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Pre-Service Teachers' Attitudes About Gender, Education, and Mathematical Aptitude: A Quantitative Study

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ABSTRACT

Females and mathematics are often not grouped together due to the gender bias surrounding the two. Perhaps attending an all-girls high school has instilled a higher level of confidence in my own mathematical abilities than many women exhibit. The focus of my research is to examine preservice elementary teachers for their confidence levels in mathematics, as well as whether they hold a form of unconscious gender bias. I completed this research by developing a six-question survey instrument. The survey was administered in the spring and fall of 2023 to Math 245 and Math 246 classes, both of which are required math courses for elementary education students. These classes cover methods for teaching elementary level mathematics. Because education is a major populated predominantly by females, the highest percentage of participants in the survey identified as a woman. The survey results indicated a higher level of math confidence than predicted, which provided hope that not all females are being pushed out of math. While these participants had a higher confidence level, they still held a level of gender bias. When picking a working partner for a graded problem, the majority of participants chose partners based upon math confidence scores. However, when the problem is ungraded, the highest chosen characteristic in a working partner is gender. This research has helped to highlight the importance of both mathematical confidence and gender when selecting a working partner in math class. It has also indicated that gender bias is present in many differing forms, which is a key point in understanding how to combat it in the classroom.

Introduction

From the start, I knew I wanted my capstone project to be focused on the realm of mathematics and gender. Both topics have fascinated me throughout both my high school and collegiate years. Because of my experiences, I feel privileged to have received encouragement from previous teachers in regards to my math ability. However, not every woman is as lucky to have a constant support system promoting confidence in science, technology, engineering, and math (STEM) related fields. This lack of confidence is a main focus of my research and study. Throughout this research, I hope to gain an understanding of how gender plays a role in math confidence levels.

Attending an all-girls private high school was perhaps the most pivotal part of my education. It was there that I learned it is perfectly normal to make mistakes, and, hopefully, we can learn from our mistakes and grow as human beings. Being in an environment of all women allowed for true growth from these errors instead of potential embarrassment that may come from having males in the classroom. My teachers encouraged every student to work their hardest in all aspects of their education, not just in one field. This created a culture where females felt comfortable pursuing their interests in STEM-related fields, and we were supported instead of discouraged. Without this positive reinforcement, I can confidently say I would not have the courage to be a secondary math education major. My high school teachers instilled a level of confidence in me that I am equally as worthy and knowledgeable as my male classmates. Had I attended a coeducational school, I cannot say I would have chosen the same degree path.

Many females begin to be pushed out of STEM-related fields in their secondary education. Up until that point, they may have been encouraged to try their best in these courses. However, once they entered middle school, that encouragement may have begun to decrease. There are two factors that play a role in women's decreased interest and participation in STEM-related fields. First, many teachers, even females, have an unconscious bias that favors male students. Since this is unconscious, many teachers will not recognize they are encouraging boys more, as well as giving them more opportunities. The second factor is negative peer response. Many students still believe males should excel in math and science courses, and females should outperform in literature and history classes. With this belief, many women receive pushback from peers if their academic choices are in STEM subjects, which instills discouragement instead of confidence level for STEM subjects. While these are not the only factors that can cause a decreased confidence level in mathematics for female students, I believe they are two of the most prominent and disruptive causes.

When I begin my teaching endeavors, I will be teaching in a coeducational classroom. Instead of condoning the traditional approach of separating males and female students into separate fields of study, I will fight for equal opportunities for both genders. Thus, it is one of my highest priorities to boost the math confidence levels of all of my students, especially the females. I want to be an advocate for those students who believe they cannot pursue a career in a STEM field because it is a traditionally male-dominated field.

The classroom environment I intend to foster will be conducive to learning and growing from mistakes rather than being embarrassed by them. By emphasizing the importance of mistakes, I believe students will begin to feel more comfortable in the classroom and about math in general. Building a safe environment is the first step to boosting confidence. Once the environment is safe, then students should be more willing to learn and grow their skills. An inclusive and welcoming classroom is vital to the success of students on their learning journeys. This inclusivity encompasses the use of encouragement instead of discouragement. In my future classroom, my hope is that no student will be discouraged during their learning process. Discouragement can cause a negative impact on their confidence levels and lead to a dislike of the subject. To further build up courage and competence, students should receive encouragement throughout their learning. By incorporating a safe, welcoming environment and minimizing

the use of discouragement, students' math confidence levels should prosper.

I plan on using this research to better inform my teaching methods as well as those of my peers. I want to be able to take the results and learn how to better serve my students. I hope the results will act as a guide when creating more effective lessons and intentional interactions to boost confidence levels among learners. Information gathered will help to decipher whether coed groups or same-gender groups are more beneficial to students when completing group work. The research also serves as a reminder to survey students about their likes and dislikes. If a female student is not comfortable working with male students and will not be as successful in that setting, it is imperative to place them with another female. Without asking students about their comfort levels, we, as educators, are not promoting the safest environment for them. Thus, I hope to discover how confidence levels in math can affect a student's choice of partners when relating to group work.

To gather information about gender and confidence levels relating to mathematics, I developed an instrument to survey college students. The focus of the research is to identify whether preservice elementary teachers hold a form of gender bias, specifically in mathematics. If a teacher holds an unconscious bias, then it is likely the students in the class will be affected. Teachers with gender bias often tend to favor the male students and sometimes do not give equal attention to the female students. The data gathered will indicate whether there is any form of gender bias present among preservice teachers relating to mathematics. The survey was administered to all of the Spring 2023 and Fall 2023 courses of Math 245 and 246,each of which is a required course for all elementary education majors. The focus of Math 245 is to introduce students to sets, the real number system, and its subsystems. The students learn methods of how to teach these topics to their future students. Math 246 covers the best teaching methods for introducing geometry and mastering measuring and the metric system. The students also spend time reviewing the best teaching practices for probability and statistics.

