pop culture merits women based on sex appeal rather than intelligence. Teenage girls have a tendency to follow social media and pop culture, which is unfortunate due to the lack of female role models in social media and pop culture that promote STEM fields. I have seen a decline in interest in mathematics among school age girls and in my own mathematics department at Medaille College. A year after I was accepted into Medaille

College, the mathematics major and secondary education with mathematics and special education major were discontinued due to the lack of students applying for these undergraduate degrees. This meant that the remaining students in those majors would participate in a teach-out program, in which the remaining students in those programs would be able to complete the courses they need to complete their major. Then no more higher level mathematics courses would be offered at Medaille College.

I believe it will be one of my greatest responsibilities as a mathematics teacher to spark interest in mathematics among my students, especially my female students, and break any stereotypes that they believe. I also believe that inspiring females to love mathematics is essential in middle school and in high school. This may lead more students, especially female students, to pursue a career in a STEM field. The purpose of this study is to gage any stereotypes students have and their levels of interest in mathematics and science.

Method

I designed a survey that would show seventh and eighth grade students' opinions on whether or not they believed STEM jobs stereotypically contain more males or females, how much they liked mathematics and science, how much anxiety they had towards mathematics or science, and how likely they believed they would be to pursue a career involving those same two fields. A copy of the survey is included in the appendix. On the first page of the survey students were asked to provide their gender and grade level, but not their name. I wanted the survey to be completely anonymous and not connect to a student in any way. This page also contained a chart with a list of 12 STEM and 12 non-STEM jobs. The students were asked to place a check mark in the row next to the job that they believed had more females, more males, or an equal number of males and females. The second page of the survey had three sets of simple questions that the

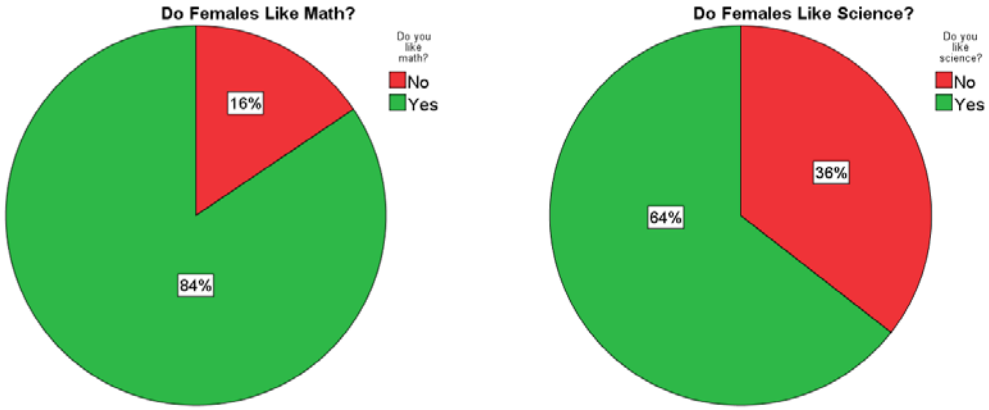
students could answer based on a scale of one to five, one being a low score and five being a high score. The questions were as follows: (1) How much do you like math? (2) How much do you like science? (3) How much anxiety do you have about math? (4) How much anxiety do you have about science? (5) How likely are you going to enter a career involving math? (6) How likely are you going to enter a career involving science? I gave the survey to four classes at an elementary/middle school in Buffalo, NY— a female 7th grade class, a female 8th grade class, a male 7th grade class, and a male 8th grade class. I chose to give the survey to both males and females in seventh and eighth grade to show the differences in opinions between the genders and grades and how perceptions about STEM fields may be different between seventh and eighth grade students.

Results

There were 23 females and 22 males who took the survey from the 7th grade, and there were 22 females and 22 males who took the survey from the 8th grade.

Graph 1

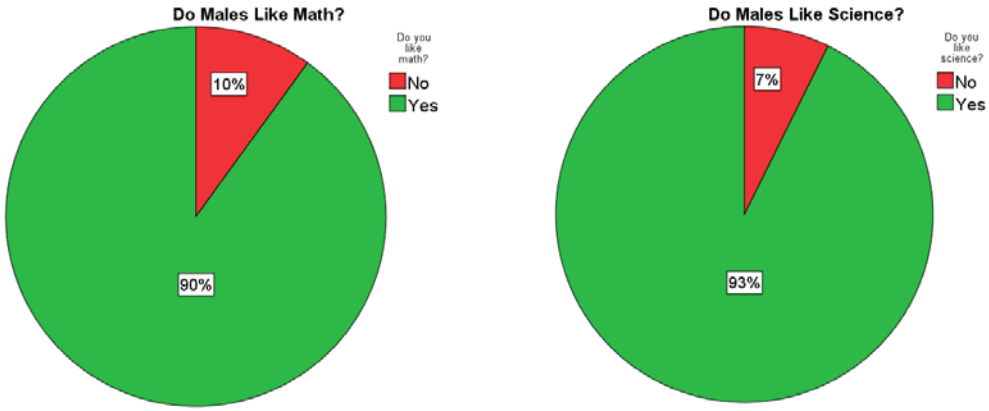
How Much Females Liked Mathematics or Science



The two pie graphs above represent how much the females in 7th and 8th grades liked mathematics and science. 84% of the females said they liked mathematics, while 16% said they did not like mathematics. 64% of the females said they liked science, while 36% said they did not like science. Thus, a majority of the females do like mathematics and science. About a third of the girls said they did not like science, which is a large portion of the 7th and 8th grade females.

Graph 2

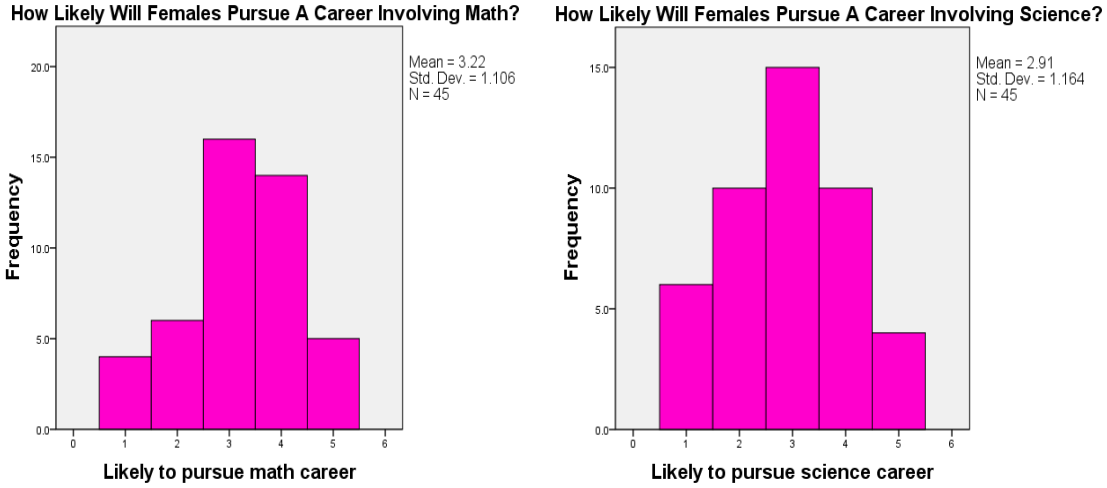
How Much Males Liked Mathematics and Science



The two pie graphs above represent how much 7th and 8th grade males liked mathematics and science. 90% of the males said they liked mathematics, while 10 percent said they did not like mathematics. 93% of the males said they liked science, while 7% of the males said they did not like science. Approximatly 9 out of 10 males in this survey said that they liked mathematics or science, which is an overwhelming majority of the males in 7th and 8th grades.

