2023

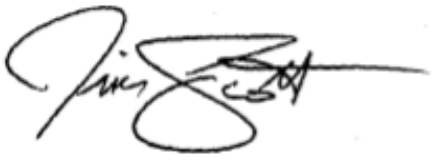
Finding the Common Denominator: Understanding the Shared Experiences of Female Math Majors

Abigail R. Rosenbaum
Colby College

Finding the Common Denominator: Understanding the Shared Experiences of Female Math Majors

Abigail Rosenbaum completed the requirements
for Honors in Education
May 2023

Adam Howard
Professor of Education and Director of Education
Advisor



Jim Scott
Associate Professor of Statistics
Reader

Table of Contents

Acknowledgments……**4**
Abstract……**5**
Introduction……...……...**6**
Literature Review……...**12**
Societal Expectations of Gender and the Pedagogy of Mathematics……12
The Relationship Between Women and STEM……16
Motivation and Self-Efficacy of Female Students…….……22
Methods……..**31**
Context……...31
Participants…….…32
Data Collection……..…35
Data Analysis……37
Narrative Findings……**38**
Elevated Status……...38
Reactions of Outsiders…….. 38
Interpersonal Feelings of Others' Opinions……...42
Thoughts and Relationships to Other Majors……46
Dismantling the Hierarchy…….50
Apprehensive Identity……53
Difficulty of Courses……..54
Self-Doubt and Imposter Syndrome……...……...56
Overcoming Uncertainty to Prove Self and Knowledge……59
Gender Solidarity……...61
Gender Makeup of Classes……62
Tendencies Toward Female Students……64
Relationships with Professors……68
Discussion……..**72**
Departmental Navigation……...73
Societal Expectations……75
Conclusion……**79**
References……..**84**
Appendix……**90**

Acknowledgments

First and foremost, I would like to thank my advisor Adam Howard for his guidance throughout this entire process. This thesis would not have been possible without you. You have allowed me to think and write in ways I didn't think I was ever capable, and I am so proud of what I have been able to accomplish. Throughout the years in your courses and as my advisor, you have changed the way I see the world, and I will carry this with me for the rest of my life.

To Jim Scott, my second reader, thank you for taking the time to read and provide feedback on my thesis. I also want to thank you for many great statistics courses over the years- I have thoroughly enjoyed my time as a part of this department.

To the Colby Math and Education departments, thank you for a great four years allowing me to learn and grow. This thesis is a culmination of the work I have done in these disciplines and has served as an inspiration to create this final product.

To my parents, thank you for all of your love and support every single day. Your strong belief in education and putting in your strongest effort has allowed me to reach where I am today and be able to look back upon my educational journey with pride and a smile on my face.

To all of my friends, thank you for making our final year here so special. And thank you for your support throughout this process and pushing me to work through the difficulty. I would do all of it over again with you all by my side.

Abby Rosenbaum

May 2023

Waterville Maine

Abstract

Despite efforts to increase gender diversity in STEM fields, women remain underrepresented in mathematics, especially in advanced academic and research positions. This study aimed to explore the experiences of female math majors as they attempt to navigate this male-dominated space. Through qualitative interviews with seven female math majors, two female math professors, and a focus group with education majors at Woodbridge College, small liberal arts college in the United States, several common themes were identified that define the experiences of female math majors. The findings suggest that math is held at an elevated status in society and that there is strong sense of gender solidarity within the mathematics department at Woodbridge College. However, women also have an apprehensive identity within the mathematics due to a lack of gender diversity within the discipline. The study also found that female math majors developed strategies to navigate these challenges, including seeking out female mentors and peers, forming study groups, and engaging in outreach efforts to inspire and support other women in math. The findings suggest that fostering supportive and inclusive communities for female math majors could help address the challenges they face and promote greater representation of women in mathematics. This research offers valuable insight into the daily experiences of female math majors and revealed that gender played into feelings of apprehension, but deep internal motivators allowed the participants to continue pursuing mathematics. These findings contribute to the understanding of the experiences of female math majors and highlights the importance of community-building efforts to increase gender diversity in mathematics.

Introduction

Growing up, I was always told I was good at math. Numbers came easily to me, and I enjoyed the puzzle of getting to the correct answer. Throughout elementary and middle school, I never had any trouble with my math homework, and was placed into gifted and talented programs due to my test scores. This was never really anything I thought much about, until going into 5th I was selected with 5 other students to take a special math placement test that would allow me to skip a math class in middle school and jump ahead. I was taken into a small testing room and noticed that I was the only female student who was selected to partake in the test. At the time, I didn't think much of this. Maybe it was a little weird to me, but it was just any other math test.

Fast forward to freshman year of college, I entered Colby College as a possible biology major. I had no idea what I wanted to do with my life or any possible career goals. However, I discovered two weeks into introductory biology that it was not for me. A few weeks later, my calculus professor pulled me aside and asked if I had considered being a math major. In all honesty, I hadn't. Despite doing well in math in high school and even doubling up on math courses during my junior year, I didn't think it was something I liked enough to devote 4 years of learning and focusing on. I still met with my professor because I didn't have a major at the time. He outlined my courses and what the next 4 years might look like, and all the things I could do after college with a mathematics major. At that point, I figured I might as well try out some more courses freshman spring, and if I didn't like them, there was still no commitment to the major yet. I enrolled in the two math courses my professor suggested and ended up enjoying them a great deal. Despite them being challenging, I was faced with great professors and learned so

much. After that semester, I became a math major. I continued to enroll in these classes and found myself enjoying the puzzles and problems I had to solve, despite how difficult they were.

During my sophomore year, I found a love and passion for educational studies. I enrolled in Education and Social Justice as an elective during my sophomore fall. I was expecting that an education course was going to be mostly about what occurs in the classroom and how to make lesson plans. Instead, I was fascinated by the material surrounding equity and social justice issues that exist in our society and overall education systems. I was inspired to take another education class the following semester, which focused on elite schooling around the world. I was challenged to think in ways I had never thought before, and it really opened my eyes to the privilege of education I had experienced. So, I made the decision to pick up educational studies as a second major. Learning about the injustices that are so deeply rooted in our educational system as a country, but also spread all the way down into each individual classroom really resonated with me and left me wanting to know more. Throughout my time navigating this major, I was also left with the desire to make a change.

And so, I continued to enroll in a variety of education courses- varying from studying elite schools worldwide to the policies of rural schools in America. The discussions we had in these classes were constantly shifting my thinking of the education system as a whole and made me look closer at my previous experiences and what I was currently experiencing in college. I couldn't help but share what I was learning with my friends and roommates after class and was continually looking forward to each new reading and discussion we would have. It was so refreshing to have conversations about the way we were learning and had been taught all of our lives amidst challenging problem set after problem set for my math major. These discussions were still challenging, but in a completely different way.

Whenever I told people that I had two majors, mathematics and educational studies, I was always greeted with a question or comment about becoming a math teacher. I usually gave a bit of a laugh, and said ‘maybe!’, but in reality, had no idea what I wanted to do. It did seem like the obvious path to go down, but was it too obvious? Is that actually what I wanted to do, or was that just what everyone assumed I would do, so should I just do that? Despite my interest in math and numbers, I knew I didn’t have interest in strict finance or banking. On the other hand, I wasn’t sure if I wanted to become a teacher for the rest of my life either. As much as I enjoyed tutoring and being a teaching assistant for a variety of math courses throughout high school and college, I didn’t know if it was something I wanted to turn into a career. As I got deeper into both of my majors, I realized I was fascinated by the intersection of my two majors. Learning about equity issues and the problems within education as a whole piqued my interest in narrowing it down to math in particular. I found myself thinking about how math education could be improved, and why some people seem to be more averse to mathematics, and if it was tied to the education it was founded in.

My junior spring I enrolled in a course entitled Gender and Education. I didn’t really know what to expect to be taught in this besides how learning differs by gender and what role biological sex and gender identity can play a role in one’s education. These ideas were the mere tipping point of the material to be covered. We talked about many different topics, from title IX policies to how different LGBTQ+ identities were being included into the classroom, to the social construct of gender and how young it is ingrained in our education. After these classes concluded on Tuesdays and Thursdays, I found myself reflecting on my education as a female student, especially in my math major. I had always enjoyed math, but I remember in middle school feeling embarrassed to say that it was my favorite subject. That was a ‘boy subject’, and

something boys were supposed to be better at. I couldn't figure out where this mentality came from, or when it started, but I remember feeling these sentiments at a young age. I never let the embarrassment of liking math deter me, and continued to pursue it as a major, but different memories of my relationship with math as a woman started surfacing to my memory that semester due to this education course. Moments I had never thought much of such as offhanded comments about my skills and ability from a male teacher, or thoughts of self-doubt I had after walking into college mathematics course with nearly entirely male student population, started slowly taking over my thoughts and left me wondering what this experience was like for other girls in my position. Was this a completely universal experience for girls my age? How did it differ from those older than me and those younger than me? This one course, Gender and Education, had me questioning the majority of my time with my major, a path I had chosen to go down because I enjoyed the subject. So, I began digging deeper into the role motivation plays with the intersection of gender and mathematics.

As a college student, the amount of change I am capable of making is miniscule compared to the large number of issues that need to be addressed to create a better, more equitable educational system. Despite this, I still knew I wanted to do something, and explore an issue that was important to me. From here, I was left at the intersection of my two majors. How could math education be more equitable? What can be improved with how math is taught? Who is able to be successful in math? This led me to consider what it is like to be a woman in STEM (Science, Technology, Engineering, and Mathematics), and how girls are encouraged in these disciplines. When I was growing up, I didn't notice many initiatives for female empowerment in math and science. In recent years that I have spent mentoring and tutoring kids of different ages, I have noticed more clubs, strategies, and even posters around schools to increase girls' interest

in math. There has been a recent push to increase this interest in not just math, but all kinds of STEM as well. All of these initiatives have been on the rise and young girls are being encouraged, but are they actually making a significant difference in the experiences of women in these subjects?

In recent years, there has been an increase in research on understanding gender discrepancy in STEM fields. Stipek and Gralinski (1991) conducted a study on achievement gender gaps and perception of success to see where differences existed between girls and boys. Many similar studies and articles have been published by authors since the 1980-1990's. Frenzel (2007) found evidence that one of the key reasons girls have more issues with mathematics than boys is due to emotions that have been ingrained in them of low competence beliefs with mathematics. While a lot of this research shows that emotion is a large influence in gender differences in mathematics, a lot of problems also exist within equity between genders and prominent stereotypes. This research brought me back to my younger thoughts of thinking math was for boys. Where in my elementary school education was this idea ingrained in me? Up until college, all of my teachers, including math teachers, had been female. Looking back, I would have assumed this played a positive role in encouraging girls with math, but somehow there is a reverse effect at play. Fennema (1979) demonstrated that equity issues had to do with teacher differential treatment of male and female students, as well as confidence or a belief that mathematics is not important for female students, which culminated in negative stereotypes leading to gender bias. New movements are popping up around the country and at different age levels to work on combating these stereotypes. So, with some of these previous studies and my questions about the effectiveness of STEM movements, I wanted to explore women's

experiences with mathematics for those who have chosen this as a path to pursue, and those who have not.

This will then be the main goal of this research project. I hope to hear from women who have chosen math as their major and understand their experiences. While there is research about some general experiences of young girls in mathematics and gender differences in mathematics careers, there is not a lot of research looking at the experiences of women who are pursuing math and the experiences they have. How are female math majors experiencing the male-dominated spaces of this discipline? The experience of female math majors still largely differs from the experiences of males in math and females in other disciplines, despite recent efforts for gender equality in STEM (Bird & Rhoton, 2021). These experiences differ and have not necessarily improved due to lower self-efficacy and motivation in women in mathematics due to societal expectations, the overall pedagogy of mathematics, and women in STEM initiatives that are lacking in overall success. While answering this question, I plan to encounter themes of societal expectations and the pedagogy of mathematics, motivation and self-efficacy of female students, and the rise of women in STEM movements throughout the interviews.

Literature Review

There are many theories and studies exploring the gender gap in STEM fields and mathematics specifically. Although the existing literature involves many different theories of gender discrepancies in STEM, this review will focus on three major themes that are frequently addressed. These themes are societal expectations relating to gender and the pedagogy of mathematics, the rise of gender equality initiatives in STEM, and the motivation and self-efficacy of female students relating to mathematics and STEM in general. These three themes help build towards the primary focus of understanding the experiences of female math majors, and seeing why they still largely differ from females in other disciplines, and males in math.

Societal Expectations of Gender and the Pedagogy of Mathematics

When starting to dive into literature regarding women and mathematics, we must step back first and look at mathematics education as a whole. The pedagogy of mathematics involves different approaches than other subjects, and helps convey important mathematical concepts, language, and methods to students. There are increasingly different approaches on how to teach math in the classroom, which deviate from straight textbook and lecture learning and weave in more practice-based learning. Jo Boaler (1998) conducted a study comparing two classrooms - one that used a very traditional textbook approach and one that solely employed open-ended and hands-on activities in the classroom. By combining classroom observations, interviews, and test scores and performance, she was looking to see if one method was proving to be better than the other for both the students and the school. When looking solely at test scores, students in the textbook classroom did not perform as well as she would have expected. These students had developed a specific kind of knowledge that they only knew how to apply when given textbook problems, or problems of an extremely similar nature, because when they were given questions

asking them to apply methods and concepts that they had learned to new and different situations, they were unsuccessful (Boaler, 1998). On the other hand, the students at the school with hands-on approaches saw math in a different light. While these students were not as well versed in mathematical methods and procedures, they were able to apply their knowledge to a wide variety of problems.

One of the most interesting findings from this study was how students in different types of math classes viewed mathematics. The students in the textbook based math class believed that math was a memory-based subject with many rules to follow. There was no room for deviation from the regular rules and procedures. However, students in the hands-on class saw math as an active and flexible subject, and that it was adaptable to many other things, and this is how they applied different concepts they learned in class to the problems they were given. This approach of mathematics shows a discrepancy in how it is viewed as a subject and the differences in the way it is taught. While neither of these approaches are extremely ideal, finding a common ground between using a textbook and applying hands-on problems would allow students to see math as both a flexible subject that allows them to apply knowledge in different ways while still emphasizing the importance of key procedures and formulas.

The notion of this finding about how mindset plays a role in performance of mathematics can be related to changes that are or should be happening in the classroom. Within mathematics, there is often a focus on developing a growth mindset that students are aware of at a young age. Schools and teachers are frequently communicating to students about their abilities in certain subjects, where ability grouping comes into play. Splitting students up by ability level is a common practice that is found in the mathematics classroom more often than in other subjects. These groupings usually start at a young age, where students are typically told if they are below,

above, or meeting average around middle school ages. No matter at what age these groupings happen or if they are told what group they are put in and what this means, students' beliefs about their own potential change in response to the groupings (Boaler, 2013). Students are very aware of the different groupings in the classroom and are being sent the message that some students are very smart and that others are not. Because of these groupings, students' mindsets for learning are shifted.

Boaler (2013) describes how when students believe that everyone has the ability to grow, their achievement increases significantly. However, grouping practices can communicate damaging mindset beliefs to students, and their belief in their ability to grow is shifted. So, while there is evidence that grouping is damaging to students in the mathematics classroom, why is it still majorly used in practice and what could be a better alternative? While it is easy to use grouping as a way to allow more math-oriented students the chance to practice their skills, the effect that it has on students' mindsets may be more damaging than beneficial. Jeannie Oakes (1995) conducted a study on tracking and found that these processes can be traced to familial support and other factors that the students can't control, but leave students feeling discouraged if they are not in the higher tracks. The change in mindset for students contributes to their motivation in the classroom, showing that how math is taught in the classroom and how it is split up for students is a crucial part of their experiences.