The survey presents a series of six multiple choice questions. The first question asks participants to identify their gender. The students are given six different options: Woman; Man; Transgender Woman; Transgender Man; Nonbinary; Prefer not to respond. The next question gives a baseline of what the students believe their math confidence level is. They have the option to choose a level from zero to five, with zero indicating no confidence and five indicating extremely confident. The third question asks students what type of high school they attended; the only two answer choices are public or private.

The fourth question states: "You are in a room with a group of peers you do not know. If you are asked to solve a math problem that *will be graded* and you can select a working partner from the people in the room, which gender are you most likely to select for your partner?" The students are given the same answer choices as the first question: Woman; Man; Transgender Woman; Transgender Man; Nonbinary; Prefer not to respond.

In the fifth question participants are given the same prompt as before, but with slightly different wording: "You are in a room with a group of peers you do not know. You are asked to solve a math problem that *will be graded* and you can select a working partner from the people in the room. If you know their math confidence score, which characteristic will most impact your decision when selecting a partner?" There are five answer choices for this question: Gender; Sexual Orientation; Math Confidence Score; Public vs. Private School Attendance; Other.

The final question is almost the same as the fifth question. However, the math problem is no longer being graded. The question states: "You are in a room with a group of peers you do not know. You are asked to solve a math problem that *will not be graded*. You can select a working partner from the people in the room to help you solve the problem. If you know their math confidence score, which characteristic will most impact your decision when selecting your partner?" The answer choices for this question are: Gender; Sexual Orientation; Math Confidence Score; Public vs. Private School Attendance; Other.

For each of the survey questions, I have developed predictions of potential results. For

the first question, I predicted that the majority of survey takers will be female, with the other categories making up the minority. The hope for the second question was to receive a data representation similar to a traditional bell curve. With this hypothesis, I predicted that about 25% of survey takers will have a confidence level between 0 and 1. I anticipated around 55% will have a level of either a 2 or a 3. Finally, I predicted close to 20% of students will feel extremely confident with a 4 or a 5. While private schooling is becoming more popular, I still believed the public schools would be more dominant among survey respondents. Thus, I predicted only 30% of students will have attended a private school, and the majority of students will have attended a public high school.

The fourth question asks students to pick the gender of their preferred classroom working partner. I anticipated a majority choosing a man, with woman being the second picked category. For the fifth question, I foresaw the math confidence score being the top answer. Because of this prediction, I thought gender would be the second most dominant answer with the math confidence score receiving a majority of the selections.

For the final question, I anticipated a swift change from the results of the fifth question. I believed there would be a switch from math confidence being the most important to gender. Thus, I predicted around half of the survey population would choose gender as the most important, and math confidence score would then move to second highest chosen.

Through attending an all-girls high school, I was constantly supported and challenged to further my knowledge in mathematics. However, this is often not the case for many female students. By the time they reach high school, they have often already been discouraged and pushed away from pursuing a degree in mathematics. My hope as a teacher is to provide a positive learning environment for all of my students. This research will help guide me to develop practices that allow students to feel comfortable and also supported in their learning processes. Every student should have the opportunity to pursue a degree in a STEM field, not just males. The purpose of this research is not only to get an accurate baseline of data from students, but also to guide future research questions. I hope to develop more effective teaching methods to promote the confidence levels of my students, as well as take steps to decrease gender bias in mathematics. This study will serve as a reminder to all preservice teachers to be aware of their unconscious bias and how it can impact a student's future opportunities.

Literature Review

Confidence Levels in Mathematics

A key part in my research is preservice teachers' confidence levels in mathematics. However, before they were elementary education majors, they once were middle and high schoolers. At a young age, students begin to develop confidence in school subjects. Some students may excel more in a language arts class than the students who do well in a math course. This plays a vital role in the development of confidence. These levels can change over time depending on many factors, including environment, teacher, and school. Thus, the purpose of this literature review is to investigate the effects of confidence levels in mathematics on K-12 students. The findings from these studies will help to inform the research and interpret the results.

Before delving into the research and results from these various studies, the definition of self confidence, specifically relating to math, must be explored. First, it is important to understand that confidence can be measured and conceptualized in various ways for research (Sheldrake et al., 2022). Self-confidence is an individual's belief that an outcome will occur as expected. The confidence is developed through past and current experiences and events (Schuh et al., 2023). These past influencing experiences can be categorized into four types: mastery experiences, social persuasions, vicarious experiences, and physiological states (Sheldrake et al., 2022). When relating to mathematics, self-confidence is the concept of how well the student

thinks they will perform on certain mathematical tasks and skills (Schuh et al., 2023). Confidence can often be tied to a particular task. If a student is able to complete a challenging word problem, their confidence will increase when going into the next problem set. This can also be the case for struggling students as their confidence levels are likely to decrease (Schuh et al., 2023). Research has proposed that if a student has a higher confidence level, they will be more inclined and motivated to surpass their normal performance; while lower confidence may be an inhibitor (Sheldrake et. al., 2022). Therefore, based upon previous research, self confidence can play a large role in a student's future endeavors and successes.