Graph 3

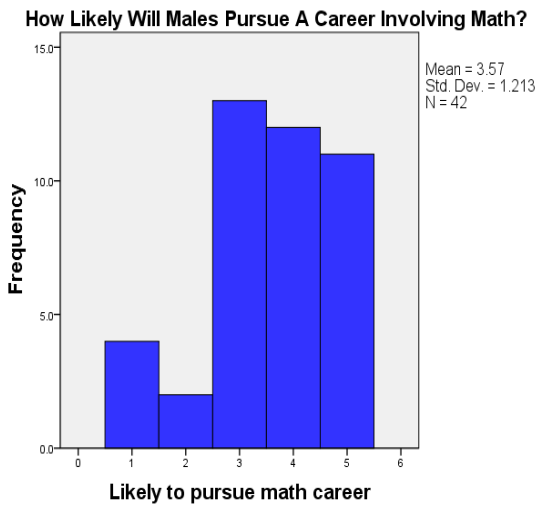
How Likely Females Will Pursue a Career in Mathematics or Science

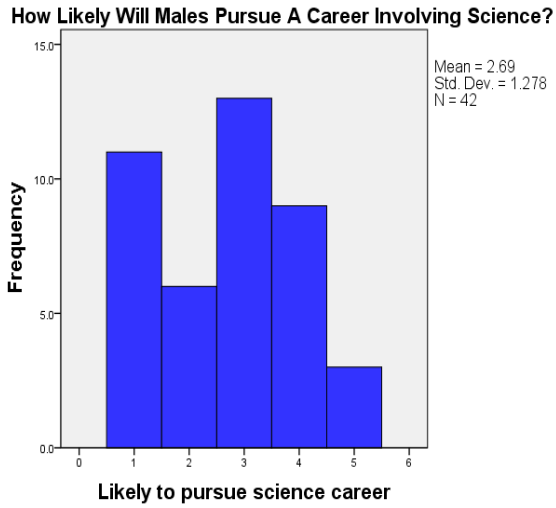


The two bar graphs above represent how likely the 7th and 8th grade femaless would pursue a career involoving mathematics or science. The mean score for pursuing a mathematics career for the females was 3.22, and the mean score for pursuing a science career for the females was a 2.91. A majority of the females answered 3, which is equivalent to a “maybe” when pursuing a job involving mathematics or science.

Graph 4

How Likely Males Will Pursue a Career in Mathematics or Science

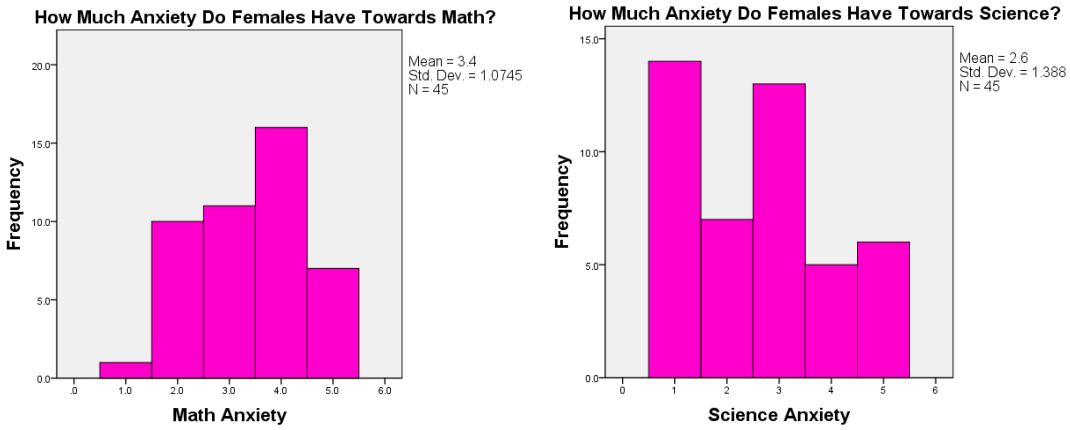




The two bar graphs above represent how likely the 7th and 8th grade males would pursue a career involving mathematics or science. The mean score for pursuing a mathematics career was 3.57, while the mean score for pursuing a science career was 2.69. These two graphs show a very different pattern of males wishing to pursue a career in mathematics than in science. A majority of the males said they would pursue a mathematics career, while just some of males said they would pursue a science career.

Graph 5

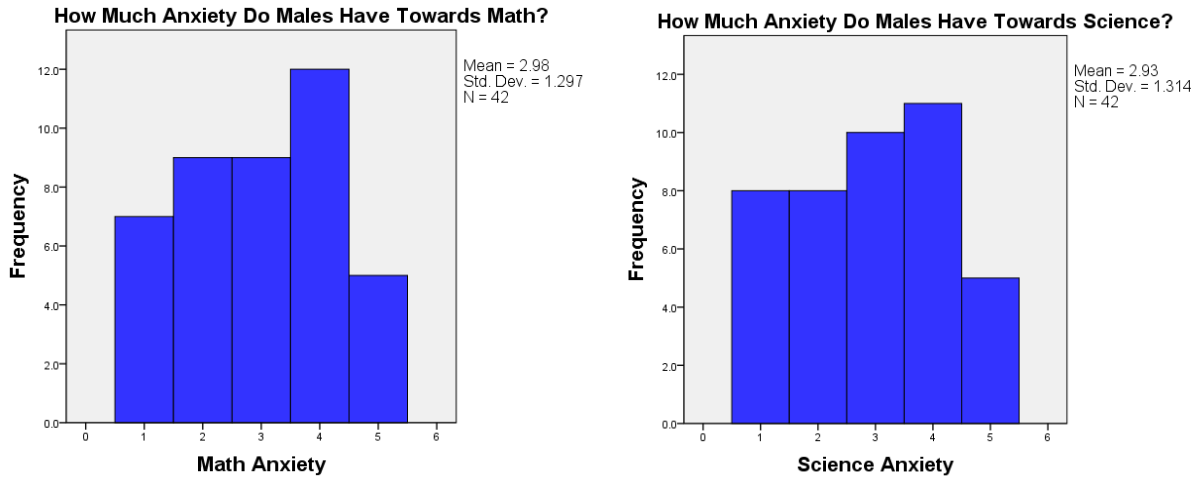
Anxiety of Females Towards Mathematics or Science



The two bar graphs above represent how much anxiety the 7th and 8th grade females had about mathematics and science. The mean score for mathematics anxiety was 3.4, while the mean score for science anxiety was 2.6. The bar graphs show that females have more anxiety about mathematics than they do about science.

Graph 6

Anxiety of Males Towards Mathematics or Science



The two bar graphs above represent how much anxiety the 7th and 8th grade males had towards mathematics and science. The mean score for mathematics anxiety was 2.98, while the mean score for science anxiety was 2.93. The bar graphs show that males have about as much anxiety towards mathematics as towards science.

Mathematics and Science Anxiety Between Genders

Anxiety Towards Mathematics

$H_0: \bar{X}_F = \bar{X}_M$

$H_1: \bar{X}_F \neq \bar{X}_M$

Anxiety level towards mathematics for the female students is the same as that of the male students.

Anxiety level towards mathematics for the female students is not the same as that of the male students.

Table 1

Anxiety Towards Mathematics

	Gender	N	Mean	Std. Deviation
Mathematics Anxiety	Female	45	3.39	0.160
	Male	42	2.98	0.200

Graph 7
Mathematics Anxiety in Male and Female Students

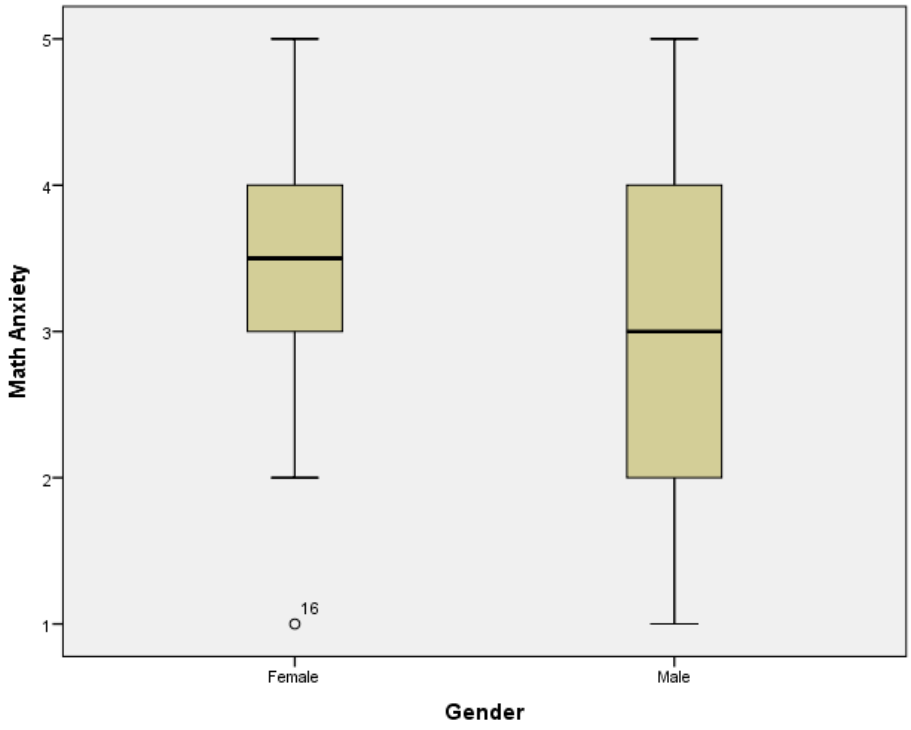


Table 2 Independent Samples t-Test				
Mathematics Anxiety		t	df	Sig (2-tailed)
	Equal Variances Assumed	-1.623	85	0.108

