KNIES, ANGELINA YASUKO. Perceptions and the Role of Personal Experiences on Females’ Participation and Persistence in Mathematics. (Under the direction of Dr. Karen Hollebrands).

Female student interest and desire to pursue STEM courses at the college level, particularly in mathematics, is significantly lower than their male counterparts. In order to address this issue, a qualitative methods design, interviews, curriculum vitae, personal photos and artifacts, were used to further examine the impact of personal experiences and perceived qualities in one’s desire to pursue mathematics. Further, this study explored the perceptions of female mathematics faculty members and the skills and abilities they perceive as integral for developing into a successful female mathematician. This study identifies ways to encourage female persistence in STEM. Data has been collected and analyzed through a feminist theoretical lens. Suggestions for possible efforts to obtain and retain female faculty members at the college level were made to benefit the needs of the diverse, female population in the mathematics classroom.
Perceptions and the Role of Personal Experiences on Females’ Participation and Persistence in Mathematics

by
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Angelina Yasuko Knies was born in Fayetteville, NC on August 20, 1990 to Paul and Jean Knies. Angelina also shared a close relationship with her grandparents from her mother’s side, John and Yasuko Mastrianni.

Angelina grew up in Fayetteville, NC for all of her childhood and graduated from Massey Hill Classical High School in 2008. Awarded the NC Teaching Fellows Scholarship, Angelina pursued her Mathematics career at East Carolina University (ECU). Angelina worked for ECU Campus Living as a Resident Advisor and received acceptance into the ECU Residential Scholar scholarship program. Involved in undergraduate mathematics research, Angelina worked under the leadership of Dr. Michael Bosse where she created and organized a curriculum that integrates Modern Algebra into the middle grades classroom to assist with conceptual development in students. Graduating with University Honors in 2012, Angelina completed the B.S. in Mathematics Secondary Education degree and B.A. in Mathematics degree.

In 2012, Angelina continued her educational career at ECU to pursue her MAEd. in Mathematics Education. During this time, Angelina had the opportunity to work as a graduate assistant for the Science, Mathematics and Instructional Technology department. She also continued working for ECU Campus Living as a graduate coordinator for CFJ Residence Hall and as a residence hall technology lab assistant. Angelina’s collegiate teaching experience commenced when she was hired to instruct Intermediate Algebra sections and freshman introductory to college seminar courses. Under the instruction of Dr. Kwaku Adu-Gyamfi, Angelina completed a mathematics action research project where she investigated the effects of undergraduate practicum courses on pre-service teacher attitudes and instruction. Angelina completed her degree in 2014.
In 2014, Angelina accepted a mathematics teaching position at Jack Britt High School in Fayetteville, NC before being admitted to North Carolina State University’s Mathematics Doctoral program in 2015. While completing her degree as a full-time student, Angelina held a student affairs position as the Assistant Director of Students Advocating for Youth Village in Syme Hall. Angelina also worked as a full-time Mathematics professor for Johnston Community College. Interested in research revolving around gender and racial gaps and the effects that gender and race have on a female student persisting within STEM, Angelina worked under the instruction of Dr. Karen Hollebrands to complete a pilot study to observe the effects of instructor race and gender on the student-professor relationship. This pilot study in turn impacted Angelina’s interests for her dissertation study led under the instruction of Dr. Karen Hollebrands and her committee members: Dr. Lee Stiff, Dr. Jessica Decuir-Gunby, and Dr. Allison McCulloch.

Upon graduation, Angelina will continue working as a full-time mathematics professor at Johnston Community College in Smithfield, NC. She will also work as an adjunct mathematics faculty member at Wake Tech Community College in Raleigh, NC. Angelina hopes to continue her research and efforts to increase the representation of females and minority females in STEM majors and STEM fields.
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Chapter 1: Introduction

Noticeable gender differences in math achievement and interest begin to emerge as early as middle school (Catsambis, 1994). Problems only persist as a student continues through high school and into higher education (Chen & Thomas, 2009). Results from the 2016 SAT college entry examination show evidence of significant gender performance gaps on the math portion of the test. In fact, with a 30-point difference in favor of males on the math portion, concerns regarding how to better address the gender gap arise (Perry, 2016). Other relevant issues include the representation of females pursuing STEM-related majors as well as the retention of females in STEM-related careers (NSF, 2011). In effort to explain the underrepresentation issues, some argue that differences are a result of socialization to mathematics while others believe in gender differences in terms of cognitive and innate abilities (Schwartz & Hanson, 1993).