The way math is also taught leaves a lot of room for criticism of both educators and students. Math is an incremental subject, and concepts build on one another throughout each subject and year in classes. Math teachers depend on students to use their prior knowledge to understand new concepts, and student's confidence in their own abilities plays a major role in the classroom. Foster (2016) conducted a study on confidence and ability in the classroom and found

that students do not always have conceptual confidence and instead have confidence in an answer “without possessing an underlying sense of confidence in the mathematics behind it” (Foster, 2016, p. 286). If students do not feel strong in their abilities in certain areas or math procedures, when they are taught new concepts that build upon old ones, they are not able to learn confidently and struggle going forward. Students then begin to build on their prior misconceptions and misunderstandings in mathematics, and when teachers do not realize this, it strengthens students' beliefs in misconceptions and teachers find it hard to correct (Hennessy et al., 2012). This makes it hard for students to come back from this and begins to separate and reinforce the different levels that mathematics is typically split into.

While speaking about the different aspects of pedagogy that play into mathematics, Hennessey also focuses on suggestions of what can be improved. For many years, math was seen as a cut and dry subject where answers are strictly right and wrong and there is one way to approach problems and procedures. Hennessey and colleagues find that shifting mathematics to constructivist practices, where students find their own understanding of the concepts by interacting with problems and having active learning experiences, provide a different view of mathematics. A similar shift in mathematics is through persuasive pedagogy practices. While people may not typically see persuasion as something that belongs in the math classroom, using persuasive practices can debunk students’ misconceptions through discussion, justification, and refutation (Hennessey et al., 2012). When students are given the opportunity to interact with math in processes of doing problems, they are more likely to be in a position where they can better understand the subject matter.

Societal expectations are a key factor in the way math is taught in the classroom and how it is portrayed to students. As I will mention more later in this literature review, women typically

have a difficult relationship with mathematics and STEM in general due to a lack of encouragement in the classroom. Starting at a young age, girls notice the differences in the way mathematics is taught and can favor boys and be discouraging for girls. However, these differences are not only attributable to the actions of teachers and are a bigger reflection of society and the social forces present in the classroom. There exists a large societal influence that tells students who is good at math at a young age, and this translates to what is taught in the classroom. One of the largest driving social forces is the way adults communicate and believe in children's math abilities, especially how parents reinforce beliefs into their children. These parental beliefs have a greater impact on students' attitudes than a student's math grades, which leads to boys having higher expectations for their mathematical abilities than girls (Eccles & Jacobs, 1986). From the research in the Eccles & Jacobs article, the sex difference seems to stem from different expectations that parents hold for their daughters compared to their sons, as well as media reports regarding sex differences in mathematics relating to girls' performances, which sometimes innately negatively affects parents' beliefs in their daughter's ability to succeed in mathematics. These beliefs begin showing up in the classroom through a combination of parental influence, coverage in the media, and the ways that teachers lead the class. These societal beliefs reflect a larger issue of an overall disbelief in girls' success in mathematics, which goes much deeper and further than their self-confidence in the subject.

The Relationship Between Women and STEM

In recent years, there has been a rise in movements to help increase the number of women in science, technology, engineering, and mathematics - more commonly known as STEM. These spaces have typically been dominated by men in the past, and women have not been encouraged to pursue classes and jobs in these fields. In order to combat stereotypes that have been

determined by society and encourage women to have an interest in these subjects, initiatives are popping up around the nation labeled “Girls in STEM” or “Women in STEM”. These take many different forms and are being integrated into school curriculums as well as appearing in everyday life through mediums such as ads. Some of these movements are being tacked onto other current initiatives, such as the maker movement. The maker movement involves getting kids to be a creator and make new things, which aligns greatly with STEM fields. Many organizers in the maker movement are attempting to directly engage women and girls and motivate them in a maker environment (Martin, 2014). The combination of these maker spaces which allow creative STEM thinking, as well as designating some of these spaces for female students only, are one type of effort that help girls feel more confident with their ability in STEM.

While these movements are crucial to increasing the number of women in these fields, it is important to examine the relationship between women and STEM altogether before one can understand the full importance of the initiatives. There is a lot of research done on what sorts of women are involved in STEM currently and the barriers they have faced along the way, their attitudes towards the subject, and how other people view women who do pursue these fields. Additionally, it is important to explore what limitations may be placed for these women, and what sorts of things need to be implemented in order to achieve gender equality. In an article from EdWeek, Langreo (2022) quotes a study done by Logitech (a computer manufacturing company) that says one of the driving factors in girls wanting to pursue technology in school or as a career is having a parent or a teacher who encouraged them. Many women do not have a role model in STEM fields and it is hard to find encouragement to pursue when for a long time STEM fields were seen as only for men, and are still largely dominated by men: “for many women, it’s hard to find inspiration to pursue a tech career because they don’t have a role model

and there's a perception that the technology industry is for men" (Langreo, 2022). However, with encouragement from either a parent or teacher, girls can find it easier to visualize themselves in these roles. When teachers encourage their female students to consider technology or computer science as a field of interest, they are helping shape a new generation of young girls who can see a place for themselves in this ever-changing field of STEM.

When looking at this relationship between women in STEM, it is crucial to start even earlier at the age of young girls. Beginning at a really young age, around elementary school, stereotypes about what girls can and cannot do are introduced. Ones that are related to STEM can be introduced in school settings, which is why the rise of some of these initiatives have targeted participants in elementary school, and not just older girls. While some of these STEM initiatives occur in the classroom or as part of a school program, out of school STEM programs can have a positive effect on students' STEM interests and attitudes. Jeanna Wieselmann and colleagues (2020) conducted a study looking into the effectiveness of the out of school STEM programs with elementary school aged girls. With 30 participants in fourth and fifth grade, they interviewed these girls about their STEM attitudes, thoughts about themselves and their relationship to STEM, and their beliefs about both girls and boys in relation to STEM. Through these interviews and observations, the authors found that by the time elementary students reach fourth grade, young girls see and believe that there is a gender gap in STEM, and boys are the ones better suited to succeed in STEM. Additionally, girls may view mathematics as a gatekeeper to participating in STEM and motivating them to continue. Both implicit and explicit messages are being sent to young girls in the classroom about their ability to succeed in these fields, with them getting sent these messages more strongly with math, which discourages them from exploring other subjects in STEM.

The authors also found that out of school STEM programs were more successful at encouraging girls than in class activities: "Students who had not previously seen themselves as people who may pursue careers in STEM spoke of new interest in STEM careers after Designs in STEM[1] " (Wieselmann et al., 2020, p. 302). Young girls had better experiences in the out of school activities, where they felt like they were given the chance to do more hands-on activities and explore, as well as having room for failure and learning that it is ok to fail. In school, young girls spoke to the pedagogy in mathematics of only getting answers correct, which discouraged them from pursuing STEM, especially when they felt that boys were better at math and the ones who were getting the answers right. By allowing girls to fail and try again in external STEM initiatives, they are able to explore the different fields within STEM and not feel pressured about performing well academically like they are in a classroom. From this study, there is evidence that these programs provide a better environment for young girls to be involved in STEM. There are many benefits to implementing additional STEM programs for young girls' interest and encouragement in these fields, and at a young age there can be benefits in helping to modify the implicit negative beliefs that young girls have internalized.

When STEM is talked about, there are many associations that come with this acronym. Starr (2018) conducted a study with undergraduate women, where she was looking at associations with a woman's identity, STEM affiliation, and the use of categorizing people into nerd-genius stereotypes. These trait-based stereotypes help explain why women frequently lean towards entering some fields of STEM, but not others. Many stereotypes about who succeeds in STEM exist, such as how the field is seen as one for men, as well as the people who may succeed in STEM can be categorized as naturally intelligent and sometimes awkward- leading to the

[1] Designs in STEM is a pseudonym for an out-of-school program that encourages students' interest in STEM.

'nerd' stereotype. When asking students about what someone in STEM may look like, researchers found women were more likely to list stereotypical descriptors than men (Starr, 2018). These implicit stereotypes that women have ingrained contribute to the gender gap in these fields because it makes them less inclined to participate in the fields. Starr found that both regular gender stereotypes, as well as nerd-genius stereotypes, may disproportionately affect women's STEM identity because they do not line up with stereotypes of what women should be. The combination of negative stereotypes regarding STEM and gender expectations makes women more averse to joining these fields, and negatively contribute to the relationship between girls and STEM.

Some of these STEM efforts also specifically target combating negative stereotypes. There are many beliefs and stereotypes surrounding STEM that it is a field that males are better at, and that females struggle with and are not successful in. When these beliefs become ingrained at such a young age, young girls find it difficult to break the barrier and pursue STEM when they have been told for years that it is something that they are not capable of. Smeding (2012) conducted a study where she investigated these implicit stereotypes, and how these were connected to a woman's math performance. She surveyed a variety of students, both male and female, and gave them different statements to measure the level of their implicit biases. Smeding was able to find that female engineering students held weaker implicit gender- math and gender-reasoning stereotypes than female humanities, male engineering, and male humanities students. These biases are deeply ingrained not just in women in STEM, but both females and males in a variety of subjects.

In a similar study, Kiefer and Sekaquaptewa (2007) examined math-related outcomes of women enrolled in a college level introductory calculus course. They presented the participants

with implicit and explicit stereotype tests about math, as well as a questionnaire regarding gender identity. They drew on previous research of high school students where implicit stereotypes led to poorer performance of women on the math section of the SAT, and wanted to see if there were similar patterns for college-aged women. The researchers ended up finding that explicit stereotypes do not play a significant role in course performance or exam scores, but implicit stereotypes are still very present (Kiefer & Sekaquaptewa, 2007). Even women who explicitly reject stereotypes may be influenced by them on an implicit level, and the researchers were able to link implicit gender-related stereotypes and gender identification to women's desire to pursue math-related careers. This research contributes to the growing literature about women's relationship to mathematics, and why an underrepresentation in these fields exists. By identifying the factors that lead to the disparity between men and women in math, it is easier to understand women's overall connections to STEM fields, and what should be targeted with gender equity initiatives.

As these STEM initiatives are starting to grow in popularity, more research is being conducted on the effectiveness of implementing them, and scholars are often finding that out of school time programs (OST) are more effective than ones in the classroom. Froschl and Sprung (2014) conducted a study looking into how OST programs are working in encouraging young girls in comparison to school settings. Programs out of school give more time for exploration and engagement for young girls, and are often staffed by younger women who can help represent a diverse group of people involved in STEM compared to what they are taught in school: "Being in frequent contact with young female adults whom they can emulate gives a tacit message to girls that 'I can do it too' " (Froschl & Sprung, 2014, p. 141).They found that while OST programs cannot do it all and school settings are still important for learning, the hands-on

experiences in OST programs are very beneficial to young girls. Additionally, they saw that girls were not as scared to make mistakes in OST initiatives and were willing to take risks to lead to more scientific discovery. Between the combination of who they are learning from, and the types of activities and spaces young girls are exposed to through these initiatives, there is improvement of attitudes, enthusiasm, and self-identity towards STEM fields (Froschl & Sprung, 2014).

Motivation and Self-Efficacy of Female Students

Whether it be motivation relating to what classes certain students choose to pursue, or what motivates students into higher education, a lot goes into the decisions students make and their self-efficacy. There is evidence of a relationship with self-efficacy and performance, as students who have higher self-efficacy in mathematics typically have a higher level of achievement, and vice versa for lower self-efficacy (Usher, 2009). There is a psychological relationship between success and motivation which stems from a source of self-efficacy. Self-efficacy has been found to be very influential in student's motivation when explaining their academic performance and choice of STEM for a college major (Zhang et al., 2021). This relationship may not be strictly linear or negative, but the psychological effects play into how students perceive certain subjects. Bandura's (1986) social cognitive theory explains how beliefs of self-efficacy stem from a few major key areas, including experience, social persuasion, and physiological states. All of these factors then play into how a student perceives their ability, which affects their performance.

Social cognitive theory has a subset known as self-efficacy theory. Bandura (1986) suggested that social cognitive theory has three major constructs to influence behavior, including personal factors, environmental factors, and the aspects of the behavior itself. If this theory helps predict and influence one's behavior, self-efficacy theory says that the two key determinants of

behavior are perceived self-efficacy and outcome expectancies (Sutton, 2001). This part of the theory has a huge role in one's motivation and says that experience, social persuasion, physiological feedback all contribute to one's self efficacy, which therefore affects behavior and performance. While self-efficacy theory is important when it comes to motivation, there are other important theories that play a role as well. Basil Bernstein (1964) and Pierre Bourdieu (1996) each present their theories on code and habitus, which both play a role in one's social experiences, and when applied in an academic setting have a role in one's motivation. Bernstein suggests that "code is a form of spoken language to see that the way it is used within a particular societal class affects the way people assign significance and meaning to the things about which they are speaking" (Sutton, 2001, p. 501). The code that a person uses can symbolize their social identity. There are many different types and meanings of code, including a mathematics code, which allows some people to succeed more, and contributes to motivation. Bourdieu's theory of habitus refers to the physical embodiment of cultural capital, to the deeply ingrained habits, skills, and dispositions that we possess due to our life experiences. According to Bourdieu (2018), motivation can be embedded in a class habitus, as life experiences and capital are extremely interwoven and affect how one approaches challenges and their self-efficacy. All of these theories can be combined to better understand how people's life experiences shape their decision processes, and therefore shape their motivations behind the choices they make and what they choose to pursue.

A specific aspect of self-efficacy is related to gender, and the ways gender plays a role in how students are encouraged and promote their own success. In certain subjects more than others, there are gender expectations on who will be successful. Part of this is self-confidence and the ability to feel comfortable in a classroom, but curriculum and society also have a role in

telling where students should and shouldn't be comfortable. As stated previously, there exists a large representation gap in mathematics between females and males, which has a few different origins (Good et. al, 2012). Motivation is driven by a sense of belonging, and Good and colleagues (2012) found that women have a lower sense of belonging in the mathematics classroom, which then affects their decisions and motivation to pursue math in the present and the future. The belief and messages that women are told that men are inherently better at math promote a lowered sense of belonging and decreases their motivation to continue math in the future. This study's findings are consistently found by other researchers.

When looking further down the line into choosing STEM majors in college, there are many factors at play when it comes to a woman's decision to do so. Out of these factors, motivation plays a key role in the pursuit of a STEM major over other disciplines. A student's demographic and social background are crucial factors into understanding their role and comfort in a classroom environment, but these also play into motivation. Achievement specific behaviors associated with test scores and self-efficacy affect a student's enrollment and motivation in STEM courses. However, there is a level of domain specific motivation that is influenced by family backgrounds, cultural norms, and reactions from previous experiences (Zhang et. al, 2021). Zhang and colleagues' (2021) study compared STEM and non-STEM majors and asked them about their beliefs and self-efficacy in mathematics and other STEM fields and the relationship to their own driving motivation into them choosing their major. The authors found that STEM majors have significantly higher self-efficacy beliefs in these fields compared to non-STEM majors, which was expected. They also found that demographic factors and backgrounds were a large factor in the motivations when choosing one of these majors, and that female students were significantly less motivated to pursue a STEM major compared to their male

counterparts. Although the researchers found that a student's identity played a role in their choice for a STEM major, additional research still needs to be done about the key factors in motivation specific to gender identity when choosing a STEM major to identify the difference in the decision process between males and females.

Another factor that influences a female college student's desires to pursue a major are the stereotypes surrounding math and STEM subjects. Women's math performance is impaired when gender stereotypes about math aptitude are present, further known as a 'stereotype threat'. Additionally, women's personal acceptance of gender stereotypes has been linked with poor performance and reduced desire to pursue math-intensive careers (Steele et al., 2002). Amy Kiefer and Denis Sekaquaptewa (2007) wanted to look at these explicit and implicit gender stereotypes in a college setting with women who were enrolled in calculus classes. They were able to successfully find a link between these stereotypes and gender identification to women's desire to pursue math-related careers. This helped prove the hypothesis that a woman's math performance is debilitated by stereotypes when they are automatically activated or when women perceive them to be self-relevant. This may explain why women who are math-oriented distance themselves from stereotypically feminine characteristics. The explicit stereotype threats that women face in regard to mathematics corresponds to their motivation and have distinct effects on their self-efficacy and performance when it comes to mathematics. This distinct change in motivation also predicts the lowered intentions to pursue a career in mathematics.