The mean mathematics anxiety level for the females was 3.39. The mean mathematics anxiety for the males to was 2.98. The females had more anxiety than the males towards mathematics, but the males had a larger spread for anxiety according to graph 7. However, since the p-value in the independent samples t-test was 0.108, which is greater than 0.05, we reject the

null hypothisis (Table 2). In other words, there is no statistical significant difference in mathematics anxiety between female and male students.

Anxiety Towards Science

$H_0: \bar{X}_F = \bar{X}_M$

$H_1: \bar{X}_F \neq \bar{X}_M$

Anxiety level towards science for the female students is the same as that of the male students.

Anxiety level towards science for the female students is not the same as that of the male students.

Table 3

Anxiety Towards Science

	Gender	N	Mean	Std. Deviation
Science Anxiety	Female	42	2.93	1.314
	Male	45	2.56	1.341

Graph 8
Science Anxiety in Male and Female Students

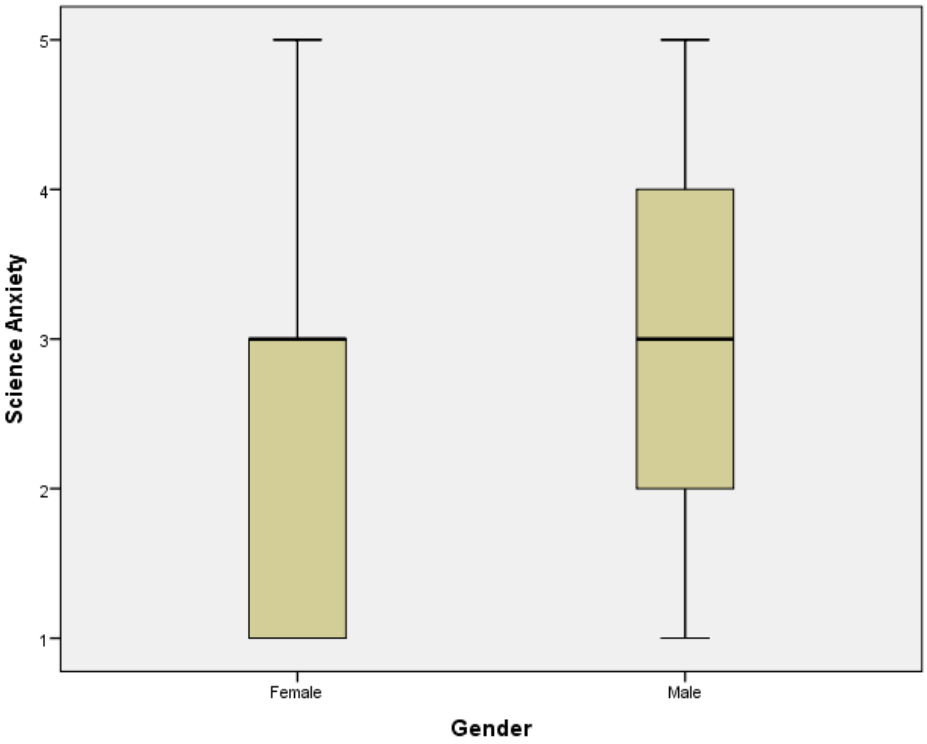


Table 4 Independent Samples t-Test				
Science Anxiety		t	df	Sig (2-tailed)
	Equal Variances Assumed	1.309	85	0.194

The mean science anxiety level for the females was 2.56. The mean science anxiety for the males was 2.93. The female and male students had similar levels of anxiety towards science. The spreads in graph 8 for the female and male students for science anxiety were the same. The female students' box plot showed that 50% of female students had lower levels of anxiety

towards science. Since the p-value in the independent samples test was 0.194, which is greater than 0.05, we reject the null hypothisis (Table 4). In other words, there is no statistical significant difference in science anxiety between female and male students.

Mathematics and Science Anxiety Between Grades

Anxiety Towards Mathematics

$H_0: \bar{X}_7 = \bar{X}_8$

$H_1: \bar{X}_7 \neq \bar{X}_8$

Anxiety level towards mathematics for the 7th grade students is the same as that of the 8th grade students.

Anxiety level towards mathematics for the 7th grade students is not the same as that of the 8th grade students.

Table 5

Anxiety Towards Mathematics

	Grade	N	Mean	Std. Deviation
Mathematics Anxiety	7	45	3.26	1.171
	8	42	3.12	1.234

Graph 9
Mathematics Anxiety in 7th and 8th Grade Students

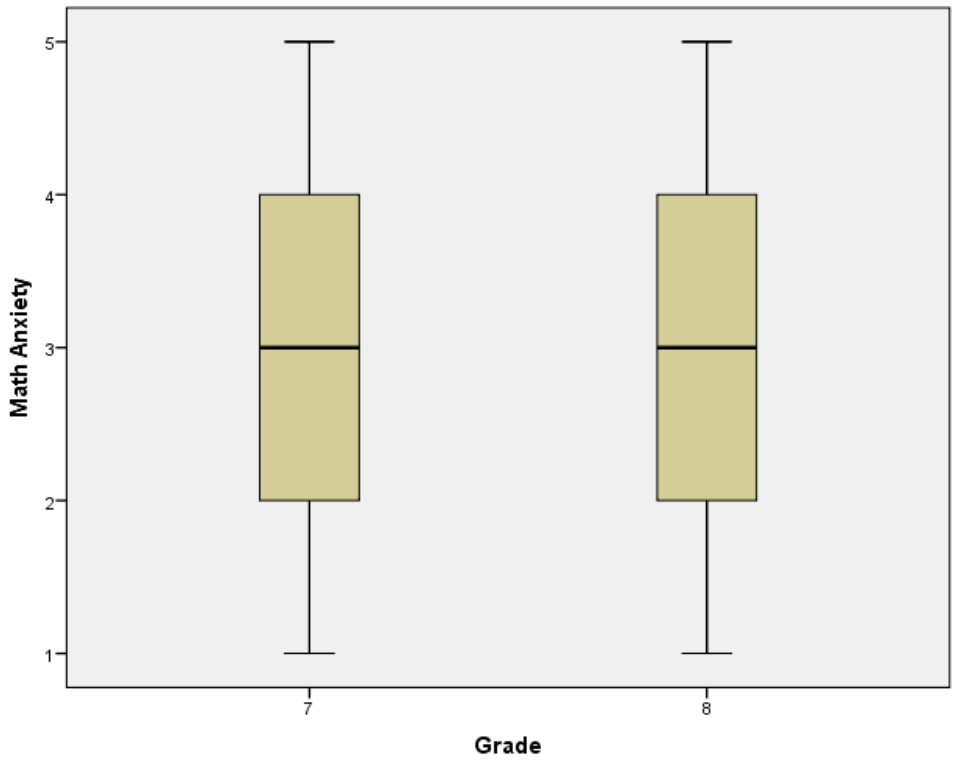


Table 6

Independent Samples t-Test

Mathematics Anxiety		t	df	Sig (2-tailed)
	Equal Variances Assumed	0.530	85	0.598

The mean mathematics anxiety level for the 7th graders to answer was 3.26. The mean mathematicsanxiety for the 8th graders was 3.12. Graph 9 shows that the mathematics anxiety levels were identical for the 7th and 8th grade students. The 7th and 8th grade students had similar

levels of anxiety towards mathematics. Since the p-value in the independent samples test was 0.530, which is greater than 0.05, we reject the null hypothisis (Table 6). In other words, there is no statistical significant difference in mathematics anxiety between 7th and 8th grade students.