Attitudes towards math can greatly affect a student's confidence. Often, if a student has a negative attitude towards math, they will have a lowered confidence level. Attitude is a multidimensional construct that includes engagement, likes, confidence, anxiety, and beliefs (Christensen & Knezek, 2022). Each one of these factors plays a different role in developing a student's attitude. Previous research has shown that students with high math anxiety often enjoy math less and will have a lower confidence level. From this, it is believed that confidence can be a predictor of how a student will perform in their math courses (Christensen & Knezek, 2022). Students begin to develop their attitudes towards math in their early years of school.

Confidence, however, is not always beneficial to students. Overconfidence and underconfidence can be detrimental to a student if they let it dictate their study habits and participation in class. If a student is overconfident, this may lead them to believe they do not need to study for a test. The student would then do poorly on their test due to the overconfidence. Students who have underconfidence typically have a lower satisfaction with their math performance, perhaps indicating the two have an impact on each other. These levels of over- or under- confidence are more often seen in lower-performing students rather than the higher performing students (Sheldrake et. al., 2022). While some research appears to indicate that there is no correlation between student confidence levels and performance/success in mathematics, overconfidence and underconfidence have shown this hypothesis to be incorrect.

Each of the articles provided a slightly different approach to investigating confidence levels in mathematics. However, the results can all be linked together to form an interesting outcome. In Christensen and Knezek's (2022) research, they found there were significant differences throughout each grade level in math enjoyment, confidence, and attitudes towards school. The data also pointed out a trend that the previously stated dispositions became lower as grade levels advanced, specifically in the period between 5th and 8th grade (Christensen & Knezek, 2022). The confidence levels in 5th grade did predict a student's success in the class. However, when the students got to 9th grade, their confidence levels positively predicted performance. The findings from this study affirm to some extent that over- and underconfidence on mathematics tasks may link with their generalized math beliefs and performance (Sheldrake et. al., 2022).

Gender and Mathematics

When it comes to mathematics and other STEM-related fields, there tends to be a smaller ratio of women to men (Muzzatti & Agnoli, 2007). Even though the number of females in these fields is continuously increasing, many people in society still believe untrue stereotypes (Kane & Mertz, 2012). The widespread nature of these beliefs may cause women to consider other lines of work due to the lack of support from their peers. Stereotype threats have also been a tool used to prevent many women from pursuing mathematics degrees. Women have come a long way from representing less than a tenth of the field, but it is unclear whether they have reached the point to close the gender gap (Muzzatti & Agnoli, 2007). The goal of this literature review is to examine if there is still a gender gap in mathematics, specifically in school aged children and young adults.

There tend to be many stereotypes surrounding gender and mathematics. It is commonly

thought that math and science are male domains where females are unable to succeed. Many parents and teachers believe their female children/students are inferior compared to their male peers when it comes to mathematical ability. This mindset is passed onto their children, who may believe boys and girls have equal mathematical abilities, but male adults are better than females in math. In one study, fathers believed their sons had on average a 12- point higher IQ level than their daughters (Lindberg et al., 2010). The mothers also believed their sons' IQs to be higher, but only by six points (Lindberg et al., 2010). Another common stereotype is that women tend to choose fields that focus more on nurturing instead of quantitative skills (Kane & Mertz, 2012). While many people are fighting against these stereotypes with time and money to increase the female representation in mathematics-intensive fields, these efforts can quickly be thwarted. This has caused some to believe it is a waste of time and resources to include more women in the field, since they will often choose a more nurturing career instead (Kane & Mertz, 2012). These stereotypes are shaping certain fields to push women out because they are seen as "incapable" instead of creating a welcoming environment where everyone is invited to become a scholar of mathematics.

Another large factor contributing to the lack of women in mathematics is the theory of stereotype threat. The theory consists of the idea that a situational decrement in a person's performance may occur due to the awareness that their own ingroup is rated as less skillful in the domain they are going to be tested in (Muzzatti & Agnoli, 2007). This threat model has been found to have effects in younger (ages 5-7) and older girls (ages 11-13) but not necessarily in intermediate age girls (ages 8-10) (Muzzatti & Agnoli, 2007). When it comes to high school females, the discrepancy between performance and recognition is quite detectable. These girls will achieve better grades than their male peers in the classroom. However, in Mathematics Olympiads, the girls who compete do not perform as well as the boys. This can be attributed to the underrepresentation of women at these types of events (Muzzatti & Agnoli, 2007). College females are also affected by stereotype threat. Studies have shown that college women underperform compared to men in the threat condition. Whenever the threat condition was removed, the women performed at an equal level as the men (Lindberg et al., 2010). Creating a stereotype threat for females will indeed impair their mathematical performance.

Other research explores whether there is a true gap between male and female performance in mathematics. The studies found that in elementary and middle school there was little to no difference in mathematical ability between the two gend ers (Kane & Mertz, 2012; Lindberg et al.,2010). It was only in high school and college where there was a small difference between males and females. In these situations, the males were *favored* to have higher ability, especially in relation to complex problem solving. This difference can be attributed to the parents' and teachers' estimates of their children. If both parties believe the boys to have a higher ability than the girls, this can affect the students greatly causing a difference in ability level. However, the findings indicate there is no longer a gender difference in mathematics performance (Lindberg et al., 2010).