A growing body of research has indicated that teachers and the classroom environment make a substantial difference in students’ successful learning (Hammond, 2000; Brazziel & Brazziel, 1994; Eccles, 1989). In addition, recent research suggests that both male and female professors can be role models to recruit female students into STEM fields, but that same gender role models are likely to have a larger impact when it comes to the retention of these female students in STEM-related programs (Cheryan et al., 2011). Unfortunately, if professors of the same gender and race serve such an integral role, both women and minority women students are at a disadvantage because both groups are under-represented as faculty members in STEM-related college departments (Griffith, 2010).

This qualitative study uses a feminist theoretical lens to better understand female mathematicians’ personal experiences and perceptions of mathematics and how these play an integral role in pushing them to pursue mathematics. Further, this study examines female
mathematicians’ qualities and personal experience they perceive pushed them to be successful in the field of mathematics. This study has implications for increasing the number of female students in STEM-related majors.

**Background of the Study**

Finding studies that focus on females in STEM-majors and the retention of females in STEM careers is not a difficult task. In fact, it is no surprise to the research community that the number of females in STEM-related majors is consistently lower than those in other fields such as business or law (Carrell et al., 2009). Research evidence has also shown that female doctoral students hired into faculty positions are disproportionately lower than that of men (Nelson & Rogers, 2005). This imbalance in hiring should propel educational researchers to better understand reasons for women’s underrepresentation in STEM (Xu, 2008).

Females’ lack of interest in STEM can be attributed to the influence of various external factors (Gunderson, Ramirez, Levine & Beilock, 2012). With negative effects stemming from individual views, family influence or societal factors, most researchers try to understand the impact of implicit biases. However, much work and positive efforts to date are focused on students at the K-12 levels and little speaks to the difficulties and needs of female college students (Kahveci & Southerland, 2006). With the completion of this study, information regarding the characteristics that play a role in influencing female mathematicians to pursue mathematics will be obtained. Mathematics plays an important role in all STEM disciplines. By understanding what these factors are, we can help bridge the gap of gender inequality within STEM.

Many researchers consider a person’s mathematical identity as being an integral part to understanding how a student approaches and gains interest in mathematics (Oyserman, 2009).
Through classroom encounters, cultural practices, and other experiences within the community of mathematics, students’ mathematical identities begin to take shape (Langer-Osuna, 2017). This identify refers to something that is within a person, like a self-concept or sense of self. From a narrative perspective, researchers try to better understand one’s identity development through the stories they tell and how one makes sense of their experiences in relation to their mathematical self. These stories shed light on how an individual positions themselves within a community of practice as well as explains how they feel others within the community view them (Langer-Osuna & Esmonde, 2017). Students that possess a strong, positive math identity are more likely to feel that they belong in the math classroom and thus engage in mathematical learning activities despite challenges they face (Froschl & Sprung, 2016).

Students are challenged daily with tasks in the mathematics classroom that influence their beliefs regarding their mathematical abilities (Wigfield & Wagner, 2005). Students who possess positive control over their achievement and positive self-efficacy are likely to tackle tasks that do not necessarily come easy to them (Wigfield & Wagner, 2005). A students’ sense of self-efficacy is a measure of their confidence to perform and succeed in academic tasks. Self-efficacy is a construct that can help predict behavior and performance outcomes (Gushue et al., 2006). A person’s sense of self-efficacy also plays a role in determining the way students react to confusing material (Lent, Brown, & Larkin, 1986). For many, confidence in their ability to succeed in mathematics is harmed by the belief that math ability is innate. With this type of fixed mindset, a person believes that no matter how hard they try, they cannot be successful (Meece, Wigfield, & Eccles, 1990). This results in students avoiding math and other STEM-related subjects while giving up easily when facing subject related obstacles (Lent, Brown, & Larkin, 1986). The notion that people are born good at math is a myth that continues to be particularly
harmful to female and minority students (Froschl & Sprung, 2016). The educational community must work to make efforts to get students to adopt a growth mindset which goes beyond effort and focuses on learning. With this, one believes that the harder they work, the more conceptual growth will occur (Dweck, 2015). This mindset results in continued persistence and optimistic attitudes towards challenging subjects and increased confidence to overcome negative stereotypes (Froschl & Sprung, 2016).