Anxiety Towards Science

$H_0: \bar{X}_7 = \bar{X}_8$

$H_1: \bar{X}_7 \neq \bar{X}_8$

Anxiety level towards science for the 7th grade students is the same as that of the 8th grade students.

Anxiety level towards science for the 7th grade students is not the same as that of the 8th grade students.

Table 7

Anxiety Towards Science

	Grade	N	Mean	Std. Deviation
Science Anxiety	7	45	3.04	1.205
	8	42	2.40	1.398

Graph 10
Science Anxiety in 7th and 8th Grade Students

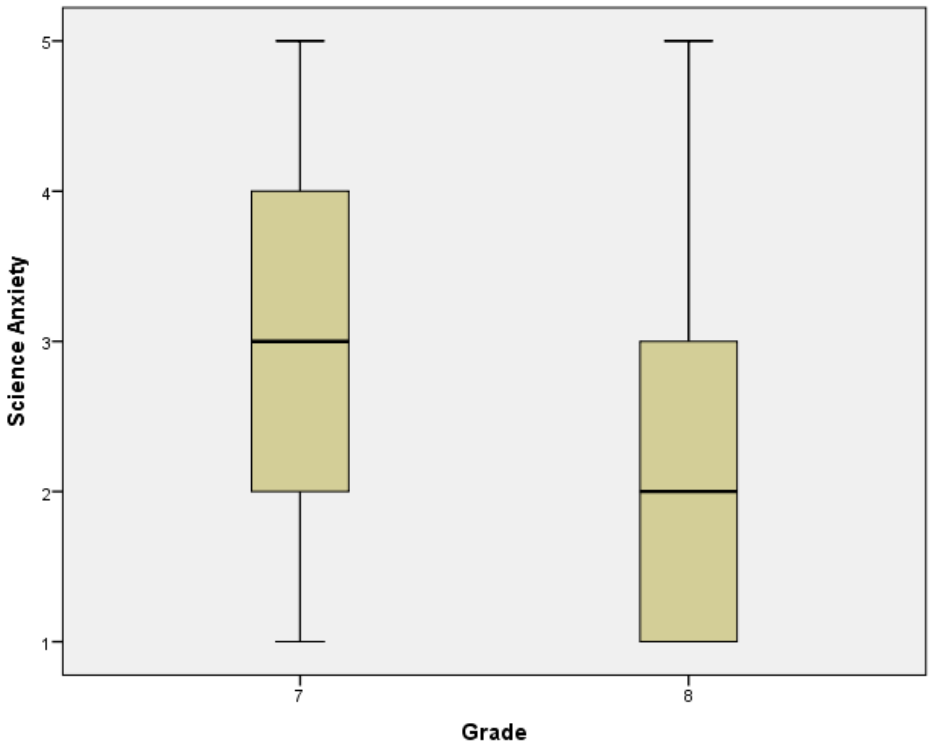


Table 8 Independent Samples t-Test				
Science Anxiety		t	df	Sig (2-tailed)
	Equal Variances Assumed	2.290	85	0.024

The mean science anxiety level for the 7th graders was 3.04. The mean science anxiety level for the 8th graders was 2.40. The 7th graders had more anxiety towards science than the 8th graders. However, the spread of the box plots in graph 10 for the 7th and 8th grade students for science anxiety were the same, but the 8th grade box plot showed that 50% had lower levels of

anxiety towards science. Since the p-value in the independent samples test was 0.024, which is *less* than 0.05, we *fail* to reject the null hypothisis (Table 8). In other words, there *is* a significant difference in science anxiety between 7th and 8th graders. The 7th graders had more science anxiety than the 8th graders.

Mathematics and Science Anxiety Levels of Female Students

Anxiety Towards Mathematics

$H_0: \bar{X}_{7F} = \bar{X}_{8F}$

$H_1: \bar{X}_{7F} \neq \bar{X}_{8F}$

Anxiety level towards mathematicsfor the 7th grade female students is the same as that of the 8th grade female students.

Anxiety level towards mathematicsfor the 7th grade female students is not the same as that of the 8th grade female students.

Table 9

Anxiety Towards Mathematics: Female Students

	Grade	N	Mean	Std. Deviation
Mathematics Anxiety	7	23	3.46	1.076
	8	22	3.32	1.086

Graph 11
Mathematics Anxiety of 7th and 8th Grade Females

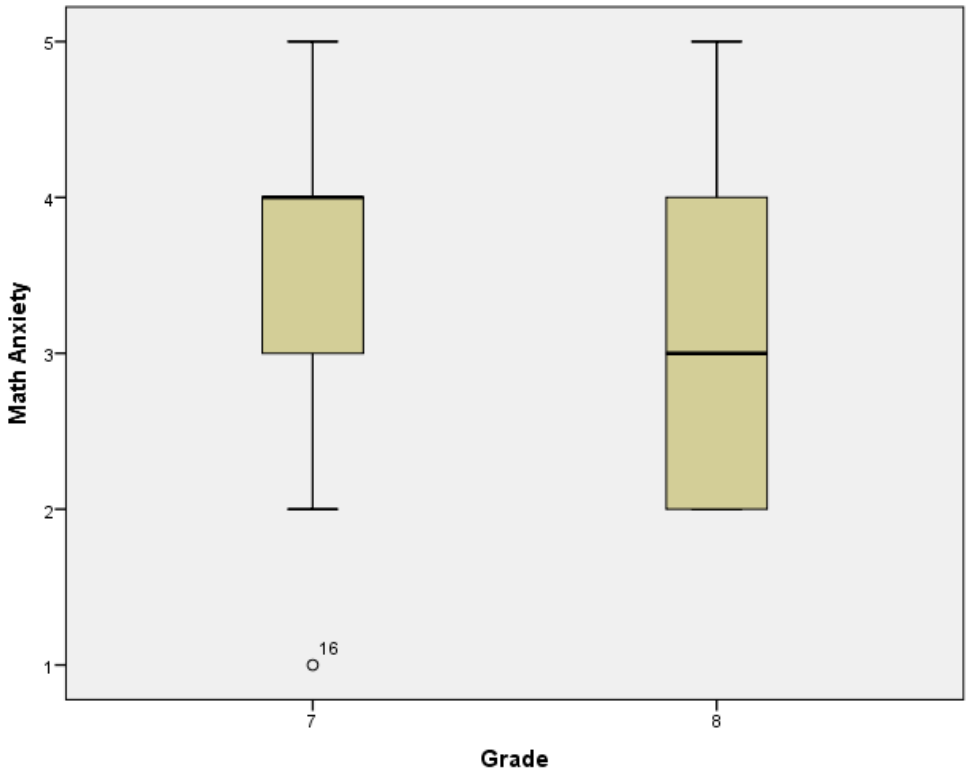


Table 10 Independent Samples t-Test				
Mathematics Anxiety: Female Students		t	df	Sig (2-tailed)
	Equal Variances Assumed	0.429	85	0.670

The mean mathematics anxiety level for the female 7th graders was 3.46. The mean mathematics anxiety level for the female 8th graders that was 3.32. The female 7th graders had more anxiety towards mathematics than the female 8th graders, though the spreads of the level of

mathematics anxiety in the box plots in graph 11 were similar between the two grades. However, since the p-value in the independent samples test was 0.670, which is greater than 0.05, we reject the null hypothisis (Table 10). In other words, there is no statistical significant difference in mathematics anxiety between the female 7th and 8th graders.

Anxiety Towards Science

$H_0: \bar{X}_{7F} = \bar{X}_{8F}$

$H_1: \bar{X}_{7F} \neq \bar{X}_{8F}$

Anxiety level towards science for the 7th grade female students is the same as that of the 8th grade female students.