The role that these negative stereotypes and stereotype threats play in a woman's self-efficacy are crucial. In the academic context, perceived self-efficacy influences the way the students learn, engage in learning and in classroom activities, motivate themselves, make decisions, feel, and behave (Todor, 2014). Students with higher self-efficacy participate more

and persist longer than students with a lower sense of self efficacy and those who are doubting their capabilities. Gender differences in mathematics self-efficacy were documented in a number of studies, but Todor's (2014) aim was to investigate gender differences in implicit theories of intelligence (general and domain-specific) and mathematics self-efficacy beliefs. She studied a group of boys and girls and presented them first with questions on theories of intelligence, and then focused on mathematics by looking at the scale of intelligence and the scale of self-efficacy. In all of these categories, she found that girls tend to hold an entity theory of intelligence, which is a belief that intelligence is a fixed trait that cannot be changed, and compared with the boys, they have lower self-efficacy and feel less competent in mathematics. These findings are continuing to support studies done by others (Steele et al., 2002, Moé & Putwain, 2020, Kiefer & Sekaquaptewa, 2007) showing that girls tend to have significantly lower self-efficacy when it comes to mathematics at a variety of different ages, and that negative stereotypes are a leading factor in why this is the case.

Many scholars present theories about girl's attitudes towards mathematics, the lack of motivation they receive in the classroom, negative stereotypes presented by society, and how teachers are interacting with female students. Based on these theories of what discourages women from pursuing mathematics, Ungadi (2015) wanted to investigate what motivates women to do mathematics at a higher level, and then when they do, what causes them to eventually abandon their careers in mathematics. The number of women that continue to pursue mathematics in college and a career is less than the number of men who do, and this study looked at why they are more likely to quit the field even after receiving a degree in mathematics. Ungadi's research led him to information globally about how familial values, as well as other cultural factors, play a role in a young woman's motivation to pursue math and science and the

reason why they abandon as well: “Women are not just intrinsically motivated to leave pure mathematics to other fields; their decisions are also attributed to close family members, in most case males, who feel that they may not excel in mathematics" (Ungadi 2015, p. 245). Girls were not well motivated and exuded fear and panic in relation to learning mathematics. This resulted from lack of enthusiasm and self confidence among them. Their lack of confidence, anxiety about mathematics, and the feeling that mathematics is a male’s world contributes heavily to their under-representation in this field (Hutchinson et al., 2009; Riegle-Crumb et al., 2016). Outside influences such as these tend to play a significant role in decisions to pursue mathematics as a career for women, and Bernstein’s code theory from earlier can be used to see that mathematics itself is a code, and women with the knowledge of it are able to gain power in society. The nature of mathematics accords women a measure of power, knowledge on how the discourse of mathematics conditions them into thinking and behaving in particular ways (Harker & May, 1993). This power in society is a driver of motivation for pursuing it, and the repeated exposure of mathematics and knowledge of this code allows women to continue.

Ungadi’s (2015) research involved interviews of three women in mathematics to understand their motivation of pursuing mathematics in the first place, and then their motivation for leaving the field and changing careers. His interviews found a lot of evidence supporting previous research on why women are motivated in mathematics: family values and encouragement, positive reinforcement of doing well in math, and teachers helping to combat negative stereotypes. However, later in their careers, women are often faced with discouragement and negative reinforcement of stereotypes which can lead to abandonment of mathematics. Ungadi found that sometimes women lose interest in the subject and want a change, but in other senses women find themselves facing a lot of discouragement, either from

colleagues or friends, with their involvement in mathematics. While women initially find motivation in mathematics and are encouraged to do so in higher education, Ungadi found that they are often met with discouragement later in their career when the number of women is even more scarce, causing them to leave the field of mathematics.

There is a lot of evidence and research that motivation and self-efficacy in math is influenced at a much younger age than college. The relationships between motivation, test anxiety, and performance with mathematics has been shown to start around elementary and middle school aged children, which affects their sense of belonging in mathematics later in life. Shores and Shannon (2007) found that significant relationships exist between motivation and performance in mathematics. Additionally, anxiety also played a role in academic achievement. Self-efficacy related judgements of the fifth-grade students were able to significantly predict mathematics anxiety in their perceptions of their mathematics ability. This study showed how these themes of motivation and self-efficacy begin at a very young age, but there is not yet a specific gender divide from this research. However, additional research shows gender changes in motivation and self-efficacy. Male students typically believe they are more skilled in mathematics, and female students have lower motivation due to stereotype beliefs (Moè & Putwain, 2020). Moè and Putwain (2020) conducted an experiment that involved an experiment by giving both males and females a message before doing a math problem and studying their mathematical performance and their intrinsic motivation. When male students were given an evaluative message before doing a math problem, it increased their performance and ability. However, female students were not affected by the messages positively and it led to a decrease in intrinsic motivation. The researchers believe this was most likely due to the consequences of the nature of stereotypes in mathematics currently. This supported their hypothesis that female

students are more likely to experience stereotype threats where they fear that no matter how much work they put in, they will not score well due to the stereotypes society has set out for them.

Within a mathematics classroom, gender differences exist between boys and girls that play into their motivation and self-efficacy. Samuelsson and Samuelsson (2016) present their research on the difference of boys' and girls' perceptions of mathematics in the classroom because of how things are taught. This directly relates to previous mentions of the pedagogy of mathematics, and the way society has ingrained gender biases relating to this subject. The way that mathematics is taught affects a student's perception of their ability to complete the subject, which then affects their own self-esteem and self-efficacy relating to school. Drawing on research, Samuelsson and Samuelsson (2020) put together a study questioning over 600 students in mathematics about their classroom experiences to understand both student's relationship with mathematics and student achievement. They were able to find that girls and boys do perceive the classroom environment as different, and part of this is due to teacher interaction. Teachers are more likely to interact with boys than girls in a mathematics classroom, and these differences end up reflecting the extent in which teachers are found supportive by girls and boys. The aim of their study was to look at the boys' and girls' relationships to mathematics due to the fact that boys perceive higher motivation and self-concept than girls when it comes to mathematics, and they were able to find a significant difference in this between boys and girls. The age of these students was about 16 years old, and the evidence that Samuelsson and Samuelsson found support the fact that girls have lower motivation in these subjects and are less likely to pursue a major, as suggested by Zhang.

While it is clear that there are stark gender discrepancies in mathematics, there are various efforts trying to combat stereotypes and encourage women to pursue this field. I am hoping to combine the themes from this literature review to better understand the encounters of female math majors and open a dialogue about their shared experiences and what can be improved. By looking at how society expects women to behave, psychological motivators for women, and general views of mathematics in conjunction with one another, we can pave a better understanding of the true daily experiences for female math majors.

Methods

Context

This study was conducted at a small private liberal arts college in the northeast of the United States. Throughout this study, I will call this school Woodbridge College. Woodbridge College has about 2,000 students and is highly selective. They offer 56 majors and 35 minors, as well as the ability to design your own major. This school was one of the first private liberal arts colleges to allow women to enroll, and now is about 47% male students and 53% female students. This is also a predominantly white institution, with approximately 34% of the student body identifying as students of color. A large portion of the student body comes from private schools, and many others come from public schools that are in districts that have very high median household incomes.

The math department at Woodbridge College is similar to those at other small liberal arts colleges. Woodbridge has 15 faculty and staff members as a part of the math department, and the majority of the professors are older, white males, and most of these professors have tenure. The statistics department has now separated from the math department and has its own major rather than being a concentration in the math major. This department is composed of 5 professors, who are also all white males, and only a few of them are tenured. Within the math department, there are two different majors - mathematics and mathematical sciences. The mathematics major is centered around pure math, with more proof-based problems. The mathematical sciences major is centered around applied mathematics, which involves applications of different concepts using more numbers. There is also a mathematics minor. For my study, I only chose to interview only majors. I had a mix of both mathematics and mathematical sciences majors, all of whom were

female. They were also a mix of sophomores, juniors, and seniors. I chose not to include first years in my study because they have not officially declared their majors.

Participants

As part of this study, I interviewed 7 female math majors, 2 female math professors, and conducted a focus group with 5 female educational studies majors all at Woodbridge college. With the 7 math majors, I conducted two interviews that were each around 45 minutes in length. These interviews were all about two weeks apart to give time for the participants to reflect on what they shared during the first interview. There was one interview with each professor that lasted about 45 minutes. The focus group took about an hour with the group of 5 education majors. The list and description of the math students that I interviewed is shown in Table 1. Table 2 has a description of the math professors, and Table 3 has descriptions of the participants in the focus group. All names were changed in this study for the purpose of anonymity.

Table 1

Name	Age	Social Class	Race	Hometown	Year at Colby	Majors/Minors
Margaret	21	Upper	White	Big City, South	2023	Mathematics and French Majors
Leah	19	Middle	White	Big City, Midwest	2025	Mathematical Sciences Major/CS and WGSS Minors
Amelia	21	Upper Middle	White	Suburb, Northeast	2024	Mathematical Sciences Major/Physics Minor
Julia	22	Upper Middle	White	Suburb, Northeast	2023	Mathematical Sciences Major/American Studies minor
Riya	20	Upper Middle	Indian	City, Northeast	2024	Mathematical Sciences and Computer Science Majors
Meiling	20	Middle	Asian	City, Asia	2024	Mathematics and Anthropology Majors/Data Science Minor
Isabel	20	Upper	White	Big City, Northeast	2024	Mathematics Major/Jewish Studies Minor

I recruited the participants in Table 1 by reaching out to a math professor to pass along a message to all students in the math department. From there, only female math majors were eligible to be in the study. This eliminated a large portion of the math department, and I wanted to speak to math majors compared to math minors because they would have more to speak about with their experiences in the department with encounters with different professors and other students. Many of these female students came from similar backgrounds, with the majority of students being white and coming from an upper class or upper middle-class background. Many of the students were also from the northeast. There was a mix of both mathematics majors and mathematical science majors, and all of the participants either had a second major or a minor, some of which were in humanities fields, and some were in STEM.

Table 2

Name	Race	College	Graduate Program	Years in Academia
Professor Hannah Wright	White	Princeton and Julliard	Princeton (Physics program)	~14 years
Professor Elizabeth Meyers	White	Smith College	University of Nebraska Lincoln (Mathematics)	~9 years

Table 2 features basic information about the two female math professors I interviewed. They have both been in academia for several years and have spent many years teaching at Woodbridge College. They both attended elite institutions for undergraduate degrees in mathematics, and programs in the top of their fields for graduate school. The main purpose of speaking with both of them was to hear about the experiences of women in mathematics who have spent a considerable amount of time in the field, and to see if their experiences are similar or differ from the experiences of current undergraduate female students.

Table 3

Name	Race	Hometown	Year at Colby	Majors/Minors
Rose	White	Suburb, Midwest	2024	Psychology and Education
Madison	White	Suburb, Northeast	2023	Education and Environmental Science
Molly	White	City, Northeast	2023	Education with American Studies Minor
Claire	White	Suburb, Northeast	2023	Education and Music
Hannah	White	City, Northeast	2024	English and Education with Sociology Minor

Table 3 features general demographic information from the focus group I did with educational studies majors. Four were only involved with humanities and social science disciplines. One of the participants was a major in a STEM field (environmental science). They were all white females who were a mix of juniors and seniors. The main purpose of hearing from them was to compare and understand the contrast of experiences between STEM majors and non-STEM majors.

The data in all of these tables were collected through interviews or surveys after all of the participants had signed an informed consent form. The general demographic data in Table 1 and Table 2 was collected in the individual interviews, and the information in Table 3 was collected through a survey sent out before the focus group. The questions on the survey were fill-in-the blank. Between the focus group with education students and the interviews with math students, the ratio of students who went to private high schools and public high schools was about even.

Everyone who I interviewed identifies as female using she/her pronouns. This was a key factor in gathering participants, as I wanted to hear the in-depth experiences of females in the math department because they are the minority in STEM fields and have historically faced a great deal of misogyny in some of these classes. After hearing from the math major participants, I spoke to the math professors with very similar questions. The idea to speak to non-math majors came during the interview process with math majors, and I realized I wanted to compare experiences within the two disciplines I study, mathematics and education, as a representation of overall experiences in STEM versus other fields.

Data Collection

The primary source of data was collected through interviews. I conducted one-on-one interviews with 7 math major students, each being interviewed two times. Interviewing them two times gave me a chance to hear about their overall educational experiences in relation to mathematics, and then by the second interview they had time to reflect on and draw meaning from them in relation to their past experiences and what they will take with them into the future. I conducted all of these interviews in person, which were all conducted in a small conference room at Woodbridge college. The two rounds of interviews averaged about 35-40 minutes in length each. The first interview focused generally on the students' mathematical experiences starting at a young age up until now, allowing them to detail their experiences and what interested them in math. I also asked general questions about their college math experiences, and their role as a woman throughout what they have experienced. The second interview was a chance for them to reflect on and develop meaning from their experiences. This interview featured more opinion-based questions, and their views of others around them, rather than asking

for details on their life. For more detail on the specific questions asked during the interviews, all interview guides can be found in the appendix.

The reason I chose to do two interviews was to allow students to have time to reflect and come in with heightened thoughts to the second interview. The goal of the first interview was just to have students give in depth details on their mathematical education and what brought them there. I wanted the second interview to build upon the first one and allow students to think back on the experiences they had mentioned in the first interview and continue to articulate the meaning they derived from it and the feelings they have experienced. While the second interview also featured questions about general experiences in the department, these were more focused on specific positive or negative experiences they could talk about and were targeted towards their relationship with math and gender. The two interviews were spaced about a week to a week and a half apart from one another to allow the participants to do some reflection and thinking on what they had shared, which aimed in helping shape what they brought into the second interview.

I also conducted an individual interview with two female professors from the math department. These were both done in their respective offices and were only a single interview to mostly hear about their experiences through school and their career. These interviews featured very similar questions as the interviews with the students, as the main goal was to hear about their experiences as a woman in mathematics who has pursued a career there. Additionally, this data was used to compare experiences of college-aged women compared to older women, and see if the experiences were similar, or if there has been improvement for gender equity.

The last form of data collection was a focus group with 5 students from the education department. In this focus group, I asked less questions than in the interviews to allow them to bounce off of one another in discussion about their experiences with math and education overall.

Their demographic information was completed via a Google Form before meeting in the focus group to allow the group to just have time to talk about their education. These questions still had similar themes to the individual interviews, but there were fewer of them to allow the students to talk with one another in sharing their experiences.

Data Analysis

The process for data analysis involved going through all the interviews to pull information to use for the findings. All the interviews were transcribed using computer software, and I went through them to check accuracy after receiving the transcripts. This produced a couple hundred pages of transcripts. I then went and read through all the interviews, keeping the information from my literature review in mind, and generated a list of 40 ‘codes’. These codes were small words or phrases that stemmed from recurring themes, ideas, and words in the interviews, such as gender dynamics, motivation, and self-doubt. I then used these 40 codes to reread all the interviews line-by-line and assign certain sections to the codes. After this, I narrowed down to 19 codes that were most significant after removing codes that did not show up enough, were redundant of one another, and combining codes that had overlap into new codes. With these new codes, I completed a second code of the data and reread the interviews again. As the last step, I was able to categorize these 19 codes, by taking the most prevalent ones from the interviews to combine them into my three main narrative finding themes - elevated status, apprehensive identity, and gender solidarity.

Narrative Findings

Elevated Status

In the second round of interviews, there were many questions focusing on the participants' opinion of being a math major, and opinions that they get from others. Many times, the participants had shared experiences when discussing the math major with outsiders and had slightly varying opinions on how this made them feel when people gave them their two cents on being a female math major. However, one of the most surprising things to emerge was how the math majors view their major in relation to other disciplines. Many outsiders see majoring in mathematics as a difficult feat and give it an additional added status. However, the math majors themselves do not necessarily agree with this. There is an element of actively disagreeing with the opinions that others are giving, especially regarding how the math major is supposedly harder than other disciplines. Despite having an overwhelming opinion from others about the high status a math major has in the education realm, many of the participants reacted to and are actively challenging the idea of how difficult the math major is and how other majors get discredited.