**Purpose Statement**

This study aimed to understand factors that contribute to female success in mathematics. Through a qualitative research study design, female mathematician interviews were conducted. These interviews shed light on the specific social and environmental experiences that encouraged the female participants to pursue mathematics. Further, these interviews allowed participants to reflect on their thoughts about women in math as well as what defines a successful female in mathematics at the college level. The use of photos, artifacts, and curriculum vitae were also used. All data has been analyzed through a feminist theoretical perspective with the understanding that the sole purpose of the researcher is to interpret how participants have constructed their unique experiences as self-encouragement to persist in mathematics. The researcher aimed to provide information beyond just understanding, but to instead empower the female mathematics research community to work more rigorously to close the gender divide.

**Significance of the Study and Research Questions**

This research was conducted to better understand the experiences of successful female mathematicians to make recommended interventions to encourage more females to pursue mathematics (Griffith, 2010). With much research focusing on the success of students in the K-12 system guided by results from national and state assessments, little efforts are made to
understand why students do not commit and pursue a mathematics degree (Maltese & Tai, 2009). We must further investigate why females earn below half of the mathematics bachelor’s degrees, and why an even smaller number go on to pursue a PhD in mathematics (Piatek-Jimenez, 2008). This research study addressed concerns regarding females in mathematics and the social supports and environmental characteristics that enable them to continue to pursue mathematics. By focusing on the experiences of females who have proven to persist in the field of mathematics, this study identified the characteristics that played a positive role in encouraging female math students to succeed in mathematics.

This study specifically sought to address the following questions:

1) What experiences or personal attributes do female mathematicians attribute their success to?
2) What are female mathematicians’ perceptions of mathematics and mathematics abilities and what role do these perceptions play in their success?
3) How do participants view themselves as mathematicians?

Overview of Methodological Approach

Qualitative methods definition and rationale. This study employed qualitative research methods. It was be guided by Merriam's (2002) description of qualitative methods which makes a clear distinction of the characteristics of a qualitative study versus a fixed, measurable quantitative research study. Merriam explains that constructions and interpretations that change with time are an integral part of qualitative research. Merriam further describes qualitative researchers as follows:

"Qualitative researchers are interested in understanding what those interpretations are at a particular point in time and in a particular context. Learning how
individuals experience and interact with their social world, the meaning it has for them, is considered an interpretive qualitative approach.” (p. 4)

**Narrative research study.** Narrative research makes efforts to embrace situational and contextual dynamics and bring similarities to discuss a circumstance or event (Woodiwiss, Smith, & Lockwood, 2017). Allowing for emerging themes and stories, this form of inquiry thrives in the world of research among those who value individual lives and lived experiences (Etherington, n.d.). Narrative research is based on communication in a variety of forms and aims to connect and weave together experiences and events among various participants. By understanding how “an individual story illustrates the large life influences that created it,” this form of inquiry can highlight tensions and challenges that exist within society (Woodiwiss, Smith, & Lockwood, 2017; pg. xii). Through exposing these influential stories, opportunities to create positive change emerge.

Specific alignment between stories and the discussions of these narratives must be clear. Despite this alignment however, strong referential claims can be made but one must accept that there is rarely a “one-to-one relationship to the happenings being presented” (Woodiwiss, Smith, & Lockwood, 2017; pg. x). Thus, what is heard can neither be taken as truth nor be dismissed but instead be responded to with sound judgement. Systematic gathering and analyzing of data can present challenges, views of truth, reality, and knowledge (Etherington, n.d.). With new understandings about a person, this mode of inquiry can help identify complex patterns, descriptions of identity construction and reconstruction, and evidence of social discourses that impact a person’s knowledge creation (Measuring, 2017)

Data for this study came from multiple structured and unstructured interviews, personal photos, artifacts, and the curriculum vitae of participants that represent their journey to
becoming a successful mathematician. All interviews were audio recorded and then transcribed. The theoretical framework guided the thematic coding process and was used as the researcher analyzed the data. Engagement with sincere collaboration with participants helped to ensure trust and openness in the research relationship (Sandelowski, 1990). Final findings revealed the extent to which stereotypical behaviors and societal structures have influenced female involvement in the mathematics community (Riessman, 1993).