Anxiety level towards science for the 7th grade female students is not he same as that of the 8th grade female students.

Table 11

Anxiety Towards Science: Female Students

	Grade	N	Mean	Std. Deviation
Science Anxiety	7	23	2.91	1.276
	8	22	2.18	1.332

Box Plot 6
Science Anxiety of 7th and 8th Grade Female Students

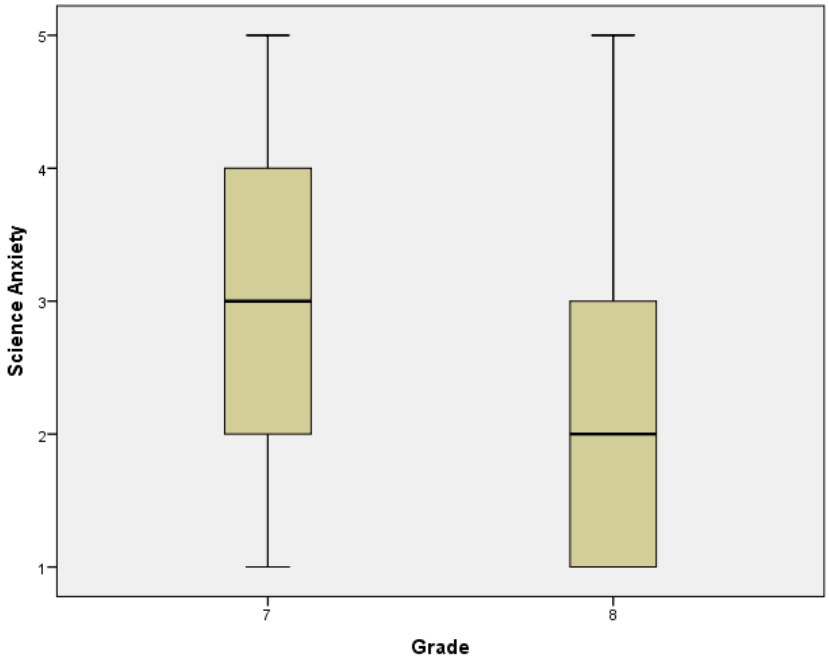


Table 12 Independent Samples t-Test				
Science Anxiety: Female Students		t	df	Sig (2-tailed)
	Equal Variances Assumed	1.881	85	0.067

The mean science anxiety level for the female 7th graders was 2.91. The mean science anxiety level for the female 8th graders was 2.18. The female 7th graders had more anxiety towards science than the female 8th graders. However, since the p-value in the independent samples test was 0.067, which is greater than 0.05, we reject the null hypothisis (Table 12). In other words, there no statistical significant difference in science anxiety between the female 7th and 8th graders.

Mathematics and Science Anxiety Levels of Male Students

Anxiety Towards Mathematics

$H_0: \bar{X}_{7M} = \bar{X}_{8M}$

$H_1: \bar{X}_{7M} \neq \bar{X}_{8M}$

Anxiety level towards mathematics for the 7th grade male students is the same as that of the 8th grade male students.

Anxiety level towards mathematics for the 7th grade male students is not the same as that of the 8th grade male students.

Table 13

Anxiety Towards Mathematics: Male Students

	Grade	N	Mean	Std. Deviation
Mathematics Anxiety	7	22	3.05	1.253
	8	20	2.90	1.373

Graph 13
Mathematics Anxiety of 7th and 8th Grade Males

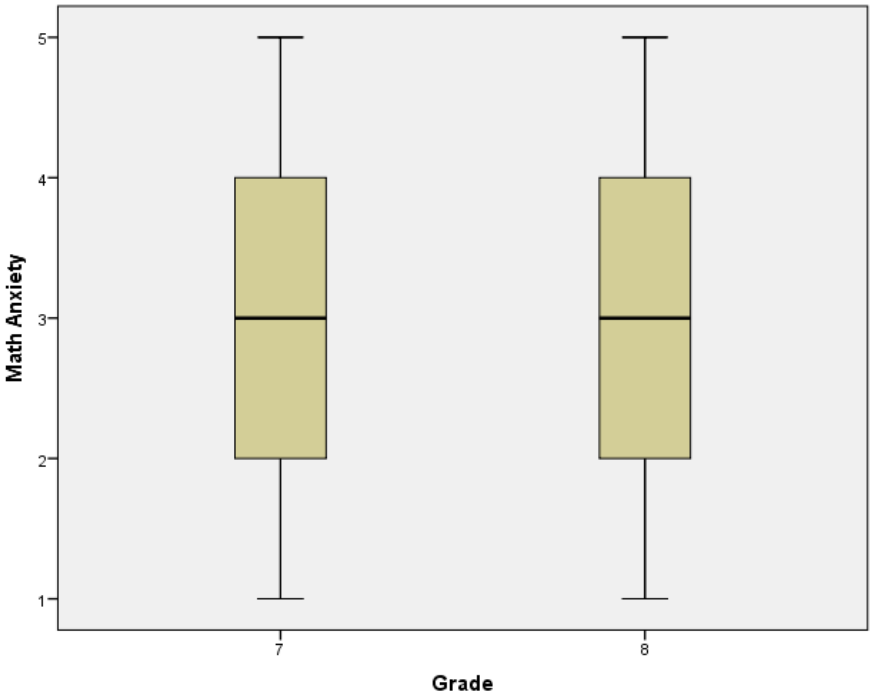


Table 14 Independent Samples t-Test				
Mathematics Anxiety: Male Students		t	df	Sig (2-tailed)
	Equal Variances Assumed	0.359	85	0.721

The mean mathematics anxiety level for the male 7th graders to was 3.05. The mean mathematics anxiety level for the male 8th graders was 2.90. Graph 13 shows that the box plots of the 7th and 8th grade male students were identical. The male 7th graders had about as much anxiety towards mathematics as the male 8th graders. However, since the p-value in the

independent samples test was 0.721, which is greater than 0.05, we reject the null hypothisis (Table 14). In other words, there is no statistical significant difference in mathematics anxiety between the male 7th and 8th graders.

Anxiety Towards Science

$H_0: \bar{X}_{7M} = \bar{X}_{8M}$

$H_1: \bar{X}_{7M} \neq \bar{X}_{8M}$

Anxiety level towards science for the 7th grade male students is the same as that of the 8th grade male students.

Anxiety level towards science for the 7th grade male students is not he same as that of the 8th grade male students.

Table 15

Anxiety Towards Science: Male Students

	Grade	N	Mean	Std. Deviation
Science Anxiety	7	22	3.18	1.140
	8	19	2.74	1.447

Graph 14
Science Anxiety in 7th and 8th Grade Males

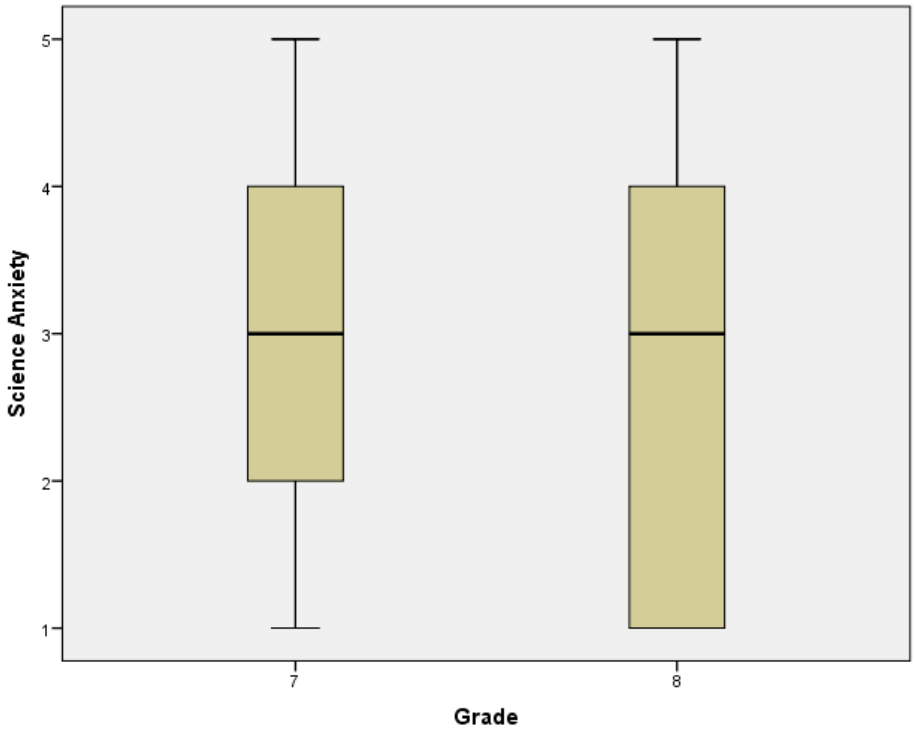


Table 15

Independent Samples t-Test

Science Anxiety: Male Students		t	df	Sig (2-tailed)
	Equal Variances Assumed	1.101	39	0.278