Reactions of Outsiders

Being a college student often comes with an accompanying question about what you are studying. When the math majors described the types of reactions they get from people, there was a very common response they received. Many gave examples of comments they have received when they first tell someone they are a math major, such as Amelia (a pseudonym, as all names of people and places in this thesis) saying “I feel like the majority of comments that I get are like ‘Oh my God, you're a math major. Why would you ever do that to yourself?’ Nothing really in regard to my gender.” There were often such strong negative reactions about being a math major, and others gave off a reaction of disgust and concern about being a math major. Amelia stated

that this did not have to do with her gender, and most of the participants had similar experiences. They mentioned that reactions about them being a math major never explicitly had anything about them being female, however there may have been implicit meanings about gender in some of the reactions they have received.

Leah echoed a very similar statement to Amelia about the type of reactions she gets: "'Why do you do that?' Just a lot of disbelief. Or I feel like people try to compliment you for it in the way of saying, 'I can't do that.'" Leah and Amelia both described these immediate negative reactions of people wondering why they would ever subject themselves to being a math major, and it is something that they have learned to brush off. Riya built off of Leah's point of how people try to say that they could never be a math major as a sentiment of indicating how smart they are:

> They're always like, 'oh, wow'. I think everyone really thinks it's a very hard major. It is hard, but I don't think it's overhyped as people make it out to be. It's not that horrible. But yeah, I think most typically they're all like 'oh my gosh that sounds really hard'.

There was a similarity in all of the reactions that usually has to do with an element of shock or disbelief. Math is seen as a difficult subject, and while the majors themselves disagree with the status it has and how difficult it truly is, it is evident in the responses they get as to how math is perceived.

Part of the reason that the participants are receiving such strong responses is because of the way the math major is viewed. It is seen as an extremely difficult subject to focus on, and since many people have negative experiences with mathematics throughout their lives, it is something that is hard for others to fathom spending 4 years dedicating their studies to this discipline. This is not the case for all majors, and sometimes STEM majors, particularly math,

get this higher level of reaction compared to a humanities major. Isabel explained this when she was talking about the difference between reactions she gets as a math major and from one of her friends who is an anthropology major, saying:

> I just feel like there is a perception that if you study math you're somehow smart. I just don't think that correlation is true, and I don't even know what it means to be smart because like I said, I don't think it has to do with your grades. I just feel like sometimes they get a certain response and I get one response and I just don't agree with the difference between them.

Here, Isabel is highlighting how she feels the stark difference in the reactions she gets compared to other majors is not always fair or accurate. The reactions she often gets allude to her being such a smart person, but she questions what it means to be smart, and why the math major is seen as something that makes you so much smarter than others. Leah echoes what Isabel says about how certain other majors do not get the same reaction from outsiders, saying, “It's just really interesting because I feel like that's not a reaction that very many other majors get, but it's really common with math.” These types of reactions are common in mathematics, as all of the participants described receiving reactions of a similar vein, which all relate back to this elevated status that mathematics has in an academic setting.

During the education major focus group, the participants were able to confirm that the reactions they get about what they are studying varies greatly from the experiences of the math majors. While the math majors are often praised for how smart they are and how difficult the material is, the education majors have occasionally been told the opposite when they tell others what they are studying and receive very different types of reactions. Rose elaborates on this, “I've learned to kind of just not look for a reaction honestly. Not even because I've had any really

bad experiences, but also with my own view on education. I love the major, don't get me wrong, but I know that people look down on it." She acknowledges that studying education has great meaning to her, but the overall consensus from others is that this major is not seen as hard or isn't as likely to provide a lucrative career as some other disciplines. While the math majors are used to receiving very specific types of reactions about how smart they are and how difficult it must be, Rose and some of the other education majors explained that it comes as a surprise if they get any reaction at all.

Another education major, Hannah, echoed some of Rachel's feelings in her interviews. She said, "Besides education, I'm also an English major and I think a lot of my STEM friends think that my work is easy. It's not always easy. It's actually very challenging sometimes. So that's one reaction I get a lot that I don't love." This shows that there is a stark difference in the reaction she gets having two majors in the humanities, and part of this reaction is coming from other students. The math majors described the reactions from other students and from other generations with a general consensus of it being very difficult, where the education students have described that other students sometimes give reactions indicating superiority of STEM majors. Molly, a senior education major, has also experienced some of this throughout her four years in the department. Despite having close friends in STEM who know the nature of her major, she said "I feel like I do hear from a lot of STEM majors that they think that we don't work hard." This reaction is not one that the math majors received at all; they were frequently told the opposite. This dichotomy shows that there is an elevated status that comes along with the math major over a major such as education which falls under the humanities.

Interpersonal Feelings of Others' Opinions

As seen from the previous section, there is a clear type of reaction that the math majors get when talking about their major. However, there are a variety of emotions that the participants talked about feeling when they get these reactions. In some cases, they experience a few different feelings at once when these comments are made. Participants expressed feeling pride and happiness of their accomplishments in the major, while some downplay the difficulty of the courses, and sometimes they just feel uncomfortable with the reactions they are getting. While they can recognize this elevated status of mathematics is causing them to get these praised reactions, they do not always feel that they are deserved.

When Riya is told that the major must be very difficult, she describes her initial feelings and how she responds: "I feel like my automatic response is to just be like, 'it's not that bad I promise!' But I think it does feel kind of nice to know that what you're studying people think of it as something hard, even if I don't know if I necessarily agree with that." Her first instinct is to combat the sentiment of how hard it is, but also acknowledges the feeling of pride she gets knowing people respect what she is studying. Leah emphasized Riya's feelings saying,

> They're like, 'That's crazy!' It's just what I like doing. I don't think it's that crazy. I could never be an English major or a studio art major, but there are people that like that and that's cool. It kind of confuses me. I don't think it's as crazy as people make it out to be.

Here, Leah is reiterating the point that these reactions usually involve someone emphasizing how difficult the major might be, but her initial reaction is to think that it really is not that difficult. She enjoys doing mathematics, so she doesn't understand why others emphasize the difficulties.

Isabel had a lot of thoughts on the reactions she receives and how they make her feel. She felt similarly to Riya in how she sometimes lessens the difficulty of the major as one of her

initial reactions, saying: “I always feel prompted to be like, ‘yes, you could definitely do it!’ Even if I don't know them or if they'd be suited for math. But I always feel like I have to downplay how difficult it can be, even though it is very challenging.” Neither she nor Riya could fully explain why they felt the need to downplay the difficulty of the major rather than acknowledging how difficult it can be at times. It was a natural response for both of them even though deep down they both acknowledged the true difficulty of some of the courses they take. Isabel also spoke on how the reactions typically involve a message about how smart someone is. Like Leah, Isabel spoke about how she enjoyed mathematics and working with numbers, so to her being a math major does not feel like something unfathomable. Below she elaborates on her initial feelings about the reactions, and how they have changed over time:

> At first, it felt good hearing that I am doing something that's hard. That is nice to hear, but then I feel like as time went on, I feel it is just misconstrued. I don't necessarily feel like I'm good with numbers. I'm usually not working with numbers. I don't know how to quantify how smart I am because I'm studying math or something like that. And so, I used to kind of like hearing it and now I'm indifferent to it.

There is an assumption that being good at math makes someone smart, but Isabel does not believe that should be the sole measure and that there should be a different measure of intelligence. Just because someone is good at math is not the only reason someone can be considered smart, and it does not make them significantly smarter than someone who does not enjoy math. Because of this change in her thinking, the reactions that she gets mean less to her because she knows being a math major does not make her smarter than another person.

As many of the math majors have pointed out, they sometimes do not understand the reactions they get from people who make it seem unthinkable to be a math major. Leah said

earlier that for her being in another major such as English or art is something she could never do, but people do not give those disciplines the same reaction. In the education major, many of the participants of the focus group described that they do not always get a positive reaction about their major. Claire, a double major in education and music, spoke about the sometimes-negative reactions she is met with, and how she has decided those opinions do not matter:

> My education major is my more 'practical major' and I think as education majors, we know that education is so important and teachers, you know, they save the world. So, one time when I was talking with someone, I said that those were my two majors and they were like, 'Wow, like that's really cool. You can change the world with that.' I thought that was really cool and inspiring. So, yeah that's why I'm doing this. And so, screw everyone else who thinks differently.

Claire is aware that her majors have a reputation for being impractical in the real world and can be looked down upon. Instead of letting these comments get to her, she has ignored them and put power back into what she is studying. Instead of letting others' comments affect her choices, she has used it as motivation knowing that she is studying what she is truly passionate about.

In the focus group, all of the participants described either very neutral or negative reactions about being an education major. Rose detailed an interaction with one of her friends who is studying biology who looks down on Rose's education major and the work that she does. For the most part, Rose said that the other reactions that she gets do not really bother her, but these interactions she has had with this other student have been quite frustrating to her:

> She just loves to rub in how hard her major is and completely rides off my psychology and education majors and it pisses me off. Not that I'm trying to get a big reaction or anything, but nobody ever says how hard it is and that does kind of get under my skin a

little bit because the education major is not easy here. I would argue at least the classes I'm taking right now I feel are not easy.

It is extremely frustrating for Rose and the other education majors to be met with an active mindset that their work is much easier than others when people not in the department do not know the true extent of the work. Just because the nature of the work is not widely seen as difficult as mathematics, they are still studying at a top institution with rigorous academics, and to have their work discredited has not been easy to deal with but are reactions that they have often learned to ignore.

Many of the math majors have acknowledged that people see what they study as something very difficult and must be a lot of work. Some of the participants mentioned, however, that these reactions that they are getting do not always make them feel good or smart in the way that some intend. Meiling talked about this and the difference in reactions that different majors get, saying, “To be honest, others saying you're smart is a positive moment. So, I would feel good about it, but I also feel like what they're saying is not really the truth. People who study math do not need to be smart at all.” She disagrees with the sentiment that studying math makes you extremely smart, or that only smart people can study math. Hearing from others that she is smart does feel good, but she doesn’t think it is necessarily accurate.

On a similar note, some of the other participants also found the reactions to be a bit unsettling and made them uncomfortable to get such praise sometimes. Julia explained feeling this way saying it makes her: “A bit uncomfortable? A little bit good but also, it's a weird thing to say because it doesn't make someone better than other people or necessarily smarter. It's just the way your brain works.” Her point goes along with Meiling’s above sentiment about how being a math major does not make someone smarter, but there exists a hierarchy of certain

disciplines being correlated with how smart an individual is. This overall sentiment leads to a feeling of discomfort because of the way the math major is viewed and comments that come along with it. Amelia also expressed this and how there can be a difference between reactions she gets from people her age compared to people who are older than her:

> I feel like they both make me a little uncomfortable. Sometimes from the older generations they're like, 'Oh my God, look at you so smart.' They say all this stuff and you're just like, 'yeah, I don't know. It's fine.' And then when I say my major, I don't really know how to respond to it. I could never be an English major.

Amelia's words echo the points made by all of the participants from this section. She explains how the reactions she gets do not always lead to a good feeling internally, as well as how she actively disagrees when people give shocked reactions. There was a very similar mindset held by all of the participants about their feelings to the reactions they are so used to getting. By repeatedly receiving comments relating to their math major, they have had many experiences to understand how the reactions make them feel and why they are receiving them.

Thoughts and Relationships to Other Disciplines

As mentioned in the previous sections, some of the reactions that the participants get highlight how some other disciplines do not receive the same level of disbelief as the math major. To follow up on these sentiments, all of the participants were asked to share their perceptions on other disciplines. I first asked them to talk about the differences in their math classes and their classes in other disciplines, and how they perceive majoring in a different discipline to vary. Julia spoke about how she would expect there to be a difference, saying "I think they spend a lot more time writing than I do obviously, and their classes are a lot more discussion based than mine. I think they're just using totally different skills than I am." Here, she

is mostly just highlighting the differences in what she has experienced in her classes, as the nature of the work is different between disciplines. Isabel also explains this when describing her minor: “I would say I have to be a lot more active in my learning in a math class than I do in my Jewish studies classes. If you don't understand math you have to go to office hours or find someone that knows how to do the problem.” She states the difference in her classes and how the in-class dynamic is where she notices the contrast between math classes and other disciplines.

The participants deemed a hierarchy of majors exists, where some are seen as more difficult and better choices for being successful after graduation. The math majors were advocates of not saying that the math major was significantly more difficult than any other major. There was a general consensus that they deemed the difficulty of the discipline was directly related to how much time and effort went into the work. Rather than just making an assumption that STEM majors are inherently more difficult, all of the participants agreed that difficulty is related to the amount of time and work one needs to do to be successful. When Riya was asked if she thought that humanities majors were easier than STEM majors, she said the following:

> I don't think so. I think it's just a different kind of work, and depending on how you just do work in general, one might be easier for you specifically than the other. But I know that for me, I like having a problem set to do as opposed to having readings because I know I just wouldn't do the reading. I would be screwed for the rest of the class.

Riya describes how it is personal preference of what type of work she likes to do and knows that while she prefers problem sets and exams, there are many other students who would hate doing that and would prefer readings and essays. Amelia elaborated on this point because she knows that having to write as the majority of her work would not be something she would be successful

at, saying, “I can't read all that quickly. So that would take me probably the same amount of time as doing a problem set. I have respect for all of the different majors, but I feel like there are some majors that just require less work and time.” She acknowledges that for her, problem sets are the type of work she prefers, and continues to build on the notion that majors that require less time are the majors that are considered easier.

To continue building off of the idea of what makes a major easier than another, participants were asked to elaborate on their thoughts of other majors and the amount of effort going into them. Riya had a lot to say about this, as she has many roommates who are in the humanities, so she has seen the work that they do. She says, “I think it's honestly the same level of rigor and work, but their schedules are just vastly different. There's little homework every single day as opposed to one that's due every single week. And their essays vary over time. So, I feel like there's a lot more flexibility.” This highlights the idea that in the math major there is a more consistent schedule of having problem sets due each week compared to the ebb and flow of having a few essays throughout a semester. Many of the education students in the focus group also had a lot to say about the comparison of different disciplines. As they often receive reactions belittling the nature of their work, they have adopted their own mindset to ignore the negativity. Rose explained her thoughts on comparison of disciplines and different attitudes she has implicitly picked up on through other’s comments:

> Part of me believes that their courses are harder, but I think that's just my own experiences with math. Clearly, they find math way easier, and maybe writing a 10- or 12-page final project or paper would not be easy for them. And so, I try to remember that there's a lot of writing that happens in the education department, at least in my own experiences, and I find that just as important as STEM or math.

Rose is nearly echoing Amelia's earlier point, saying that while she would find math very difficult, others would find the work that she typically does in the education major very difficult. Hannah agreed with this point. She says, "I know if they [STEM majors] had three papers to write in a week that would really stress some of my friends out. I feel like it's just because of the fact that everybody has different strengths." It is a better way to look at the difficulty of disciplines person by person through the idea of individual strengths rather than generalizing out to the discipline as a whole and characterizing some as 'hard' and 'easy'.

Nearly all the participants of this study, both the math majors and the education majors, shared similar points of view about how they viewed each other's work as difficult, and everyone has different strengths and weaknesses. There was not a general consensus that math or STEM disciplines are always going to be more difficult, as every discipline has hard courses and will require a lot of hard work. Isabel was one of the participants who had the most to say on this subject, as she thought the reactions about the math major were sometimes unjust:

> I think it's such a misconception when people say, 'STEM is so much harder than the humanities.' I will say, sometimes it feels like we have to complete more of our work. If you didn't want to read a passage, maybe it wouldn't bite you in the butt right now, but it might for your final or anything like that. But you might be able to not read the passage and be fine for class, unless you have a big discussion about it. But if I don't turn in my problem set, that very much directly affects my grade right now. I'm sure they probably will need all those readings, but sometimes it feels like my work piles up more than it does for the humanities. But I don't think the humanities are easier; I think they're quite possibly harder.