Teacher Perceptions and Mathematics

Teachers play an important role in students' success in school. Their perceptions can have both positive and negative effects on students' perceptions of themselves. Oftentimes teachers carry unconscious biases and perceptions that can be harmful to students when implemented into the classroom and workday lessons. These biases can have a detrimental effect on students and their future success due to a lack of support. Teachers tend to overestimate the mathematical ability of the male students in the classroom and underestimate the abilities of female students. This places the males on a pedestal, giving them more support for success. Overestimation of a student's abilities can lead to a positive impact on their own beliefs and ability level. One focus of this literature review is to investigate how teachers' perceptions and biases impact both female and male students.

The way a teacher interacts with their classroom can have a large impact on their students. Thus, it is important to recognize and understand the different biases and perceptions many teachers hold. It is more common for implicit stereotypes about gender differences in mathematics to be present in a classroom than explicit ones. Gender bias is so socially ingrained into society it can be a difficult subject to grasp (Riegle Crumb & Humphries, 2012). Teachers and parents are the top socializing agents in the construction of these gender norms (Robinson-Cimpian, 2014). Due to these norms, elementary teachers tend to rate the mathematics skills of the girls lower than the boys, even though the girls will behave and perform in a similar manner to their male counterparts. Teachers often give boys more specific and positive feedback due to higher expectations. This is in part due to the belief that boys have a natural gift for excelling in math. In this article, the teachers attributed female student failure to lack of abilities and male student failure to lack of effort (Robinson-Cimpian, 2014). It was found that the only time teachers tend to rate their female students higher than the boys is in the spring of kindergarten (Robinson-Cimpian, 2014). After this period, the male students are perceived to have higher abilities. By understanding the biases teachers hold, one can further examine how teachers' biases impact their students.

A teacher's perception of a student is sometimes associated with a negative impact. However, there are many studies indicating that the perception a teacher holds of a student can have a positive impact on their ability level. The student-perceived teacher ability-beliefs can be used as a prediction of the student's academic achievement (Gniewosz & Watt, 2017). If a teacher or parent holds a more optimistic view about a student's ability, then the student feels supported and is likely to reach a level of competency. Thus, the overestimation of skill level by a teacher can promote students' intrinsic motivation. This perceived teacher overestimation of ability does not have any predictive power of intrinsic values until the student reaches eighth grade. After that point, the more the teacher overestimated the skill level, the more the student's utility and intrinsic values increased. This was specifically detected during the period between eighth and tenth grade. A study revealed that students are motivated by believing their teachers think highly of them and their ability levels (Gniewosz & Watt, 2017). Even if the student did not feel strong in their math abilities, the positive perception from the teacher helped to boost their confidence and increase their competency level. However, the use of overestimation by the teacher should be used moderately and not to an excessive amount. If a student is receiving too much pressure from the teacher, it can lead to a negative effect on their skill level. Thus, teachers must learn how to use their perceptions about a student's ability to positively create change in the learner.

Capstone

The survey instrument was created with the purpose of identifying any gender bias present in preservice elementary teachers in relation to mathematics. Since the instrument was implemented in two different semesters, the data will be broken down into two groups. The first group will include only the Spring 2023 classes of Math 245 and 246. The second group will examine both the results from the Spring 2023 and Fall 2023 classes to include a wider review and analysis of the data. The results from each question will be further analyzed for both groups. From the research and results, I will develop action steps and recommendations to further prevent gender bias in the mathematics classroom. The data will also be used to inform how to implement these steps into my future classroom.

Question 1

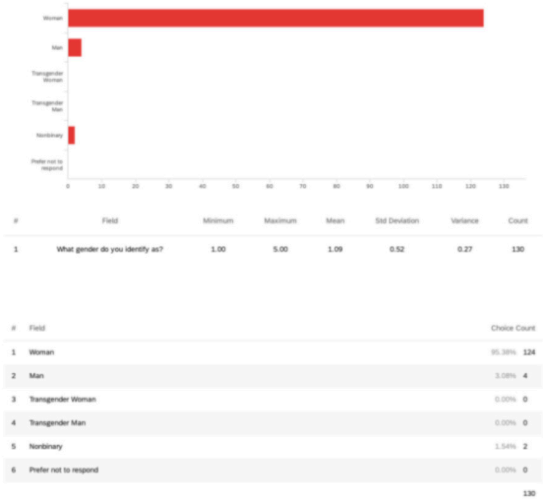
The first survey question asked participants to identify their gender. As mentioned in the introduction, I predicted the survey takers would be majority female, with a small percentage of male, transgender woman, transgender man, and nonbinary participants. The results from the first round of the surveying indicated there were 70 participants. Of these 70, 66 indicated they identify as a female, which is around 94%. Only two people identified as male, which equaled 3%. Nonbinary identifiers also equaled 3%. No one identified as a transgender woman or man. Once the survey was administered again, there were 130 participants. Of those survey takers, 124 identified as female, equaling close to 95.5%. There were four males, and the number of non-binary participants stayed the same. The other categories remained unidentified. These results indicated the majority of elementary education students taking these two required courses were females, which coincides with the fact there are more female teachers than males. With there being a high population of women taking the survey, this could potentially skew the data. A common belief associated with gender bias is that males are better at math than females. However, it is possible that because a majority of the survey takers were women there will not be as strong of a bias towards students of their own gender.