The mean science anxiety level for the male 7th graders to was 3.18. The mean science anxiety level for the male 8th graders was 2.74. The box plots in graph 14 show that the 8th graders had a larger spread than that of the 7th graders, but the medians in the box plots for the male 7th and 8th graders were both the same.However, since the p-value in the independent samples test was 0.278, which is greater than 0.05, we reject the null hypothisis (Table 15). In

other words, there is no statistical significant difference between science anxiety between the male 7th and 8th graders.

Regression Analyses

Table 16

Regression: Mathematics Anxiety vs. Mathematics Career

	r	F	p
Mathematics Anxiety of Both Males and Females vs. the Likelihood of Pursuing a Career Involving Mathematics	0.234	4.924	0.029

Since the p value of 0.029 is less than 0.05, there *is* a statistical significant difference in the relationship between mathematics anxiety and the likelihood of pursuing a career involving mathematics (Table 16). The positive r value of 0.234 indicates that as anxiety increases, the likelihood of pursuing a career involving mathematics increases. However, since the correlation coefficent (r) is very small and is close to 0, the relationship is weak.

Table 17 Regression: Science Anxiety vs. Science Career			
	r	F	p
Science Anxiety of Both Males and Females vs. the Likelihood of Pursuing a Career Involving Science	0.266	6.403	0.013

Since the p value of 0.013 is less than 0.05, there *is* a statistical significant difference in the relationship between science anxiety and the likelihood of pursuing a career involving science (Table 17). The positive r value of 0.266 indicates that as anxiety increases, the likelihood of persuing a career involving mathematics increases. However, since the correlation coefficent (r) is very small and close to 0, the relationship is weak.

Do STEM Jobs Contain More Males or More Females or an Equal Number of Males and Females?

Do STEM Jobs Contain More Males?

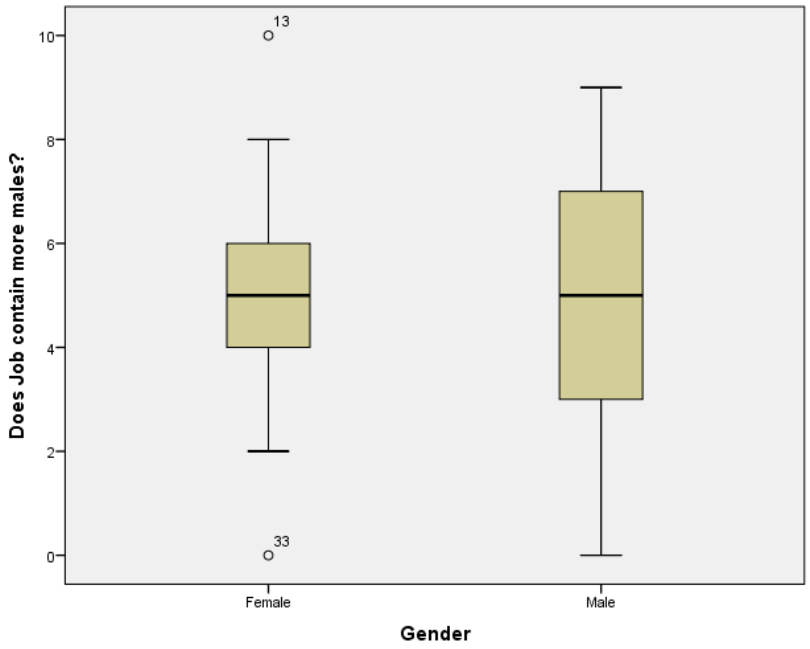
Table 18 below shows the mean differences between females and males in their opinions as to whether or not STEM jobs have more males.

Table 18 Do Stem Jobs Contain More Males?			
	N	Mean	Std. Deviation
Females	45	4.84	1.906
Males	44	4.95	2.382

The mean represents the average number of STEM jobs that the students believed had more males within its population. The female and male students had similar means. In other words, on average, both the female and male students believed that about 5 out of 12 STEM jobs contained more males (Table 18).

Graph 15 below is a representation of the medians and spreads of the number of STEM jobs that contained more males. The medians (Median = 5) are the same for the female and male students. The spread for the males was larger than that of the females. In other words, there was more consistancy in the females' opinions about whether the job contains more males.

Graph 15
Does The Job Contain More Males?



Do STEM Jobs Contain More Females?

Table 19 below shows the mean differences between females and males in their opinions as to whether or not STEM jobs have more females.

Table 19

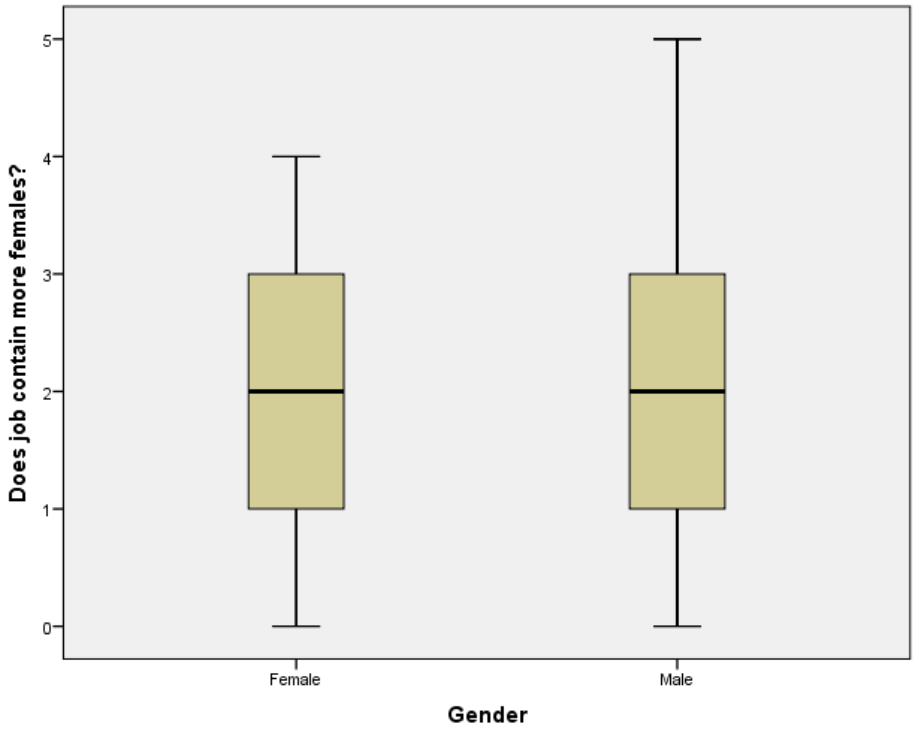
Do STEM Jobs Contain More Females?

	N	Mean	Std. Deviation
Females	45	2.00	1.279
Males	44	2.00	1.431

The mean represents the average number of STEM jobs that the students believed had more females within its population. The female and male students had the same means. In other words, on average, both the female and male students believed that about 2 out of 12 STEM jobs contained more females (Table 19).

Graph 16 below is a representation of the medians and spreads of the number of STEM jobs that contained more females. The medians (Median = 2) are the same for the female and male students. The spread for the males was larger than that of the females. In other words, there was more consistancy in the females' opinions about whether the job contains more females.

Graph 16
Does The Job Contain More Females?