Isabel highlights the different nature of the work and how different disciplines look over the course of a semester. She is actively disagreeing with this sentiment that STEM courses are harder and is working to show others this is not the case and change the general mindset of valuing the work of some majors over others.

Dismantling the Hierarchy

A hierarchy of majors and disciplines has been established, leading to a variety of reactions and comments depending on what one is studying. Despite there being this unspoken ranking and math majors being at or near the top, the participants had a lot to say about going against the notion of a hierarchy. Isabel actively disagreed with an idea that math majors should be held in higher esteem than a humanities major, saying "I really dislike when people say, 'Oh the STEM fields are much harder than the humanities fields because I don't think like that at all, and I don't think it's true because I have such a hard time writing essays." She emphasizes this point many times throughout her interviews and is an advocate for making sure all majors have their hard work recognized. Leah similarly had a lot of thoughts on this idea, and shared her opinions on changing mindsets about the difficulty of majors:

> I don't think they're actually easier. I think the nature of the work is different. And the thing about math is that you have pretty consistent work all the time and with other humanities majors it tends to fluctuate more where we just read for a couple weeks and then you have to write a paper and all of a sudden, you're like, 'Oh shit, I gotta write this 10-page paper' and then it'll kind of go back again. So, I don't think they're easier at all.

Leah continues to talk about the difference of the nature in the work, and by taking courses in these disciplines, she has realized that they are not easier by any means and does not agree with people who say otherwise.

While nearly all of the participants have mentioned moving towards a new mindset seeing all majors as equally difficult, a few spoke about how their parents hold this mindset and that the idea of a hierarchy comes from older generations. Margaret spoke about how her parents had a bit of an influence in her deciding to be a math major. While she has always enjoyed the subject greatly, her father had an opinion which was a very small reason why she stuck with the major. She explained, “My dad is a very conservative man and so he definitely believed that there was a hierarchy in classes and majors. And so, he was always like, ‘Keep the French major because you like it, but also do as much as you can to stay in the STEM field.” Although she greatly enjoyed math growing up and was a huge part in her decision to major in it, her dad encouraged her to keep it as a means to help her post-graduation. Margaret elaborated on this point:

> I tried to see them [majors] as equal as possible. Like I said in the last interview, my dad thinks that there's this hierarchy of majors and classes. I try not to think that way because I try to recognize that the complexity of subjects is relative to every single person. I think that I'm good at math and I like doing math, but I hate physics with a passion and find it extremely difficult.

As part of actively combating the idea of a hierarchy, many of the participants have decided to look at each major holistically and separately. What one person may find very difficult could be easy to another, which is why it is not fair to characterize only some majors as difficult.

Isabel had similar thoughts to Margaret about how there is a generational difference in how disciplines are perceived. She described the interactions that she has had with them and how she has noticed a difference in their thinking, and how she disagrees with that mindset:

> I know my parents and some of the older generation, they just don't understand how something like anthropology is like a subject that people are studying, which is so discrediting to them because it is such a real thing to study. So, I just feel like there is a perception that if you study math you're somehow smart.

Not only was she highlighting how others believe there is a hierarchy that she doesn't agree with, but she also points out that some disciplines aren't taken seriously at all or given any credit. She refers to anthropology in her interviews, but other participants brought up other subjects in the humanities and social sciences that were brought up. Isabel works on disregarding these misconceptions herself, as she knows they are not true, and many of the other participants are working on doing that as well. Leah spoke about how she also is actively trying to adjust her mindset about other majors because she knows that what she had been told growing up is not true:

> And there are moments when I'm like, 'Your life is so much easier.' And then I have to catch myself. That's not actually true. There are different skills and it's just a different way of thinking. But there are moments sometimes when it feels like I could have picked a path of least resistance and I didn't, but that's okay.

Leah actively works on correcting herself as she has learned that the perceptions she has formed are not always an accurate representation of all the hard work that goes into different disciplines. The time spent dismantling the hierarchy from the math majors who are coming from an elevated status is positive thinking towards giving deserved credit to all disciplines.

All of the participants did mention that what determined the difficulty of a major was how much time and effort went into it. With this, they acknowledged that not only STEM majors required a lot of time and hard work, which is why they believe that it is not fair for them to have

such an elevated status. Although the math major may require a lot of weekly work, the schedule looks different for humanities majors but that does not mean they are not working as hard. Julia described this idea in her comparison of math majors compared to others:

> I feel like there are some majors that you can kind of get what you want out of it, and you might be able to coast through more easily than you can coast through math. But I think that if you want it to be hard and you want to get a lot out of it, you can do that with any major.

Leah agreed with Julia's above points by saying, "It's just different. It's different structure and different skills. And just because it sounds nicer doesn't mean you would actually enjoy it or that you would be good at it." These two participants speak to a similar point that the nature of majors is inherently different, and just because the structure is different does not make one easier than the other. This hierarchy has existed to make it seem like some disciplines do not involve as much work as other disciplines, but with recognition that everyone works hard, and it is a matter of what people enjoy and where their strengths lie, the playing field is leveled of how all majors are seen and recognizing hard work will be put in no matter what one is studying.

Apprehensive Identity

The math majors discussed the feelings that they were left with after receiving comments and the idea that people view math very highly. These female students highlighted that this started by recognizing the reason people credit them greatly for math was due to the nature of the coursework, unrelated to their gender. However, gender becomes relevant when the recognition of the difficulty comes with a doubt in one's ability to complete certain courses in the discipline through forms of self-doubt and feelings of imposter syndrome. Both of these can be rooted in implicit biases of gender through experiences they have had started at young ages being

conditioned to assume math is a ‘subject for boys’. This transitions into questioning skills and abilities later when the gender disparities are much larger, and the material is more difficult. Despite feelings of doubt, the math majors are able to overcome their apprehension and focus on the enjoyment of the subject to drive them through the difficulty and prove that they belong in this space despite it being male dominated.

Difficulty of Courses

As mentioned in the previous section, one of the findings about what the math majors consider making a major harder than one another is the time commitment necessary to be successful in it. As many of the interviewees stated, being a math major involves a lot of time outside class working on problem sets and going to office hours. Some of the material can still be extremely difficult and is personal to the experiences of each participant. This difficulty has increased levels of doubting their ability to be successful and if they can complete the discipline, especially when getting into the higher-level courses. Margaret explained how the difficulty of some of the courses started to get to her, and that other math majors have had experiences similar to this as well:

> Can you really call yourself a math major if you haven't stared at a problem set and said, why am I here? Linear algebra and real analysis made me question that if I had decided to do another major, I wouldn't have to be sitting here on the brink of tears trying to figure out this take home.

Amelia echoed this sentiment, sharing, “It just seemed unfair and no matter how much work I put into it, it just seemed like it was kind of never enough,” when prompted to talk about one of her most difficult math classes she has taken at Woodbridge. Despite spending hours trying to

understand the course material, the difficulty of the material was still overwhelming and left her in a position greatly questioning her abilities.

Julia elaborated on these similar feelings when she was prompted to speak about a time she ever considered dropping the math major. She explained that when she has encountered a really difficult course, she can begin to question her own abilities, but then additionally question her overall decision to major in mathematics. While she spoke about occasionally wavering from the discipline when she was really struggling, she stuck with her decision:

> I think that when you're in a really hard course, you're like 'Why am I doing this? Is this stupid?' Especially because I feel like sometimes math can feel pretty inapplicable to the real world. You're like, 'why do I care what the derivative is or something like that?' And I feel like that's the time where you don't want to do this anymore.

Overall, when participants have been faced with a difficult course or problem set, a feeling of doubt can sometimes come along with it which can be in the form of questioning their own ability or a decision to pursue the math major. When speaking to the professors in the department, they emphasized the struggles and difficulties they had to go through to get to this point in their career and empathized with female students taking difficult courses in a very male dominated space. Professor Hannah Wright described this as, "Excruciatingly hard. It took me longer than most people. My background isn't what the mathematics department expects. So, before the time that I got this tenure-track job, it was always here to here." While she continued to go to graduate school and has more experience dealing with difficulties than the participants of this study, she spoke about how the same dynamics existed in some of her undergraduate courses and her graduate courses before becoming a professor with the major time commitment and hard work that the field requires.

Self-Doubt and Imposter Syndrome

As all of the participants are taking very difficult courses and are dealing with the opinions and reactions of others, it has been a natural feeling for many of them to question themselves. This doubt arises for a number of reasons and can take different forms, but this feeling of self-doubt was expressed by all of the participants at one point in their lives, whether that was in their college math experience or before. Amelia described that one of her biggest areas of feeling self-doubt is a feeling of imposter syndrome, where she wonders if she knows enough to really call herself a math major. Even though she has taken many courses in mathematics, she doubts her ability to be considered knowledgeable in the field:

> I feel like it's definitely tricky. I was talking with Olivia [her mentor] about this- I feel like I don't know enough math to call myself like a math major, where I feel like some other majors, they could go into so much detail about certain events or global studies and I feel they can just pull all these things out and I can do that to a certain extent, but I don't know enough math to really talk about all that much math.

She doubts her ability to know enough mathematics to be successful and feel that she is capable and smart in the field. Isabel said something similar in her interview, expressing the feeling of a lack of knowledge about mathematics: “Am I really equipped to use math out in the real world? If I don't know how to do this or anything like that. Or would studying math in grad school be too much if I don't know how to do this type of thing.” Both Isabel and Amelia find themselves doubting their abilities due to the nature of mathematics despite being capable of handling the coursework.

Self-doubt can also come from not feeling ‘smart enough’ or ‘stupid’ in mathematics. Meiling described how she sometimes faces this doubt and sees it as a challenge when she is

struggling with a problem set or an exam. She said, “I feel like especially in math, most people will think that is based on your intelligence. So, I feel like if I cannot figure that problem all by myself, then I'm not as smart as other people.” This heightens a feeling of self-doubt when one isn’t secure in their mathematical abilities or is able to solve problems because there is such a stigma around intelligence with a math major. Professor Meyers spoke of a similar feeling she had during her undergraduate years when she was studying mathematics. She completed a research summer program shortly after she had decided to major in mathematics, and had a difficult experience which led her to doubt herself and her abilities:

> I didn't understand it, and I asked some questions to my fellow classmates, and they seemed to think I was just ridiculous for never having heard of these things. I just remember I felt so out of place. I felt so stupid for the whole summer and there was nothing nice about any part of that experience.

Meyers was left with a feeling of stupidity because she had not heard of certain concepts before, which said nothing about her capabilities in the subject. However, she was left doubting herself because of the way others made her feel about her knowledge. Neither this experience nor ones that Meiling and other participants described about doubting themselves come from a place where others' opinions affect how they see their ability with math, however the negative comments from others is what leads to self-doubt.

Imposter syndrome was another occurrence that some participants mentioned when speaking about doubting themselves. This phenomenon is when people feel that they aren’t as competent or intelligent as others might think and are afraid of being exposed as a fraud. A few participants used this term explicitly to describe the struggles they deal with being a female math major. Isabel spoke multiple times about how she has felt this during her time in the math

department. She explains, “Sometimes I feel a little bit of imposter syndrome. Like, ‘oh that person seems so smart, I'm not sure if I'm as equipped as they are.’ And then other times I feel really good about being able to explain stuff to them or help them or anything like that.” When she first mentioned this in her interviews, she was not sure where this came from. However, later when discussing it she realized part of it has to do with her gender and the math major. Isabel specifically spoke about how she has had a very positive experience as a woman in mathematics and did not feel a connection to some of the women in STEM initiatives, but she did say, “I'll feel a little bit of an imposter syndrome, which I think definitely is correlated to being a woman in STEM.” Despite her desire to distance herself from defining herself as a ‘woman in STEM’, this part of her identity is part of why she has feelings of imposter syndrome.

Amelia also mentioned feeling imposter syndrome in her interview. While Isabel talked about how she felt it in relation to solely being a woman in mathematics, Amelia found that this feeling presented itself specifically related to gender dynamics and ratios in the classroom: “I feel like not necessarily my gender played into my self-doubt, but we would kind of joke, ‘oh, there's like two of us in here right now.’ You know what I mean? But I feel like it's more that I don't feel like I'm smart enough for this. Imposter syndrome? A little bit of it.” Her experience with imposter syndrome was extremely interwoven into feelings of self-doubt and the lack of gender diversity in the math department. While Amelia and Isabel were the only two participants that mentioned feeling imposter syndrome by name, the general feelings of self-doubt that other participants mentioned occasionally had overlap with feelings associated with imposter syndrome and the relationship of this and being a woman in STEM.

Overcoming Uncertainty to Prove Self and Knowledge

Despite all of the participants dealing with difficult courses and feelings of self-doubt throughout different points in their experience, they all have stuck out the mathematics major. When asked if they ever considered dropping the major or if there was a point where they were wavering, many explained moments of apprehension that they had, but there was an overwhelming desire to stay with the major because they enjoyed the material. Some participants also mentioned part of their motivation in continuing had to do with a feeling of needing to prove themselves, especially in a male-dominated environment. Margaret explained this feeling when talking about the math course she is in now and is the only female. She explains, "They're trying to patronize me almost. Like saying, 'well it's okay that you don't understand it right now'. So, then it's more of my own feeling of 'I need to prove more than them that I belong here.'" In this male heavy environment and in a difficult class, a piece of what was motivating her to do well in the class was not just succeeding for her own sake, but also to prove her knowledge to others.

Some of the participants came into college knowing that they were going to be a part of the math department, such as Isabel who "always knew I was going to either major or minor." However, some of the participants landed on mathematics after having good experiences prior to college and just ended up there. Leah was another student who had always known she was interested in studying math. She had taken many advanced math courses before coming to college, and started with linear algebra her freshman fall as opposed to a calculus course which is the standard starting course for first years. Leah described when her feelings of self-doubt most prevalent, saying, "I waved about it a little bit, you know, freshman fall when I was really struggling. But it was never serious. I think I always kind of knew … It was pretty tough, but I emerged unscathed and then kind of decided that nothing could ever be worse than that." Leah

goes on to describe how realizing that this was one of the most difficult courses she was going to take motivated her to continue with the major, therefore allowing her to prove that she was capable of handling the material to both herself and her professors.

Margaret also explained how part of her ability to overcome the doubt and prove herself was external and came from her mother: “She would tell me try your best to work past it and not take anything they say to heart. And so, because of that, I don't think that I've ever questioned my ability because I'm a female. I've definitely said this is really freaking hard, but not related to my gender.” While there are many aspects of intrinsic motivation for the math majors and enjoyment of the material driving them, external factors can also play a role in motivation and perseverance. While Margaret mentioned her mom as someone who helped motivate her and navigate self-doubt, some of the other participants had mentors as external motivators to help them prove their knowledge. Amelia has a mentor, Olivia, who is a graduate of Woodbridge College as a mathematics major who she knows from her athletic team. Amelia has a close relationship with Olivia, and mentioned how when she has had moments of doubt she has turned to Olivia as someone to help her navigate through the math major:

> We basically played throughout every scenario with courses and thinking about applying to graduate school. She's in her masters now and she would ask me ‘Why do you want to take this class? Why don't you want to take that one?’ Also talking about how it is going to be taking hard math classes in season and what's the balance there.

Having someone to turn to has added onto the feelings that Amelia has of wanting to prove herself and that she belongs in the mathematics space. This allows her someone to ask questions to who has been in her shoes before and reminds her she is capable of being in this space when feeling moments of doubt.

This idea of having positive external motivators is important, especially at a younger age. All the participants had experiences where they were told they were good at math at a young age, which served as motivation knowing that they were good at math and had validation throughout their experiences. However, in the education focus group, all the participants expressed a hatred for math that stemmed from negative experiences growing up. Rose described her experience in middle school and why she dislikes math now. She said, “I think it’s because I've been so traumatized by math in the past. I also had tons of tutors and I was never a failing student in math, but it made me so upset that I just have never really learned to love it again.” After explaining her early experiences with mathematics where she had never felt comfortable with the material, she knows that this caused her to view math a certain way for the rest of her life and hold negative beliefs towards the subject. Many of the education majors share similar experiences to Rose at different points in their educational experiences, and none of them pushed past the apprehension due to a lack of motivation, both internal and external. The math majors, however, were able to use their early experiences as drivers to continue, and while facing moments of doubt over the course of years and different material, their overall internal drive to prove themselves as a mathematics major and the knowledge they hold has allowed them to push past questioning themselves and their abilities.