Table 1 (Spring): Data results from the spring 2023 administration of Question 1.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What gender do you identify as?	1.00	5.00	1.14	0.68	0.47	70

#	Field	Choice Count
1	Woman	66
2	Man	2
3	Transgender Woman	0
4	Transgener Man	0
5	Nonbinary	2
6	Prefer not to respond	0
		70

Table 2 (Spring and Fall): Data results from the spring and fall 2023 administration of Question 1.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What gender do you identify as?	1.00	5.00	1.09	0.52	0.27	130

#	Field	Choice Count
1	Woman	124
2	Man	4
3	Transgender Woman	0
4	Transgender Man	0
5	Nonbinary	2
6	Prefer not to respond	0
		130

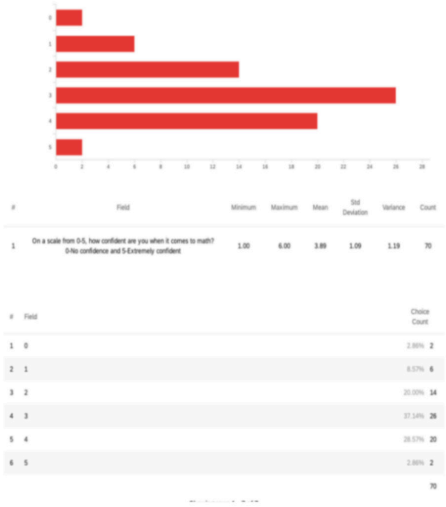
Question 2

The second question explored student confidence levels. The participants were asked to self-identify their confidence levels when it comes to math. In my previous predictions, there were three groups. The first group included levels 0 and 1, which was predicted to be 25% of the population. The second group was the largest group, predicted with 55% in the 2 or 3 levels. The final group was levels 4 and 5, which received a smaller prediction of 20% of participants. The actual data results proved to be quite different. At both the 0 and 5 levels, there were only two students, which totaled 3% of participants for each level. Level 1 received about 8.5% of survey takers, with six students. The confidence level of 2 ended up being 20% of the population, with 14 students. The third level received the highest number of students, resulting in about 37%. Level 4 was the second highest identified category with 28.5% of participants. After the completion of the second round of surveying, the data changed ever so slightly and became more centralized to the middle. Levels 0, 3, and 5 saw decreases, while levels 1, 2, and

4 had slight increases. Level 0 received five participants, and level 5 saw the second least with seven participants. Levels 1 and 2 received around a 1% decrease to 7% and 18.5%, respectively. The largest decrease was in the 4th level, which went down 4.5% to allow for level 3 to increase by that same number. Level 3 ended up with 41.5% of survey participants, and level 4 received 24%.

In the second round of surveying, the data changed slightly towards the middle confidence levels. Level 0 increased from 3% to 4%, while level 1 decreased down to 7%. The levels where the most change occurred are 2, 3, and 4. Both levels 2 and 4 saw decreases.
A possible explanation for the results being higher than predicted is the date of instrument administration. The survey was not implemented until the middle of the semester. The students had a longer time to increase their confidence in their math skills, which potentially led to a higher level of confidence reported. The next round of surveying took place at the beginning of the semester to see if there were any differences. The data from the next round did not indicate there was much of a difference in confidence level in relation to the time in the semester it was administered.

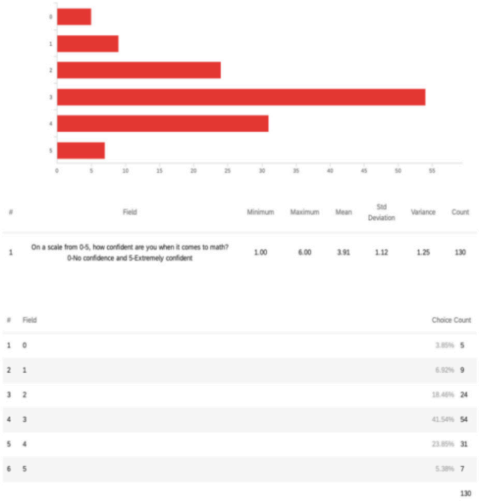
Table 3 (Spring): Data results from the spring 2023 administration of Question 2.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	On a scale from 0-5, how confident are you when it comes to math? 0-No confidence and 5-Extremely confident	1.00	6.00	3.89	1.09	1.19	70

#	Field	Choice Count
1	0	2
2	1	6
3	2	14
4	3	26
5	4	20
6	5	2
		70

Table 4 (Spring and Fall): Data results from the spring and fall 2023 administration of Question 2.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	On a scale from 0-5, how confident are you when it comes to math? 0-No confidence and 5-Extremely confident	1.00	6.00	3.91	1.12	1.25	130

#	Field	Choice Count
1	0	5
2	1	9
3	2	24
4	3	54
5	4	31
6	5	7
		130

Question 3

The third question asked participants to identify which type of high school they attended. Students were given the choice of either public or private high school. I predicted a majority of the participants to have attended a public high school, averaging about ⅔ of the target population. This left around ⅓ of survey takers to have attended a private high school. The results from the instrument show a similar response. Around 73% of the participants attended a public high school, and 27% attended a private high school. These results remained the same after the second administration of the survey. This question was examined because both high school settings can provide a different amount of support to students. Oftentimes, students in a private high school may receive more support and individualized attention compared to their public-school peers. This extra support can foster a higher confidence in mathematical abilities. Many students in a public-school setting will receive that level of attention and support; however, it is not as common. Thus, we use these results to examine whether the public-school students or the private school students will have a higher math confidence level. After further investigation, the public-school students had a slightly higher average confidence level of 2.904. The private school students average was 2.842.

Table 6 (Spring): Data results from the spring 2023 administration of Question 3.