I then explored only the females' opinions in 7th and 8th grades to determine if there was a difference in their thoughts about whether or not a STEM job contains more females. Table 20 below shows the results of the independent samples t-Test.

$H_0: \bar{X}_{7F} = \bar{X}_{8F}$

$H_1: \bar{X}_{7F} \neq \bar{X}_{8F}$

7th grade female opinions about whether a STEM job contains more females is the same as that of the 8th grade female students.

7th grade female opinions about whether a STEM job contains more females is not the same as that of the 8th grade female students.

Table 20

Independent Samples t-Test

Does the job contain more females?		t	df	Sig (2-tailed)
	Equal Variances Assumed	0.00	43	1.00

Since the p-value in the independent samples test was 1.00, which is greater than 0.05, we reject the null hypothisis (Table 20). In other words, there is no statistical significant difference between 7th and 8th grade female students' opinions about whether a STEM job contains more females.

Next, I explored the males' opinions in 7th and 8th grade to determine if there was a difference in their thoughts about whether or not a job contains more females. The table below shows the results of the independent samples t-Test.

$H_0: \bar{X}_{7M} = \bar{X}_{8M}$

$H_1: \bar{X}_{7M} \neq \bar{X}_{8M}$

7th grade male opinions about whether a STEM job contains more females is the same as that of the 8th grade male students.

7th grade male opinions about whether a STEM job contains more females is not the same as that of the 8th grade male students.

Table 21

Independent Samples t-Test

Does the job contain more females?		t	df	Sig (2-tailed)
	Equal Variances Assumed	-1.055	42	0.297

Since the p-value in the independent samples test was 0.297, which is greater than 0.05, we reject the null hypothisis (Table 21). In other words, there is no statistical significant difference between 7th and 8th grade male students' opinions about whether a STEM job contains more females.

Finally, I explored the females' and males' opinions to determine if there was a difference in their thoughts about whether or not a STEM job contains more females. The table below shows the results of the independent samples t-Test.

$H_0: \bar{X}_F = \bar{X}_M$

$H_1: \bar{X}_F \neq \bar{X}_M$

The female students' opinions about whether a STEM job contains more females is the same as that of the male students' opintions.

The female students' opinions about whether a STEM job contains more females is not the same as that of the male students' opinions.

Table 22

Independent Samples t-Test

Does the job contain more females?		t	df	Sig (2-tailed)
	Equal Variances Assumed	0.000	87	1.00

Since the p-value in the independent samples test was 1.00, which is greater than 0.05, we reject the null hypothisis (Table 22). In other words, there is no statistical significant difference between female and male students' opinions about whether a STEM job contains more females.

Do STEM Jobs Contain An Equal Number of Females and Males?

Table 23 below shows the differences between females and males in their opinions as to whether or not STEM jobs have an equal number of females and males within its population.

Table 23

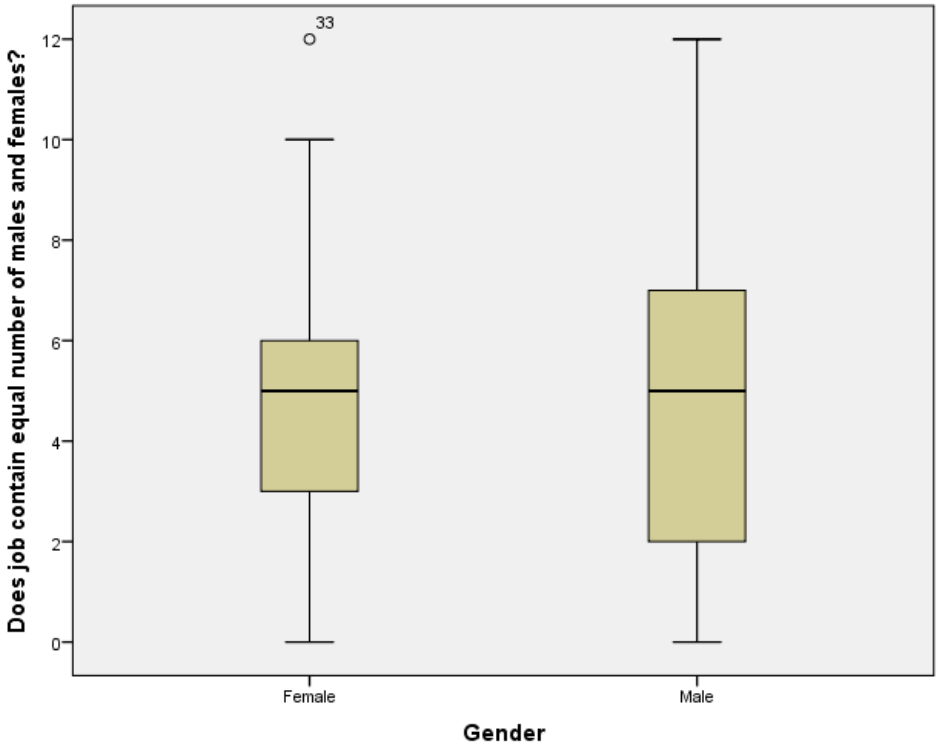
Do STEM Jobs Contain An Equal Number of Females and Males?

	N	Mean	Std. Deviation
Females	45	4.98	2.500
Males	44	4.80	3.115

The mean represents the average number of STEM jobs that the students believed had an equal number of females and males within its population. The female and male students had similar means. In other words, on average, both the female and male students believed that about 5 out of 12 STEM jobs contained an equal number of females as males (Table 23).

Graph 17 below is a representation of the medians and spreads of the number of STEM jobs that contained an equal number of females and males within its population. The medians (Median = 5) are the same for the female and male students. The spread for the males was larger than that of the females. In other words, there was more consistancy in the females' opinions about whether the job contains an equal number of males and females.

Graph 17
Does The Job Contain an Equal Number of Females and Males?



Disscussion

It was interesting that the percentage of dislike of science was greater than that of mathematics among the 7th and 8th grade females, and that the percentage was considerably high according to Graph 1. About a third of the females said they did not like science. I thought that this was an extremely high value. Even though the portions of the females who said they did not like mathematics or science are not the majority of the 7th and 8th grade females, that does not mean that these numbers could not be lowered. Compared to the females' scores, the males liked mathematics and science more than the females according to Graph 2. Looking at Graphs 3 and 4, I thought that it was interesting that the mean scores showed that the students seemed to be unsure about whether or not they would pursue a career involving mathematics or science. Considering that a score of 1 meant not very likely and a score of 5 meant very likely, I

considered a 3 to be a maybe. The males had a slightly higher mean when asked whether or not they would pursue a mathematics career compared to the females, 3.57 to 3.22 respectively, which could have been contributed to the anxiety levels of the genders, 3.40 and 2.98, respectively, for the female and male students (Graphs 3, 4, 5 and 6). Because the males had less anxiety in mathematics, it seemed that they were more interested in pursuing a career involving mathematics. I also thought that it was interesting that the males had a higher interest in pursuing a mathematics career than a career involving science due to the fact that they had such a high interest in science and had lower levels of anxiety in science, but the males were just as unsure as the females whether or not to pursue a science career. Looking at this data it seemed that the females as well as the males need more encouragement in science to be more likely to pursue a career involving science. The students also need encouragement in mathematics and help in lowering their levels of anxiety towards mathematics to help boost interest in the subject and perhaps the likelihood of pursuing a mathematics career.

Looking at Graphs 5 and 6, the females seemed to have higher levels of anxiety compared to the males. There was not a significant difference in the levels of anxiety between the females and males (Table 2). There was also no significant difference in anxiety levels between the female and male students since their means for anxiety were similar according to Graphs 5 and 6. This means that the students are equally anxious about mathematics and science. The means for mathematics and science anxiety for the females and males were approximatly 3, which, in my opinion, could still be lowered to a smaller number.

There was no significant difference in mathematics anxiety between 7^{th} and 8^{th} grade students, but there was a significant difference in science anxiety between the 7^{th} and 8^{th} grade

students (Tables 6 and 8). The 7th graders had a much higher mean for anxiety than the 8th graders, 3.04 to 2.40 respectively. For future research I would like to investigate why the 8th graders had lower levels of anxiety towards science than the 7th graders. Do the 8th graders have a teacher who explains the topic well and engages the students? Do the 8th graders enjoy the topics in science that they are learning more than the topics that the 7th graders are learning? Do the 8th graders understand the science topics that they have learned better than the 7th graders? These are all factors that I could investigate to discover why the 7th graders had more anxiety towards science than the 8th graders.