Gender Solidarity

The participants were asked to describe gender dynamics within all discipline experiences, but specifically elaborate on the relationships with other students in the math discipline. The questions started with a more neutral pace trying to simply understand what the experience was like both in class and outside of the classroom, and then the questions turned more into detailing experiences that may have made them uncomfortable as a female student or

both positive and difficult relationships formed throughout their time in the math department. Many of the participants shared very similar experiences, especially with the male students in their classes and certain professors, both male and female. This showed signs of an overall gender solidarity and universal experiences that the female students in the math department at Woodbridge College were all experiencing.

Gender Makeup of Classes

When explaining how many females are typically in her math classes, Isabel said, "Normally it has been more like 70-30 males to females. A lot more males. Um, and I find that mostly in theoretical math classes and not like the applied ones." All participants similarly noted that there is a large gender drop-off after the introductory math courses (typically single variable or multivariable calculus), with these courses being fairly evenly split gender wise because many other majors require these courses or students are fulfilling their quantitative distribution requirement. When they reach upper-level math classes, the gender distribution heavily skews towards males. Amelia described this, and the feelings that come along with being in a room surrounded by men: "I'd say that divide is even more guys and there's typically a couple of girls. I used to feel like I was a bit out of place in most of the math classes that I had, but I ignore it more now." In comparison to other disciplines, this gender divide is not so stark, and some courses may even lean the other way with having more females than males.

In the focus group with the female education majors, they spoke about how many of the classes have more female students in the education major, but it is also a pattern they have noticed in their other humanities courses. When Rose was speaking about her education courses, she mentioned this but also the male presence that does exist in the department:

> I'd say the majority are female, but there's still a decent number of men. It also depends on the course. I took a woman and gender class last semester and there were no men in it. And then right now I'm taking schools in society and that's a pretty even split I'd say.

This dynamic differs from the math department where the gender makeup of courses can be more of a stark difference. The gender divide in courses changes the dynamic of the classroom, as many of the interviewees spoke about how it can feel intimidating and difficult to be in a classroom of mostly men.

Despite this uneven gender ratio in the classroom, many of the female math students have talked about it being something they have gotten used to and are almost desensitized to being in classes with mostly males at this point. The only time that they really notice this difference is early on in the course. Julia explains, "I think on the first day of class it's kind of intimidating to see who was in the class. And how few girls are in each class." She elaborated on this sentiment by saying, "Yeah and it's definitely intimidating when you're one of the only girls in the class. Or when your professors are mostly male. That dynamic is interesting no matter the discipline, just the gender difference." Another point that was brought up about the gender makeup of classes was how due to being one of the few females in the room sometimes they are apprehensive to participate or ask questions because the environment feels intimidating. Especially in courses where some of the participants happened to be the only female present, this feeling was amplified.

While Leah has not had this particular experience yet, she spoke about the overall feeling of not wanting to be much of a presence in the classroom:

> Both of my classes last year were really low on the count of female students and had old white male professors and sometimes it's hard not to feel sometimes, especially if you

> choose to speak, that there is at least one male student in your class who's waiting for you to screw up just so they can be like, 'well actually it's this'.

This feeling that someone is waiting to correct her has been built on dynamics with male students, tracing back to middle and high school experiences for some. In classes where participants are the only female, this was amplified and turned into a feeling of needing to prove oneself to a new extreme. Margaret mentioned this feeling since she is the only female in a small class of all males for her math topics course, saying "It's weird and sometimes I feel like, especially in the all-male class, that I almost have to prove myself to an extent, even though I know I deserve and I'm supposed to be there, sometimes it feels like I do have to do a little bit more." This feeling of needing to prove oneself is rooted in dynamics with other male students that they have been experiencing for years and is worsened in classes where males greatly outnumber females.

Tendencies Toward Female Students

A very frequently expressed sentiment and pattern of the female students was that they always opted to work more with female students in classes. Despite there being a larger percentage of male students in most of their math courses, when it comes to working on problem sets, studying for exams, or even who to sit near in class, many of the interviewees will seek out other females. Leah expressed this opinion by saying, "Even though in my head I know that I can be friends with the male students in my class, anytime there's group work, I always want to gravitate towards any other female student that's around me. I notice that pattern in my math classes that we kind of seek each other out." This demonstrates how internally Leah feels closer to the female students and would rather work with them in these spaces where males are heavily represented in the classroom.

When it comes to the nature of the work in math classes, it can be easier to work in groups or with partners on assignments to better one's understanding. In some math classes, due to the gender imbalances, it is not always easy to have many other female students available to work with. Every single participant mentioned having worked with male students in their classes on projects and assignments, and most did not describe their experience as positive. Meiling spoke about how she is currently in a class where she is the only female student, so she does not have a choice in working with male students. She explains, "Well, I feel like most of the time my group mates are male, and we figure out problems together. Because right now I'm taking some high-level courses and I would say that I'm the only female in the classroom. Yeah. So definitely it's a subject dominated by males." Riya echoed a similar sentiment as Meiling but spoke more positively than other participants and explained one of her best friends and roommates is a male math major. Because of this, she had a very different experience than the other participants when overall working with male students. She says, "I'd say nobody has an upper hand. We both help each other out and I know some things that he doesn't know. He knows some things I don't know. We explain them to each other. Just generally collaborative." The two share a positive relationship, and Riya will choose to work with her roommate unlike many of the other female math majors who would prefer female partners.

Despite some of the participants having positive experiences with other male math majors, the overall opinion was considering the interactions 'neutral'. While there can be experiences that are positive with male students in the department, overall, the interactions are considered impartial. Margaret spoke on this idea as someone who spends a lot of time with male math students being the only girl in one of her seminar classes, saying "I think most of my experiences with other math male math majors have been more neutral. It's just reaching out

when they can. Cause I really only reach out to females when I need help. You know, unless I absolutely have to reach out to them [male students].” This echoes the idea of gravitating towards other female students and wanting to work with them over male students. As Margaret spoke how these experiences are neutral, Amelia similarly described a positive experience with a male student: “I feel like there's no particular positive experience because I feel like a lot of them are kind of just normal. And I feel like it's more that some of them stand out when they're negative.” While the number of positive experiences is slimmer, the number of negative ones is higher, and most of the students would categorize interactions as somewhere in the middle-neither positive nor negative.

While not all the students had a positive experience spending time with other male math majors, nearly everyone had at least one, and sometimes multiple, negative interactions to talk about with other male students in the department. Many of the students spoke about how the negative interactions did not happen in the classroom, but mostly when working together on problem sets or during office hours. Riya spoke about an experience she witnessed with a male math student talking down to another female student when studying for an exam. Even though she was not the recipient of the negative comments, she said that the experience made her uncomfortable:

> I just remember another female in the class was asking a question that none of us really knew the answer to, but he started explaining like he was belittling her. Just patronizing her and making it sound like she didn't know the basics of what she was asking.

Her use of the word ‘belittling’ was a word that came up in many of the different interviews, as it was a feeling many of the participants had felt through their interactions with either male

students or professors at one point in time. Julia echoed the difficulties in office hours with other male students, saying,

> I feel like sometimes in class the guys are a lot more willing to speak up and ask questions and not leave space for other people to speak up. There's one in particular in my class right now who literally doesn't stop talking and asks questions over your questions in office hours, which is really annoying. But I feel like that's more common in guys than girls.

Many of the students have accepted these negative comments and experiences, as it is just something they have to deal with as a female math major.

Throughout these negative experiences, the female math majors continue to stick with each other when they can, especially when they reach higher level math classes where there is a significant drop-off in the number of females in the classes. Isabel described these relationships with female students by saying, “So it's very much a feeling of camaraderie. Like, ‘we're in this together, we can do this if we've done so-and so class before we can get through this class.’” This sense of camaraderie was echoed throughout interviews, and a reason why many of the female majors have formed a network with other females in the department. They share experiences that the male students in the department don’t have to deal with and can relate to one another which is why they prefer working with other females. Leah captured this feeling by describing the connection that she says she feels with other female math majors: “I feel like I always have, and I have talked to other female math students who say this too, that it's a lot easier to form an emotional connection with them because there's just kind, just kind of like shared bond of we tend to be in the minority here and there are some people who kind of try to walk all over you while you do this.” Although all the students spoke on different types of

interactions with male math majors, ranging from very positive to very negative, the running sentiment was that when given the choice, they will always opt to work with other female math students because of a sense of shared experience.

Relationships with Professors

The last aspect of gender in the classroom that participants spoke on had to do with the gender of the professor. While the types of students and gender makeup of courses play a role in shaping participants' experiences as a math major, the gender of the professor also plays a major part. At Woodbridge college, most of the professors in the math department are older white males, but there are a few female professors in the department. Most of the participants in the study have had at least one female math professor during their time at Woodbridge, but a few of the participants have only had male professors. The narrative from the students overall was that they were much closer with female professors than male professors, and these relationships were mostly developed outside of the classroom. Meiling described this saying:

> I feel like somehow having a female professor makes you feel closer to them. And at least for me, I'm more willing to follow them than when it is a male professor. I feel like it's more during office hours. So, in the classroom you don't really notice a difference between having a female or male professor.

Many others expressed this feeling that one of the times the gender of the professor was most noticeable during office hours compared to in the classroom. Margaret spoke about this difference saying, "I just think that the female professors try and make the class more engaging, more inviting than the male professors. You know, they give off just a better persona in my opinion, than the male professors." In discussing this point further, she later attributed this

opinion to a feeling of closeness with female professors and preference towards certain professors over others.

Professor Elizabeth Meyers serves as an advisor for many of these students, and many of them mentioned going to her for help in mathematics but also created a relationship with her through their interactions with her. Isabel spoke very highly of Professor Meyers: “I would be in her office hours all the time, and I didn't dread going, it was always such an amazing experience.” Isabel also echoed Meiling’s earlier point about office hours being one of the true differences between having a male and female professor when talking about her relationship with Meyers:

> I think when it really differs is office hours. I feel like when I'm talking to my male professors one-on-one, they make less of an effort to be comforting and understanding about where questions are coming from. It feels like they’re more willing to just point out where we're wrong rather than say ‘oh, that might not be right, but here's a way that you could approach it.’

Professor Meyers is the faculty advisor of the Women in Math club and has met many of the female students in the math department as well as had them in courses, and many of them speak very highly of her. Margaret echoed Isabel’s thoughts, as both have Meyers as their advisor and have taken courses with her: “I obviously feel a hundred percent more comfortable going to female professors than male professors. I'll go to them outside of office hours and stuff too. But specifically with Elizabeth because she's the only female math professor I've had here.” There is a sense of comfort described by participants with Meyers through shared experiences they know Meyers has also gone through.

While the overall thought was that office hours were the real differentiation between a male and female professor, some students mentioned that they have had different in-class dynamics with specific male professors. The participants did not have bad experiences with all male math professors. In fact, some participants spoke very highly of a few of them. However, there were a few professors who were frequently brought up across the interviews as someone that the female students either felt uncomfortable with or have had negative experiences with. Leah described the overall feeling with male professors from her experience freshman year:

> Some male teachers and professors can be really off putting at times. I think especially in STEM, they kind of have a superiority complex that they know more than you do, and they will always know more than you do. And it can be really intimidating and off putting, especially when you're an 18-year-old girl in your freshman year of college and it's this fully grown scary male math professor.

The professor Leah is referring to at the end of this quote was brought up in many interviews. Professor David Anderson is an older tenured white male professor, who many of the participants have had very negative experiences with. They described his classes as extremely difficult, and he was a hard person to meet with. Amelia also has had Professor Anderson for one of the core math classes in the major, and similarly to Leah, felt intimidated by him, explaining, “He didn't think that I could do or produce the same work or have the same knowledge as some of the other guys in my class. Because there was just me and one other girl and he definitely talked down to me.” This is not the case for all male professors, and most of the extremely negative experiences with male math professors were limited to just a couple male professors in the department. Leah elaborated on this difference between some professors, as well as the difference of seeing a professor one-on-one compared to in their classroom as well: “Some of

them are almost nicer when you speak to them one-on-one than I feel like when I've heard them speak to male students one-on-one. But others can be dismissive in a way that I haven't seen them be with male students." Nearly all the participants described feeling a difference with male professors to some extent compared to a female professor, with a lot of the experiences skewing slightly negative.

When the participants had a female professor, they also described not noticing as much of a difference in the classroom, but the only difference they did notice was a slightly different feeling of the classroom environment. Many described this feeling of it being a better environment by relating more to the female professors through feelings of shared experiences. Julia emphasized this feeling by saying, "I think it was different because of what the class was, but I felt like it was more nurturing in any environment with the female." This word 'nurturing' and words like 'comfort' came up when the participants who had a female professor were talking about feelings in the classroom. There was an overall consensus that students preferred having a female professor when they could due to a feeling of comfort. However, the true difference was in office hours with a male professor, so having a male professor in the classroom was not where they felt big distinctions.

Discussion

Throughout the literature review, theory regarding self-efficacy and social cognition were relevant to the understanding why one is motivated to choose certain disciplines. In talking to the participants, they all mentioned their driving forces and motivations as to why they decided to be a math major. However, when navigating these male-dominated spaces and understanding their experiences, their female identity plays a very significant role. Due to this significance, I will draw on feminist theory, as well as a few other theories, to explore how the significance of their identity as women affects their actions, decisions, and self-perception. Within this discussion, the analysis will be split into two sections, one looking at the role of how female identity and expectations directly affect the experience within Woodbridge College's math department, and one looking with a wider lens of how this identity is a larger reflection of society and perceptions of women and math.

In order to understand how female identity affects the math majors on both a small and large scale, we must start with different feminist theories. To begin understanding the role identity plays, it is important to note that the two key identities are being female and being a math major. Kimberle Crenshaw (2017) introduced her theory of intersectionality, which she used to describe the intersection of race and gender but can be used with any identity that an individual holds. In its simplest form, intersectionality is a concept that describes the interaction between systems of oppression by looking at one's identities (Weldon, 1998). In the case of the participants of this study, the intersection of these two identities has left them in the minority in these spaces. Keeping this in mind, we will explore why these two identities affect the way that they approach and react to their experiences within the mathematics discipline.

Departmental Navigation

In order to be successful within the mathematics department, many of the participants spoke about how they formed groups or had partners to work with on problem sets or to study with. When they could, the participants would prefer to work with other female students compared to male students. As the participants have continued to take higher level classes, their experience has had an even more stark difference in the number of males versus females in each class, leaning majority male. Participants elaborated on how they preferred to work with female students whenever possible, and they were not opposed to working with male students but would look to work with other females first. Returning to Crenshaw's definition of intersectionality, the intersection of these two identities creates a sense of sisterhood and solidarity between female math majors. The use of these two words, sisterhood and solidarity, comes from an examination of feminist movements from Verta Taylor (1989). While looking at these historical feminist movements, she found that sisterhood was transforming within its own definition from something quaint to challenging the patriarchy and oppression. This stronger use of sisterhood has allowed for the participants to challenge the male majority in the discipline. Although Taylor's work has not included very recent feminist movements, her findings support the participants' experiences decades later.

Participants find solidarity working with other female students and create a form of sisterhood within classes and the department. Whether creating a sisterhood is an intentional part of the decision when choosing who to work with or something that just happens naturally, the data from the participants reflects the idea of solidarity to conquer the male-dominated space. In spaces like these where females typically face oppression, the participants not only detailed working with other students, but also highlighted the relationship with the few female professors

in the department. Isabel and Margaret, in particular, shared their experiences with Professor Meyers, and how their relationship with her gave them comfort in the discipline. Hearing the shared experiences among generations is one reason there is a sense of gender solidarity between the participants and contributes to the sisterhood Taylor proposed.