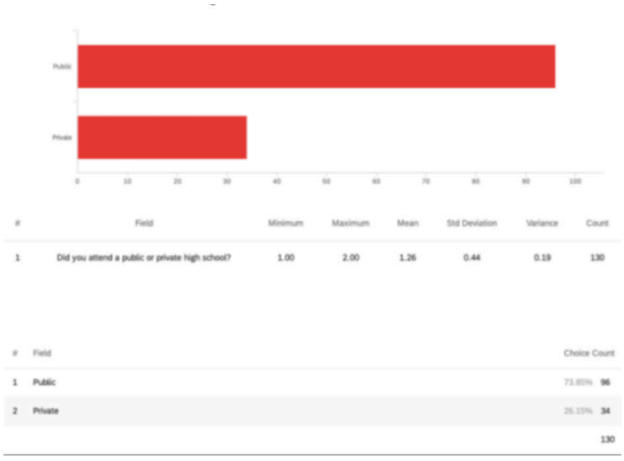


Table 7 (Spring and Fall): Data results from the spring and fall 2023 administration of Question 3.

Question 4

The fourth question had perhaps the most surprising results. As previously stated, I predicted around half of the participants would most likely choose a male as a working partner. The next highest chosen gender was predicted to be a female. In actuality, the highest picked gender for a working partner was a female. There were over 59 students who chose this gender, equivalent to about 84%. The next highest picked gender was a male, which received about 14% of participant votes. The transgender woman, transgender man, and non binary all received zero votes. Only one participant chose not to respond, equating to about 2%. The second round of surveying produced similar results. The female working partner received 85% of participant votes, the male working partner stayed at 14%, and those who preferred not to respond decreased down to 0.78%.

This response was shocking due to the widely accepted gender norms for males and

females. One would expect the male working partner option to be the most widely chosen due to the common belief that men are inherently better at math. There are two possible explanations for this type of response. The first would be due to the fact there were only four students who did not identify as a woman. With a class full of females, the students may have felt more comfortable and confident in choosing a female for a working partner. The other possibility is that the population sampled does not have as strong of a gender bias relating to mathematics. If their bias is not as strong, then they are more accepting of all genders in math compared to those who believe math is a male-dominated field. The continuation of this survey in the Fall 2023 semester indicated that gender bias is present, so the second explanation is not as feasible. The results, however, are likely to have been influenced by the high population of females in this major.

Table 8 (Spring) : Data results from the spring 2023 administration of Question 4.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. If you are asked to solve a math problem that will be graded and you can select a partner from the people in the room, which gender are you most likely to select for your partner?	1.00	6.00	1.18	0.55	0.30	129

#	Field	Choice Count
1	Woman	85.27% 110
2	Man	13.95% 18
3	Transgender Woman	0.00% 0
4	Transgender Man	0.00% 0
5	Nonbinary	0.00% 0
6	Prefer not to respond	0.78% 1
		129

Table 9 (Spring and Fall): Data results from the spring and fall 2023 administration of Question 4.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. If you are asked to solve a math problem that will be graded and you can select a partner from the people in the room, which gender are you most likely to select for your partner?	1.00	6.00	1.21	0.67	0.45	70

#	Field	Choice Count
1	Woman	84.29% 59
2	Man	14.29% 10
3	Transgender Woman	0.00% 0
4	Transgender Man	0.00% 0
5	Nonbinary	0.00% 0
6	Prefer not to respond	1.43% 1
		70

Question 5

The purpose of the fifth question was to investigate which characteristic most impacts the decision when selecting a working partner for a graded question. The math confidence score is a known variable, but is also used as a characteristic. The prediction was the math confidence score would be the highest chosen characteristic. The second highest was gender, and the other three categories: Sexual orientation, Public vs. Private education, and others were predicted to make up the smallest percentage. The results proved to be quite similar to the predictions. The math confidence score was the highest chosen characteristic with 61 participants or an 87% selection rate. Gender was the second rated characteristic with 11.5% of students choosing it. One student selected other and indicated they would pick based upon math grades. The sexual orientation and public vs. private education characteristics were not chosen in the first survey administration. After the second round of surveying, the data remained consistent. Eighty-seven percent of survey respondents chose math confidence score, 11% chose gender, 1.5% specified other, and .78% chose sexual orientation.

This indicates the students are the most confident with a working partner who has a high level of math confidence. If the partner does not feel confident in their abilities to complete the problem, the student is not likely to select them due to it being graded. Students also found gender to be an important characteristic as well. The gender of the working partner might help

the students to feel more comfortable expressing their ideas and opinions. Thus, this question indicates students need to either feel comfortable to solve a graded problem or have someone else who is confident in their abilities.

Table 10 (Spring): Data results from the Spring 2023 administration of Question 5.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. If you are asked to solve a math problem that will be graded and you can select a partner from the people in the room. If you know their math confidence score, which characteristic will most impact your decision when selecting for your partner? - Selected Choice	1.00	5.00	3.67	0.97	0.93	70

#	Field	Choice Count
1	Gender	8
2	Sexual Orientation	0
3	Public vs. Private Education	0
4	Math Confidence Score	61
5	Other	1
		70

Table 11 (Spring and Fall): Data results from the Spring and Fall 2023 administration of Question 5.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. If you are asked to solve a math problem that will be graded and you can select a partner from the people in the room. If you know their math confidence score, which characteristic will most impact your decision when selecting for your partner? - Selected Choice	1.00	5.00	3.67	0.96	0.92	129

#	Field	Choice Count
1	Gender	14
2	Sexual Orientation	1
3	Public vs. Private Education	0
4	Math Confidence Score	112
5	Other	2
		129