There was also no significant difference between the female 7th and 8th graders' levels of anxiety towards mathematics or science (Tables 6 and 8). Similarly, there was no significant difference in the male 7th and 8th graders' levels of anxiety towards mathematics and science (Tables 9 and 10). My research contradicted my original belief that the 8th grade females would have a higher level of anxiety towards the subjects than the 7th graders. Instead, my research showed that females can become more anxious towards mathematics as as they continue through school, which is why they have a tendancy to "drop out of the mathematics pipeline" (Ganley & Vasilyeva, 2014). In my study however, this was not the case. Though I cannot compare the 7th and 8th graders anxiety towards mathematics because my reasearch does not show how a single students' attitudes changed from 7th to 8th grade. If I were to distribute my survey again, I would ask the following additional questions: "Has your level of anxiety towards mathematics increased or decreased since last year?" and "Has your level of anxiety towards science increased or decreased since last year?" I could then compare the answers of the female and male students to see how their levels of anxiety have changed over time. I could narrow down my focus to just

the females to see if their anxiety levels towards the topics shifted, and if anxiety really does increase as my research suggests.

I did find, however, a significant difference between mathematics anxiety and the likelihood of pursuing a career involving mathematics between the females and males, as well as a significant difference between science anxiety and likelihood of pursuing a career involving science between females and males (Tables 16 and 17). The corelation coefficents were both positive and significant meaning that as anxiety increased about the subjects, the more likely a student was to pursue a career involving that subject. This seems odd because one would think students would avoid pursuing a career in a topic that made them anxious. The only reason that I could think that would make the students pursue a career that made them anxious was because as their awareness of job qualifications increases, awareness that many jobs require basic if not extensive training in the subjects of mathematics or science increases. With this knowledge, students may be considering pursuing a career in which they know they will need training in mathematics or science even though they are anxious about those subjects.

I also found that, on average, both the female and male students thought that 5 out of 12 STEM jobs contained more males, 2 out of 12 STEM jobs contained more females, and 5 out of 12 STEM jobs contained an equal number of males as females (Tables 18, 19, and 23). The fact that, on average, the students believed that 2 out of the 12 STEM jobs contained more females and that 5 out of 12 STEM jobs, which is less than half, contained an equal number of females and males within it's population is of concern. This clearly indicates that the students have pre-existing steryotypes about whether or not a STEM career belongs to a female or a male. Having pre-existing notions about STEM fields could deter the female students from entering a STEM

field knowing that the population is male dominated. After seeing these statistics, I will need to encourage my students, especially my female students, to break gender steryotypes and to pursue their dreams.

I did not find a significant difference between 7th and 8th grade female students' opinions about whether a STEM job contains more females, a significant difference between 7th and 8th grade male students' opinions about whether a STEM job contains more females, or a significant difference between the female and male students' opinions about whether a STEM job contains more females. This was an interesting finding. Unfortunately, I do not have enough information to determine if the students' opinions changed over the course of one year. I would have liked to have seen if the female and male students' opinions changed between the 7th and 8th grades. I also would have liked to investigate why the female and male students' opinions were different and what different factors contributed to the difference in the 7th and 8th graders' opinions about whether a STEM job contained more females. I would also have liked to investigate why the female and male students' opinions about whether a job contains more females was different. For future research, I could hand out the survey again to the same students in one year to see how their opinions changed and if there was a significant difference between 7th and 8th grades or between the female and male students. I would also like to investegate the factors that contributed to why their opinions changed.

What can teachers do to encourage students to break gender steryotypes and pursue STEM careers?

It is important for teachers to know what they can do to encourage both female and male students to pursue a career involving mathematics or science and to help break the sterotypes

about females in mathematics and science fields. This is especially true for young females since there is a shortage of women in STEM fields. The article, "Encouraging Girls in Mathematics and Science" was written by a panel of researchers who wished to target teachers and other personnel who work with students to provide them with different evidence-based practices that could be used to increase student interest in mathematics and science, and encourage young female students to pursue STEM careers (Halpern, Aronson, et al., 2007). The five evidence-based practices that the researchers recommended included teaching students that academic abilities are expandable and improvable, provide prescriptive and informational feedback, expose girls to female role models who have succeeded in mathematics and science, create a classroom environment that sparks initial curiosity and fosters long-term interest in mathematics and science, and provide spatial skills training. Reinforcing the fact that intelligence is not a "fixed trait" will help students see the worth in learning and help them work harder to improve what they know. Students need to be encouraged to do their best and build upon what they know. Providing accurate feedback, specific to the student, is also essential. Teachers can give inaccurate information on how a student is doing in their classroom based on their own misconceptions about gender equality (Ganley & Vasilyeva, 2014). By focusing on the students' strengths and what they need to work on in order to succeed, a teacher can provide informational feedback on exactly how the students need to improve. This, in turn, can promote learning and curiosity.

Media has done a poor job in providing female role models that encourage young females to pursue STEM careers (Kitzinger, Haran, Chimba, et al., 2013 and Marsden, Lord, & Miller, 2009). Therefore, it is a teacher's duty to provide information about role models that students can aspire to be. Also, providing engaging lessons in the areas of mathematics and science can

increase a student's curiosity about the subjects and help instill positive attitudes towards the subjects. Because mathematics and science are very focused on mental manipulation of objects and figures, Kitzinger, et al. also suggest providing spatial training to students so that they can better understand relationships between objects and figures. An additional recommendation that teachers can do to promote females to like math, science, and other STEM fields, as well as provide female role models to the female students is to celebrate Ida Lovelace Day (Conway Hall Ethical Society, 2015). Ida Lovelace was the first computer programmer. The second Tuesday of every October is dedicated in her name to recognize women making a difference in STEM fields and to support and encourage the women in STEM fields. With this knowledge a teacher could successfully encourage his or her female students to do well and like mathematics and science.

Conclusion

STEM fields are male dominated due to the lack of women entering the fields. Young women develop their attitudes towards mathematics and science through schooling, which can be affected by their anxiety towards mathematics and science. Stereotypes of career fields that belong to women also develop at this time. Through the survey that I conducted and the analysis of the data, I found that attitudes towards mathematics and science vary between genders and that stereotypes already exist among the students. These attitudes and stereotypes could definitely affect the female students and their opinions about whether or not they should pursue a career involving mathematics or science. The survey showed that the female students are not yet decided about whether or not they would pursue a career involving mathematics or science. Therefore, their opinions could be changed through evidence-based practices that can encourage

them to do better in mathematics and science. This could increase their likelihood of pursuing a career in those subjects. It should be the goal of the teachers to break gender stereotypes and encourage girls to do well in mathematics and science and promote STEM careers.

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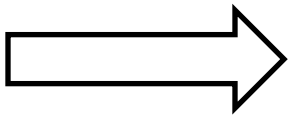
Appendix

Please circle your gender: Male  Female 

Please provide your grade level: _____

Please check if you feel a certain job contains more males, more females, or an equal amount of males and females.

	Males	**Females**	**Equal Amount**
Surgeon			
Cashier			
Dentist			
Dental Hygienist			
Janitor			
Pilot			
Secretary			
Chef			
Nurse			
Psychologist			
Construction Worker			
Engineer			
Plumber			
Computer Specialist			
Librarian			
Architect			
Hair Stylists			
Mathematics Teacher			
Police Officer			
Social Studies Teacher			
Science Teacher			
School Principal			
Author			
Mechanic			



Do you like math? Yes No

Do you like science? Yes No

Circle one number between 1 and 5 for each of the following questions. 1 means not very likely and 5 means very likely.

How likely do you think you will pursue a career involving math?

1 2 3 4 5

How likely do you think you will pursue a career involving science?

1 2 3 4 5

For the next two questions, 1 means very little and 5 means very much.

How much anxiety do you have about math?

1 2 3 4 5

How much anxiety do you have about science?

1 2 3 4 5