Despite having these tendencies towards other female students, the majority of their math courses have mostly male students and male professors. Participants described how in these classes they felt there was a certain way they needed to behave because of the gender makeup in the classroom. Bernstein's code theory (1995) was originally used to describe how spoken language changes with societal class and how this affects the way people assign significance to things about which they are speaking. Drawing on this idea, we can use code to see how and apply how people use certain language in an academic setting. In mathematics, there are certain ways to present the information to create a proof or to share knowledge, and students are actively learning how to do this in classes. In some settings, the math majors spoke about being afraid to participate in class for fear that they would be wrong. Additionally, they touched on imposter syndrome and the fear that they do not have enough mathematical knowledge and know how to present it correctly. This fear directly correlates to there being a certain mathematical code, and the self-doubt and apprehensive identity mentioned in the previous section explains why participants hold back in the classroom sometimes. Although the participants may understand the code and have the mathematical knowledge to succeed, their female identity and how women are expected to behave plays a role in their participation and tendency to be more reserved in the classroom.

While codes of knowledge can be a reason that leads to hesitation in the classroom, the participants' female identity also plays a role. Due to psychological differences, self-silencing

theory says that women are more likely to silence certain feelings, thoughts, and actions than men (Jack, 1991). Since then, this theory has been used to explore why women behave in certain ways in many different social situations. Maji and Dixit (2019) drew on this theory and the implications that these behaviors had on women's mental health. They were able to determine that self-silencing comes from an attempt to uphold gender norms determined by overall culture, where women have a gender role to be passive, docile, and submissive. Drawing on these ideas, we can look at how these gender norms of female identity can play a role in how the participants behave in the classroom.

While none of them explicitly used the term 'self-silencing' when describing classroom dynamics, a few of the participants described how they made themselves quieter in the classrooms with majority males. Both Leah and Margaret touched on this, explaining how they have a tendency to be quiet in class for fear of being wrong and then being corrected by a male, or feeling that they needed to prove themselves when they did speak up. Julia also emphasized this point by explaining how especially in office hours male students are more willing to speak up than female students. All of these points are examples of the gender norms and self-silencing theory at play, where the female students find themselves holding in what they have to say or making themselves more docile. This is largely due to the male-dominated nature of the spaces they encounter in the math discipline, and how they feel the need to uphold particular gender norms in these spaces.

Societal Expectations

Building off self-silencing theory, there are many societal expectations and gender norms for women to uphold. Maji and Dixit (2019) found that motivation of self-silencing stems from existing gender norms that portray women as docile and inferior to men. Within the math

discipline, participants behaved in specific ways in this academic setting because of the way that society expects women to behave. However, there are other aspects of how women are expected to behave that have translated into how participants navigate the male-dominated math discipline at Woodbridge College.

One of the common experiences among participants had to do with the reactions they got when they told others that they were a math major. They were often met with reactions of awe and disbelief when people learned that they are a math major. In response, the participants had a tendency to downplay the difficulty of the major. Riya, Isabel, and Leah had a lot to say about how their immediate reactions were to say that it was not that bad and other people would be capable of being a math major. Despite them describing the amount of work that the discipline required, they still found themselves downplaying how much effort and time went into being successful in the major. Whether or not the participants are conscious of the responses they give, some of this may be due to the way they were raised as females to uphold certain standards of behaviors in society. This could be considered a type of self-silencing, where they find themselves keeping the true difficulty under wraps in order to uphold a gender norm where women are expected not to complain and be quiet.

We can also draw on other research about sex differences to understand why they may downplay the struggles that they deal with. Holmes (1989) explored sex differences and apologies, and how the psychological difference between males and females has created a dichotomy of feeling guilt and needing to apologize. The results that Holmes found showed the differences of how male and female values elicit a variety of apologies and other forms of communication. Using these ideas, there is a psychological reason why women feel more guilt and the need to apologize, as well as not take credit for what they deserve, which is shown

through the way participants communicate about their major. Isabel and Julia spoke about how the praise they receive for majoring in math can sometimes make them uncomfortable, and the need to downplay the struggles they face in the major comes from sex differences and female apologetic tendencies.

Another reason why the participants may feel the need to downplay the struggles they experience in the mathematics discipline is through feelings of imposter syndrome. Both Isabel and Amelia spoke about how they encountered this phenomenon after spending a lot of time in male heavy spaces. While all of the participants have been successful in the discipline despite facing adversity as a woman, many highlighted feeling imposter syndrome, and discredited the mathematics knowledge they have. As researchers have pointed out (e.g., Clance and Imes, 1978), the origins of imposter syndrome in women stem from societal sex-role stereotyping that begins at a young age. In conjunction with self-silencing theory, imposter syndrome can be used to explore how participants navigate the classroom and their experiences in the math discipline. When women feel imposter syndrome that they may not know enough information to be confident in math, this can cause them to silence themselves in these spaces. This becomes a hard cycle to break, where the lack of women in mathematics contributes to difficulty gaining confidence, and the lack of confidence leads to imposter syndrome and docile behaviors in academic settings. All of these factors contribute to how women in mathematics navigate the spaces around them and are heavily due to the female identity and societal expectations for women.

Despite the math majors feeling the need to downplay the difficulty of the major, every single one of the participants acknowledged the idea of there being a hierarchy of disciplines at Woodbridge with math being very high up. At the same time, they disagreed that math was more

difficult than any other discipline. This was one of the more surprising findings, as I was expecting the math majors to agree that it should be seen as a superior discipline because they know the amount of time and hard work it requires. However, they all noted that for them majoring in something in the humanities or social sciences seemed extremely difficult to them. Different researchers have shown that there is an elitist view of mathematics from males in the discipline and students of different genders encounter barriers with mathematics (Altendorff & Kent, 2011). Considering that males are the ones who think mathematics is more elite, as well as the previously mentioned theories on female behavior, this could be another explanation as to why the participants disagreed with a hierarchy. As women, they are expected to be docile and downplay the struggles that they encounter, which could play into the reason that they disagree with how difficult people view the major. This combination of unconscious efforts of conforming to gender expectations for women in academic settings and males holding math in an elite sense contributes to the hierarchy of disciplines and the gender divide within mathematics.

Conclusion

This research offers valuable insight into the daily experiences of female math majors, and how mathematics is viewed overall. Findings from this study showed that there is a high level of gender solidarity within the math department at Woodbridge College, and that the female students are motivated to continue pursuing the major despite feelings of apprehension. There was also evidence that being a math major has a higher status compared to other disciplines, but the math majors themselves did not believe that this hierarchy should exist. The literature points to evidence of gender being a determining factor in an individual's motivation to pursue mathematics (Moé & Putwain, 2020); however, the participants noted that while gender was something they were aware of, it did not overtake their motivation or decision to become a math major. This study revealed that while gender played into feelings of apprehension, deep internal motivators allowed the participants to continue pursuing mathematics.

It is important to note that this study has its limitations and outside influences that may have restricted the conclusions that I am drawing. First, all of the participants opted to participate, and while the email recruiting participants was sent to the entire math department, only seven female students responded with interest. These students may have had more interest in the topic of female experiences, so while there were unanimous experiences among these seven students, we cannot generalize these experiences to all female math majors at Woodbridge College as there may have been other contradicting narratives that were not heard. Hearing the perspectives of all of the female math majors at Woodbridge college would provide a fuller picture and understanding of the true experience. Additionally, hearing about the negatives of being a female math major was a key part of their experiences. For future research, interviewing women who were interested in pursuing mathematics but dropped the major would provide

insight into motivation and further negatives of the experiences. This shows another limitation of this study, as research from Ungadi (2015) and Riegle-Crumb and colleagues (2016) points to women abandoning mathematics as a common phenomenon. Hearing from women who did not stick with the mathematics major would give deeper understanding to the issues of these male dominated spaces, and again, provide a greater picture of the department at Woodbridge College.

Throughout my research, it became clear that a perceived hierarchy of majors exists, with math being close to the top, but the participants did not agree with this sentiment. Their lived experiences and interactions with others revealed their opposing views to this hierarchy and belief that other disciplines deserve more recognition for their true difficulty. This belief in dismantling a hierarchy of majors is an important takeaway, as it is an important step in destigmatizing mathematics as a difficult subject and one suited for males. As part of a new generation, current females in mathematics are capable of changing the view on this hierarchy to allow both males and other females to see that mathematics is a subject for everybody. By dismantling the idea of math holding an elevated status, it is a step to breaking down the idea that math is a subject for males and may lead to better gender equality in this discipline.

The additional breakdown of this hierarchy may lead to a better balance and recognition of hard work in all disciplines. As the students from the education focus group mentioned, they often feel that their work gets discredited and is not held in high regard the way that a subject like mathematics is. Working on recognizing all disciplines as equal and realizing that the nature of the work is where they differ will help lead to a broader understanding and equality. It became obvious from the participant's narratives, especially Isabel and Margaret's, that many of the math majors shared a matching belief to the education majors that breaking down the idea of a hierarchy would be very vital. This could largely destigmatize the idea that many disciplines are

gendered, which therefore skews the gender ratios in all disciplines, STEM or otherwise. By opening a dialogue about the true nature of these disciplines, a greater understanding can be held by all and eventually lead to more balanced gender proportions in these subjects, and better experiences for females.

However, while the gender ratio is still imbalanced within the mathematics discipline, there are high levels of the females sticking together in these spaces. As the literature suggests (Good & Dweck, 2012; Taylor, 1989), the presence of other females in these spaces is extremely important and forms a crucial gender solidarity in places where females are the minority. The participants of this study all mentioned having relationships with other female students in the department that provided a sense of belonging and comfort in the discipline. It is important for women to have these relationships with other women in these male dominated spaces, and they need a place where they can connect with one another. Creating spaces for women to connect and collaborate is crucial to promote gender solidarity and support for women in math. The additional relationships with the female professors contribute to an even stronger sense of solidarity, as the participants found it helpful to have a role model who went through the similar struggles they are encountering now. Drawing on Wieselmann and colleagues' study (2020), the importance of having a female role model in STEM was a large motivator and gave young women encouragement to continue their pursuit. The female professors at Woodbridge College are great mentors for many of the participants, but the overall lack of gender diversity in the field does not leave many women for the students to look up to. However, increasing the number of female role models in mathematics first requires a larger population of female students, where some may eventually stay in the field, and serve as inspiration for younger girls. The domino effect of breaking down barriers and stereotypes about who belongs in mathematics will

encourage more girls to continue with mathematics, and eventually become role models for the next generation of women in math and lead to a more gender diverse field.

When I began the process of writing this thesis, I simply thought I was going to conduct some interviews, read relevant literature, and use both to analyze and draw conclusions. I did not expect that this study was going to have a deeper meaning for me, and change the way that I, the researcher, viewed mathematics and the world around me. The heart of this project had personal significance, as I am a female math major in a space dominated by males, but I didn't think that interviewing other students on their experiences would affect the way I viewed my own. My findings led me to reflecting on my past four years as a part of the mathematics discipline, and what the future holds for incoming female math majors. Although I interviewed students younger than me, our experiences in these spaces and with males in the department were largely the same. But what will lead to positive change in these spaces? Would a change in the gender ratio in these spaces generally improve the experiences of the female population in mathematics, or are additional efforts and movements that are necessary? If I had more time and resources to further develop this project, I would have explored more deeply the role that Girls in STEM movements are having on younger students, and looked generationally to see if there are differences.

As gender solidarity and having other females in mathematics was something that was important to the participants and their comfort in the discipline, increasing the number of females in the department seems to be one way to improve the gender disparity and overall experiences. However, this is not a simple fix, as there are underlying societal factors to why women back away from mathematics. While the literature points to Women in STEM movements being successful in motivating young women to pursue mathematics (Gonzalez et al., 2020; Hutchinson et al., 2009; Langreo, 2022), none of the participants mentioned these being

influential. However, the majority of these efforts have started in recent years, and are aimed at younger girls, so they would not have been around as much for the participants. While implementing these programs nationwide is a large undertaking, I believe that using these models is an important way to encourage and motivate young women as the literature showed, which will then be an important step in increasing the number of females in mathematics. By starting at a young age, girls will gain confidence in their mathematical abilities to continue pursuing the field, which will in turn lead to these spaces having greater gender equality. Fostering supportive and inclusive communities for female math majors could help address the unique challenges they face and promote greater representation of women in mathematics.

And so, I am concluding this with not just a reflection on the past four years, but a reflection of my academic track with mathematics. This project was inspired by a culmination of what I thought were disjointed experiences, but as I spent time drawing conclusions, I have realized that they all led me to completing this project. From enjoying math at a young age, to a resistance to the subject, to declaring the math major and finding a passion for studying equity in education - together these served as inspiration for this study. But I hope to have inspired more than just myself, and opened a dialogue about what it is like to be a female math major in today's day and age. By the participants being transparent and sharing their true experiences, we all gain a better understanding of the realities they face in the math discipline. In order to achieve better experiences for females in this male dominated space, these dialogues need to continue. With conversation comes change, and I hope that with these conversations, gender equality can be achieved within mathematics, and create an even brighter future for young women.

References

Bandura, A. (2002). Social cognitive theory in cultural context. *Applied Psychology, 51*(2), 269-290.

Barth, J. M., Kim, H., Eno, C. A., & Guadagno, R. E. (2018). Matching abilities to careers for others and self: Do gender stereotypes matter to students in advanced math and science classes? *Sex Roles, 79*(1-2), 83-97. doi:10.1007/s11199-017-0857-5

Bernstein, B. (1964). Elaborated and restricted codes: Their social origins and some consequences. American anthropologist, 66(6), 55-69.

Bird, S. R., & Rhoton, L. A. (2021). Seeing isn't always believing: Gender, academic STEM, and women scientists' perceptions of career opportunities. *Gender & Society, 35*(3), 422-448. doi:10.1177/08912432211008814

Boaler, J. (1998). Open and Closed Mathematics: Student Experiences and Understandings. *Journal for Research in Mathematics Education*, *29*(1), 41–62. https://doi.org/10.2307/749717

Boaler, J., (2013). Ability and Mathematics: the mindset revolution that is reshaping education, FORUM, 55(1), 143-152. https://doi.org/10.2304/forum.2013.55.1.143

Bourdieu, P. (1996). Physical space, social space and habitus. Vilhelm Aubert Memorial lecture, Report, 10, 87-101.

Bourdieu, P. (2018). Structures, habitus, practices. In Rethinking the Subject (pp. 31-45). Routledge.

Chang, HC.H., Fu, F. Elitism in mathematics and inequality. Humanity Soc Sci Commun 8, 7 (2021). https://doi.org/10.1057/s41599-020-00680-y

Clance, P. R., & Imes, S. A. (1978). The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention. Psychotherapy: Theory, Research & Practice, 15(3), 241–247. https://doi.org/10.1037/h0086006

Crenshaw, K. W. (2017). On intersectionality: Essential writings. The New Press.

Eccles, J. S., & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society, 11*(2), 367-380. doi:10.1086/494229

Foster, C. Confidence and competence with mathematical procedures. Educ Stud Math 91, 271–288 (2016). https://doi.org/10.1007/s10649-015-9660-9

Frenzel, A. C., Pekrun, R. & Goetz, T. (2006). Girls and mathematics —A "hopeless" issue? A control-value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education*, *22*(4), 497. https://doi.org/10.1007/BF03173468

Fröschl, M., & Sprung, B. (2014). The Role of Out-of-School Time in Encouraging Girls in STEM. In J. Koch, B. Polnick, & B. Irby (eds.), *Girls and women in STEM: A never ending story* (pp. 139-152). Information Age Publishing.

González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is It a Female Role-Model Thing?. Frontiers in psychology, 11, 2204. https://doi.org/10.3389/fpsyg.2020.02204

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. Journal of personality and social psychology, 102(4), 700–717. https://doi.org/10.1037/a0026659

Harker, R., & May, S. A. (1993). Code and habitus: Comparing the accounts of Bernstein and Bourdieu. *British Journal of Sociology of Education, 14*(2), 169-178.