Question 3

The final question of the survey examined who a student will choose for a working partner when the math problem is ungraded. When the last question was posed as a graded problem most participants chose a working partner based upon confidence score. The prediction for the ungraded problem was most participants would switch from math confidence score to gender as the most important characteristic. I predicted a majority would select gender and the next highest selection would be math confidence score. The actual results for the first round of survey administration proved to be very similar to the predictions. Gender was the highest selected characteristic with a 51.5% selection rate. The second highest characteristic was math confidence score and it was chosen 39% of the time. Public vs. private education and the other categories were both chosen by 3 people each, totaling to a combined 8%. Only 1 participant chose sexual orientation as the most important characteristic. When the survey was readministered, the results remained similar to the results from the first administration. The gender decreased to 47.5%, and the math confidence score saw a slight increase to 45%. The other three categories make up the remaining 7.5% of respondents.

From this big switch between math confidence score and gender we can see how prevalent gender is in mathematics. When students know they are going to be graded they tend to choose a working partner that will help them succeed. However, when the stakes are taken away the participants choose working partners of the gender they feel most comfortable with. The results of this question paired with the results from question four are a large indicator of the level of gender bias in mathematics the group holds. A majority of the students in question four chose to work with a female partner. This shows there is still a higher level of gender bias in this group. The participants believe they can achieve an ungraded problem when choosing a working partner based upon gender. However, they do not feel as confident in choosing the same characteristic when the problem is graded. While the students chose female working partners in the fourth question, they still hold a form of gender bias which can be easily seen by

the switch in responses for this question.

Table 12 (Spring): Data results from the Spring 2023 administration of Question 6.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. You are asked to solve a math problem that will not be graded. You can select a partner from the people in the room to help you solve the problem. If you know their math confidence score, which characteristic will most impact your decision when selecting for your partner? - Selected Choice	1.00	5.00	2.43	1.52	2.30	70

#	Field	Choice Count
1	Gender	35
2	Sexual Orientation	1
3	Public vs. Private Education	3
4	Math Confidence Score	27
5	Other	3
		70

Table 12(Spring and Fall): Data results from the Spring and Fall 2023 administration of Question 6.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	You are in a room with a group of peers you do not know. You are asked to solve a math problem that will not be graded. You can select a partner from the people in the room to help you solve the problem. If you know their math confidence score, which characteristic will most impact your decision when selecting for your partner? - Selected Choice	1.00	5.00	2.55	1.51	2.28	129

#	Field	Choice Count
1	Gender	61
2	Sexual Orientation	2
3	Public vs. Private Education	4
4	Math Confidence Score	58
5	Other	4
		129

Recommendations

The research gathered from this case study has led me to develop three action steps and recommendations I plan to implement in my future classroom. The first of these ideas is to provide positive role models for all students. It is important for students to see someone who looks like them as a role model. If there are only white male mathematicians being displayed in the classroom, the students who do not identify as such will feel discouraged from becoming a mathematician. There needs to be an equal representation of role models both widely diverse in race and gender. All students deserve to have a role model who they can identify with.

The second recommendation is to incorporate more encouragement in the classroom. In math the boys tend to get more praise than the rest of their classmates. This excess of encouragement often leads to the females feeling like they do not belong or cannot succeed in math. Thus, it is important that all students receive praise and encouragement throughout the entirety of the learning process. When students are all getting an equal amount of encouragement then they all feel they are worthy of succeeding in mathematics. I want to ensure the students are getting the amount of support they need to build their confidence and mathematical skills. The final action step I have developed is to use learning materials that are equitable for all students. This means examining the curriculum and other resources in order to provide examples of both boys and girls. The materials will need to portray all genders as being skilled in mathematics, not one being better than another. This also goes to the use of examples that reach all genders of the students. Only having examples about trucks and sports can be discouraging for students who are not interested in these topics. Thus, the examples need to have a wide variety of interests to get the students excited about math. By implementing these three steps into my classroom, I believe I can significantly reduce the amount of gender bias present. While it will take more steps than just these three, I am committed to trying many different recommendations to achieve a classroom with little to no gender bias.

After inspection, the survey instrument yielded slightly different results than predicted.

There was a greater number of female participants than expected, which potentially could have caused most students to choose a female partner in the fourth question. The confidence levels of the students were significantly higher than the predicted average of 2. The instrument also revealed a level of gender bias the participants as a whole hold. When a question is graded, students feel more confident in a partner with a higher math confidence level.

However, when the question is no longer graded the students choose a partner based upon gender. From these results, I have developed action steps to help prevent gender bias in my own classroom. Through more encouragement and fair learning materials and role models for all genders, I believe I can reduce the amount of gender bias students are exposed to in the math classroom. In combination with the action steps, this instrument can be used in the future to assess the success of the action steps on eliminating gender bias in mathematics.

Conclusion

Through this research I have examined different aspects of gender, math confidence levels, and bias in the mathematics classroom. There are two questions that help narrow the field of research:first, how does gender play a role in the math confidence levels of students? The second research question examines whether preservice elementary teachers hold some form of gender bias in relation to mathematics. The results showed that for pre-service elementary teachers, they value mathematical confidence, and that gender plays a large role when working with partners in a math classroom. There still appears to be some form of gender bias held by preservice teachers, even though a majority of them are females. The data also showed that gender is not the only factor in the development of math confidence scores. Where a student attended school and the amount of encouragement and support they received also made an impact on the level. This research is important because gender bias is constantly pushing females out of STEM fields and into areas they are less passionate about. Everyone deserves to have the opportunity to pursue a career in whatever field they so choose, not what is traditionally male- or female-dominated.