Hennessey, M.N., Higley, K. & Chestnut, S.R. Persuasive Pedagogy: A New Paradigm for Mathematics Education. Educ Psychol Rev 24, 187–204 (2012). https://doi.org/10.1007/s10648-011-9190-7

Holmes, J. (1989). Sex differences and apologies: One aspect of communicative competence. Applied Linguistics, 10, 194-213. http://dx.doi.org/10.1093/applin/10.2.194

Hutchinson, J., Stagg, P., & Bentley, K. (2009).STEM Careers Awareness Timelines Attitudes and ambitions towards science, technology, engineering and maths (STEM at Key Stage 3) Retrieved 19 April 2023, from http://www.derby.ac.uk/files/icegs_stem_careers_awareness_timelines.pdf.

Jack, D. C. (1991). *Silencing the self: Women and depression.* Harvard University Press.

Kiefer, A. K., & Sekaquaptewa, D. (2007a). Implicit stereotypes, gender identification, and math-related outcomes. *Psychol Sci, 18*(1), 13-18. doi:10.1111/j.1467-9280.2007.01841.x

Langreo, L. (2022). *The key to getting girls interested in stem could be their teacher*. Education Week. Retrieved April 19, 2023, from https://www.edweek.org/technology/the-key-to-getting-girls-interested-in-stem-could-be-their-teacher/2022/08

Leaper, C., & Starr, C. R. (2019). Helping and hindering undergraduate women's STEM motivation: Experiences with STEM encouragement, STEM-related gender bias, and sexual harassment. Psychology of Women Quarterly, 43(2), 165–183. https://doi.org/10.1177/0361684318806302

Maji S, Dixit S. Self-silencing and women's health: A review. International Journal of Social Psychiatry. 2019;65(1):3-13. doi:10.1177/0020764018814271

Moè, A., & Putwain, D. W. (2020). An evaluative message fosters mathematics performance in male students but decreases intrinsic motivation in female students. *Educational Psychology, 40*(8), 941-960. doi:10.1080/01443410.2020.1730767

Oakes, J., & Guiton, G. (1995). Matchmaking: The Dynamics of High School Tracking Decisions. *American Educational Research Journal*, *32*(1), 3–33. https://doi.org/10.2307/1163210

Parr, A., Amemiya, J., & Wang, M. (2019). Student learning emotions in middle school mathematics classrooms: Investigating associations with dialogic instructional practices. *Educational Psychology, 39*(5), 636-658. doi:10.1080/01443410.2018.1560395

Riegle-Crumb, C., King, B., & Moore, C. (2016). Do they stay or do they go?: The switching decisions of individuals who enter gender atypical college majors. *Sex Roles, 74*(9-10), 436-449. doi:10.1007/s11199-016-0583-4

Samuelsson M., Samuelsson J. (2016) Gender differences in boys' and girls' perception of teaching and learning mathematics. *Open Review of Educational Research*, 18-34, DOI: 10.1080/23265507.2015.1127770

Shores, M. L., & Shannon, D. M. (2007). The effects of self-regulation, motivation, anxiety, and attributions on mathematics achievement for fifth and sixth grade students. *School Science & Mathematics, 107*(6), 225-236. doi:10.1111/j.1949-8594.2007.tb18284.x

Smeding, A. (2012). Women in science, technology, engineering, and mathematics (STEM): An investigation of their implicit gender stereotypes and stereotypes' connectedness to math performance. *Sex Roles, 67*(11-12), 617-629. doi:10.1007/s11199-012-0209-4

Starr, C. R. (2018). 'I'm not a science nerd!'. *Psychology of Women Quarterly, 42*(4), 489-503. doi:10.1177/0361684318793848

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. *Advances in Experimental Social Psychology, 34*, 379-440. doi:10.1016/S0065-2601(02)80009-0

Sutton, S. (2001). Health behavior: Psychosocial theories. In N. J. Smelser, & P. B. Baltes (Eds.), *International encyclopedia of the social & behavioral sciences* (pp. 6499-6506). Pergamon. doi:10.1016/B0-08-043076-7/03872-9

Taylor, V. (1989). Sisterhood, Solidarity, and Modern Feminism [Review of *Sisterhood and Solidarity: Feminism and Labor in Modern Times; The Grounding of Modern Feminism; Female Revolt: Women's Movements in World and Historical Perspective*, by D. Balser, N. F. Cott, J. S. Chafetz, & A. G. Dworkin]. *Gender and Society*, *3*(2), 277–286. http://www.jstor.org/stable/189987

Todor, I. (2014). Investigating "The Old Stereotype" about Boys/Girls and Mathematics: Gender Differences in Implicit Theory of Intelligence and Mathematics Self-efficacy Beliefs. Procedia - Social and Behavioral Sciences, 159, 319-323.

Ungadi, B. A. (2015). 'I was just done with calculations…. I realized that I like working with people': Understanding why women abandon careers in mathematics. *Journal of Education and Practice, 6*(19), 234-250.

Usher, E. L. (2009). Sources of Middle School Students' Self-Efficacy in Mathematics: A Qualitative Investigation. *American Educational Research Journal*, *46*(1), 275–314. http://www.jstor.org/stable/27667179

Wieselmann J., Roehrig G., Kim J. (2020). Who succeeds in STEM? Elementary girls' attitudes and beliefs about self and STEM. *School Science and Mathematics*. 2020;120:297–308. https://doi.org/10.1111/ssm.12407

Zhang, J., Bohrnstedt, G., Zheng, X., Bai, Y., Yee, D., & Broer, M. (2021, June). *Choosing a college STEM major: The roles of motivation, high school STEM coursetaking,* NAEP Mathematics Achievement, and Social Networks (AIR-NAEP Working Paper 2021-02). Washington, DC: American Institutes for Research.

Appendix

Interview Scripts

Interview 1 with Math Majors

1. What is your first and last name?
2. How old are you?
3. What social class do you identify with?
4. How would you identify your race?
5. Where are you from? What high school did you attend?
    a. Was this a private or public school?
6. What were the students like at your school?
7. What were the teachers like at your school?
8. What were the classes like at your school?
9. What year are you at Colby?
    a. What are your majors/minors?
10. Do you have any idea what you want to do after college?
11. How was your transition to college from high school?
    a. Tell me a bit about the first math class you took in college and what that was like. Please describe the professor, the class environment, the workload, etc.
12. Tell me a bit about your parents? What do they do for a living? Did they go to college?
13. When did you start being interested in math?
    a. What led to this interest? Was it one thing? Multiple things?
    b. Was this a teacher? Parental influence?
14. What is your earliest memory of math?
    a. Was this a positive/negative experience?
15. Can you describe a negative experience you've had with math?
    a. How have you dealt with this?
16. Can you describe a positive experience you've had with math that sticks out to you?
    a. Why does this stick out to you?
17. When is math most valuable to you?
    a. What happens in the classroom?

18. How many female math teachers/professors have you had? (Excluding elementary school)
19. Can you describe the difference between having a male math professor and a female math professor?
20. How would you describe someone who is good at math?
    a. What characteristics do they have?
    b. What about someone who is bad at math?
    c. Do you think there is an explicit gender difference about what makes someone good at math?
21. In elementary school or middle school, was math split up by skill level and test scores? (i.e., were students with higher test scores placed in different math classes)
    a. If so, where were you put? Can you describe the makeup of these classes?
    b. Who was at the top of the classes? Who was at the bottom of the classes?
    c. What was the experience of girls in these classes?
22. Do you have any siblings?
    a. Do they like math as well?
23. How many girls are in your math classes now/on average?
24. How do your math classes differ from classes in other disciplines?
25. How were you encouraged with math?
    a. With parents? Teachers?
26. How were you prepared to handle mathematics at a college level?
    a. What were some ways you weren't as prepared/wish you had been prepared more?
27. How are you supported in the math department to be successful?
    a. Do you think this differs from any other students?
28. What made you decide to major in math?
    a. Did you ever have any doubts about doing so?
    b. When did you make this decision?
29. Do you have other math major friends? Can you tell me about them?
30. Do you have other female friends in different majors, specifically not in STEM?
    a. Can you tell me how you perceive your experience to differ from theirs?

    b. Do you talk about the differences openly within the majors?
31. At Colby/high school, were you encouraged to be involved in STEM?
    a. What did this look like?
    b. Were you ever discouraged? What did this discouragement look like?
32. Are you a part of any extracurricular activities that have to do with math?
    a. Have you ever been a part of these types of activities?
33. Can you tell me about a time you have either felt uncomfortable/out of place as a female math major?
34. Are you thinking about attending a graduate program that has to do with math?
35. Are you thinking about having a career that has to do with math?
36. What does being a math major mean to you?
    a. What significance does math play in your life?

Interview 2 with Math Majors

1. Describe your path with math. How did you decide to major in math?
2. What academic standards do you set for yourself?
    a. What role do your parents play in that?
    b. What about your friends?
    c. Did your parents ever tell you that you had to study certain things or could not study certain things?
3. Tell me about an educational obstacle that you have overcome. Who or what helped you overcome that obstacle?
4. Are you familiar with girls in STEM initiatives?
    a. What do you know about them?
    b. Where have you seen them?
    c. How about girls in math in particular?
5. Are you part of any clubs/have you been involved in any female encouragement groups for math?
6. Has there been any point when you wanted to give up math?
7. Can you recall any times where you questioned your major/involvement in math because of your gender?

    a. Please detail these experiences.
8. Can you recall any times where OTHERS questioned your major/involvement in math because of your gender?
9. With your male math professors, do you feel like you have had different experiences with them from male students in your class?
    a. How about with a female professor? Is your experience different from that of a male student?
10. Can you detail a negative experience you have had with another male math major?
    a. How did you respond to this?
    b. A positive experience?
11. If someone told you, “Boys/males are better at math”, how would you respond?
    a. How do these sentiments make you feel?
12. Do you have a network of women in math, or STEM more widely?
    a. How did you connect with these people?
13. Do you have a mentor?
    a. How did this person become your mentor?
    b. What do you talk about?
14. What motivates you to do math and continue being a major?
15. Who is a woman that inspires you, and why?
16. When you tell people you are majoring in math, what are people’s reactions?
    a. How do these reactions make you feel?
17. What are your perceptions of other majors? Especially those in social sciences/humanities?
    a. Do you feel like those majors are “easier” than yours?
18. In your opinion, do you believe it is important to get more females interested in math and STEM education?
    a. Why do you think this?
    b. What do you think needs to happen to encourage more girls and women in mathematics?
    c. If it was all up to you, what would you say would be the leading thing to do to encourage young girls in math?

19. What did you know about math/STEM when you were in elementary school?
    a. What about middle school?
20. If a young girl came to you and told you she enjoyed math, what would you say to her/what advice would you give to her?
    a. What would you say to a younger college student?
21. Do you wish you had been more involved in girls in math or girls in STEM encouragement groups when you were younger?
22. What is your conception of the girls in math or girls in STEM groups on campus?
23. If you are a part of these groups, what has made you want to join? If you are not part of these groups, what has held you back from joining?
24. Do you think these girls in math/STEM initiatives are successful on this campus?
    a. If so, why do you think that?
    b. If not, why do you think that they aren't?
25. Have you ever attended any events with these clubs?
    a. What were they like?
    b. If you have not attended, why have you not?
26. Are you encouraged to go to some of these events by professors/mentors?
27. What are your goals for the future?
28. What is your dream job?
    a. How do you see math playing a role in this?
29. How is being a math major different from taking math classes in high school? How is that similar?
30. Have you ever witnessed/seen any other initiatives to increase women in math?
    a. Can you describe these?
31. Do you know any younger math majors or girls who are interested in math in high school?
    a. What have you heard about their experiences? Do they differ from yours?
32. Do you feel like being a math major has cost you anything? This can be psychological, emotional, social, etc.
33. Do you ever wish you had majored in something different? Why or why not?
34. What does being a math major mean to you?

Interview with Math Professors

1. Where are you from? What college did you attend?
    a. Tell me about your experience there.
    b. What did you study?
    c. What were the students like in your major classes?
2. What graduate program did you attend?
    a. How many people were in this program? How many of these people were women?
    b. Please describe your experiences through this program as a woman.
3. What made you decide to pursue a career in mathematics?
    a. How were you encouraged to do so? Where did you face a lack of encouragement?
4. When did you start being interested in math?
    a. What led to this interest? Was it one thing? Multiple things?
    b. Was this a teacher? Parental influence?
5. How did you end up becoming a professor?
    a. How long have you been a professor?
6. What is your earliest memory of math?
    a. Was this a positive/negative experience?
7. Can you describe a negative experience you've had with math?
    a. How have you dealt with this?
8. Can you describe a positive experience you've had with math that sticks out to you?
    a. Why does this stick out to you?
9. Was there any point in your career/education that you wanted to give up math?
10. How many female math professors did you have in your college/graduate school experience?
11. Please describe a time in your career/education where you were faced with misogyny and/or sexist attitudes about your decision to major in math.
12. How were you treated by other male students in your major/graduate program?
13. What has been your experience being a female math professor?

    a. What struggles do you deal with that your male counterparts may not?

14. Does your relationship vary with male students compared to female students?
    a. Can you describe this difference?
15. Do you/did you have a mentor?
    a. How did this person become your mentor?
    b. What do/did you talk about?
16. Do you mentor any younger math majors?
17. Do you have a network of women in math, or STEM more widely?
    a. Do you have similar experiences as them? If so, can you detail what you have experienced that is similar?
    b. What is different?
18. One of the things I am interested in my research is looking at efforts to get girls into STEM and their effectiveness "girls in STEM/women in STEM"?
    a. What do you know about these efforts?
    b. What do you think about these efforts?
    c. Were these types of movements/efforts around when you were going through school?
        i. If so, were you a part of them?
        ii. When was the first time you encountered some of these movements?
    d. As an educator now, are you part of any of these movements on a leadership front?
    e. Do you encourage your students to join/take part in any of these movements?
19. What did you know about math/STEM when you were in elementary school?
    a. What about middle school?
20. If a young girl came to you and told you she enjoyed math, what would you say to her/what advice would you give to her?
    a. What would you say to a college student?
21. Do you think these girls in math/STEM initiatives are successful on this campus?
    a. Please detail how so. If not, please describe what could be better.
22. At Colby, and at any previous teaching jobs you have had, how many other female teachers/professors are there compared to male?

23. Please detail your experience with your male counterparts when teaching, and what you did in these situations.
    a. Can you describe a negative experience?
    b. A positive experience?
24. Have you ever witnessed/seen any other initiatives to increase women in math?
    a. Can you describe these?
25. What does being a math professor mean to you?

Focus Group with Education Majors

1. What made you decide to major/minor in education?
    a. Did you ever have any doubts about doing so?
2. Do you have any idea what you want to do after college?
3. What do your education classes typically look like?
    a. How do your education classes differ from classes in other disciplines?
4. How many girls are in your education classes now/on average?
    a. How does this compare to classes in other disciplines?
5. How are you supported in the education department to be successful?
    a. Do you think this differs from any other students?
6. What is your relationship with math classes and STEM classes?
7. What were your experiences with math and STEM when you were younger?
8. What has been your experience with math and STEM here at Colby? Everyone here has to take a Q and N course; how do these courses differ from your experiences in education?
    a. What are some similarities between these types of classes and your education classes?
9. Can you describe the difference between having a male professor and a female professor?
10. When you tell people you are majoring or minoring in education, what are people's reactions?
    a. How do these reactions make you feel?
11. What are your perceptions of other majors or minors? Especially those in STEM?

   a. Do you have perceptions of any of these disciplines being ‘gendered’? (i.e., education is for ‘girls’, STEM is for ‘boys’)
   b. Do you feel like those majors or minors are “more demanding” than yours?

12. What does being an education major/minor mean to you?

Debrief Questions for All Participants

1. To conclude, what was your favorite part of the interview process? Your least favorite?
2. Are there any questions you wish I had asked you, and would like to answer now?
3. Are there any questions you wish hadn’t been asked or were difficult for you to answer?
4. Is there anything more you want to share with me?
5. Do you have any concerns or questions about the research project?