There are a few main points that have impacted the way I have thought about and approached gender bias in mathematics. The first of these being confidence levels begin to drop in the fifth grade for female students. By the time they reach ninth grade, confidence levels can be used as a predictor of student performance. Gender bias is introduced at a young age not only in schools but also in individual households. Previous research indicated fathers believe their sons to have an IQ 12 points higher than their daughters and mothers believe their sons to have an IQ 6 points higher. Not only can parent beliefs and perceptions affect their children, teachers have a large impact on performance. A teacher's perception of a student's mathematical ability is one of the biggest predictors of future grades and performance. The last two key points came from the capstone portion of the research. The most surprising results indicated the participants felt more comfortable with a female partner than a male partner. This was surprising due to the fact the predictions were in favor of the males due to the traditional form of gender bias present. The participants showed their gender bias in the later questions. When choosing a partner for a graded question, math confidence level was the most important characteristic. However, when the question was ungraded, they trusted their female partners more. All of these key points have shown that gender bias can be present in many different aspects, not just the typical avenues. Thus, it is important to be hyper-aware of where gender bias may be present in the classroom.

The results uncovered throughout the project are relevant and useful for all teachers, not just math or elementary teachers. It was discovered that gender bias is present in many different ways. The bias can be seen and modeled by parents, teachers, other students, and also in the way students are partnered up. The research also helped to remind teachers the impor-

tance of surveying students about their likes and dislikes so that students feel comfortable in the classroom, especially in relation to group work. The capstone project revealed that students prefer to be partnered up with another student of the same gender. However, the occasional coed groups can be beneficial to students. While my research has provided new insight on the topic, there is always further research to be done. An idea for future research would be to examine the most effective methods to combat gender bias in the classroom. This research would be a much more extensive process due to the nature of it. However, it would provide educators with valuable insight on how to eliminate gender bias in the classroom. Another possible avenue for more research would be to examine if students tend to endure more gender bias in a public or private school setting. The goal of not only this research but also future research is to pinpoint where gender bias is occurring and develop steps and methods to eventually eliminate it from schools.

My high school experience has been the catalyst for this entire research process. The support I received from all my teachers and peers at Nerinx has led me to take an interest in gender equality. Many students are not lucky enough to receive constant encouragement from their teachers to pursue an education in a STEM field. Thus, I took an interest in discovering where gender bias is present in the math classroom and how to combat it. I believe this capstone encompasses my mission to create a positive learning environment where all students are able to reach their full potential. However, until everyone examines the biases they hold, the cycle of gender bias in mathematics will continue. Our teachers must receive specialized training to be more inclusive of all students and provide them with a safe learning environment. The math field needs to be rebranded as an inclusive space for anyone wanting to further their mathematical knowledge. Because the math itself is not biased, it is our duty to work to eliminate all the bias we have allowed to build up around the teaching and learning of mathematics.

References

Christensen, R., & Knezek, G. (2020). Indicators of middle school students' mathematics enjoyment and confidence. *School Science and Mathematics,* 120(8), 491–503. https://doi.org/10.1111/ssm.12439

Gniewosz, B., & Watt, H. M. G. (2017). Adolescent-perceived parent and teacher overestimation of mathematics ability: Developmental implications for students' mathematics task values. *Developmental Psychology, 53*(7), 1371–1383. https://doi.org/10.1037/dev0000332

Kane, J. M., & Mertz, J. E. (2012). Debunking myths about gender and mathematics performance. *Notices of the American Mathematical Society, 59*(1), 10. https://doi.org/10.1090/noti790

Leder, G. C., & Forgasz, H. J. (2018). Measuring who counts: Gender and mathematics assessment. *ZDM Mathematics Education, 50*(4), 687–697. https://doi.org/10.1007/s11858-018-0939-z

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. https://doi.org/10.1037/a0021276

Muzzatti, B., & Agnoli, F. (2007). Gender and mathematics: Attitudes and stereotype threat susceptibility in Italian children. *Developmental Psychology, 43*(3), 747–759. https://doi.org/10.1037/0012-1649.43.3.747

Tiedemann, J. (2000). Parents' gender stereotypes and teachers' beliefs as predictors of children's concept of their mathematical ability in elementary school. *Journal of Educational Psychology, 92*(1), 144–151. https://doi.org/10.1037/0022-0663.92.1.144

Reigle-Crumb, C. & Humphries, M. (2012). Exploring bias in math teachers' perceptions of students' ability by gender and race/ethnicity. *Gender and Society, 26*(2), 290-322. https://doi.org/10.1177/0891243211434614

Robinson-Cimpian, J. P., Lubienski, S. T., Ganley, C. M., & Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement. *Developmental Psychology, 50*(4), 1262–1281. https://doi.org/10.1037/a0035073

Sheldrake, R., Mujtaba, T., & Reiss, M. (2022). Implications of under-confidence and over-confidence in mathematics at secondary school. *International Journal of Educational Research, 116*, 102085. https://doi.org/10.1016/j.ijer.2022.102085

Schuh, K., Meiners, A., Ferguson, C., Hageman, K., George, S., Cox, M., Zou, Y. & Lin, C.J. (2023). Junior high school students' self-confidence during transition to above-grade-level mathematics courses. *The Journal of Educational Research, 116*(2), 61-76. https://doi.org/10.1080/00220671.2023.2186338