Proposal Organization

The second chapter of this paper aims to provide a relevant review of the literature and theoretical framework guiding this study. The third chapter of this proposal will explain the methods in detail that were utilized to collect data for this study. Chapter four contains each of the unique narratives of the participants involved in the study. Chapter five provides an analysis of all the data collected and chapter six provides conclusions, limitations, and implications for future studies.
Chapter 2: Literature Review

Female Mathematics Achievement

Achievement of Females in Mathematics at the Collegiate Level. Before the 1890’s, women were not allowed to pursue doctoral degrees in mathematics at most institutions. As a result, the population of female faculty was low (Hyde & Mertz, 2009). Upon special approval from the Board of Trustees at Columbia University, Winifred Edgerton became the first American female to earn a Ph.D in mathematics in 1896 (Rozner, 2008). She would pave the way for more women to begin to pursue advanced degrees. Over the course of decades, college level enrollment of females into college mathematics courses has risen but still remains low. Furthermore, females transitioning into a career related to mathematics has also declined over years (Hill, Corbett & Rose, 2013). In 1970, approximately 8% of mathematics Ph.D recipients in mathematics were female. Although an increased percentage over the course of fifty years, females only represent about 30% of those who obtain a Ph.D in mathematics across the United States (Hyde & Mertz, 2009). About 41% obtain a Bachelor’s degree in mathematics. In fact, according to the National Center for Education Statistics, women obtaining a Bachelor’s degree in 1970 was roughly 38%, showing only a 2% increase over the course of 40 years (NCES, 2013). Efforts to gain female students interest at the K-12 level has been evident but less noticeable at the college level (Kahveci & Southerland, 2006). With knowledge that many factors play a role in student persistence of mathematics more than interest and confidence alone, we must take more opportunities to provide resources, implement programs and analyze their effectiveness (Kahveci & Southerland, 2006). To remain a competitive country in the global economy, we must ensure that we are developing strong workers in the field of mathematics. Further, there is the growing need to diversify the workforce to include more women. With more
female outlooks, we can ensure that products, services, and solutions are designed to represent more than just the male population.

**Female Achievements in Mathematics at the K-12 Level.** At the elementary level, there are not extreme differences among proficiency scores of girls versus boys in mathematics (Bae & Smith, 1997). Further, both groups express similar interests in the learning of mathematics (Amelink, 2012). However, as students advance grade levels, noticeable differences become evident among the boys and girls (Maccoby & Jacklin, 1974). With more years spent in the mathematics classroom, students obtain the ability to judge their own competency and value in the subject area (Eccles, 1983). Their sense of self-efficacy is much lower in respect to mathematics performance and a noticeable lack of academic interest towards mathematics is evident (Koller et al., 2001).

To help explain the underrepresentation issues of females in math at the high school level, many argue that differences are a result of socialization to mathematics while others believe in gender differences in terms of cognitive and innate abilities (Schwartz & Hanson, 1993). The concept that males are gifted with the “brilliance effect” and that women are less brilliant in terms of mathematics, can be disheartening. Society can only attribute women’s mathematical success to hard work and efforts, rarely to talent and ability (Piatek-Jimanez, 2008). “Children begin their lives as eager and competent learners. They have to learn to have trouble with learning in general and mathematics in particular” (Papert, 1980, p. 40). Negative beliefs that females are not as capable as their male counterparts are even held by students’ parents and teachers (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). These observed and taught behaviors end in many students losing interest in mathematics and discontinuing their mathematical education (Meece, Wigfield, & Eccles, 1990). Further, beliefs that intellectual
abilities are something you are born with and unchangeable can also cause a lack of self-confidence (Dweck, 2008). Thus, by teaching students to focus on the process that leads to learning, a growth mindset can be fostered (Dweck, 2015). This knowledge requires that researchers further look at how mathematical identity is formed within students and what factors play a role in female success and persistence within mathematics.

**Factors Related to Women and Their Participation in Mathematics**

One’s identity can be described as not only how one regards themselves but also “how an individual is recognized and looked upon by others (Grootenboer & Zevenbergen, 2008, p. 243). To understand one’s mathematical identity, studying their commitment and engagement to mathematics can help give insight as to how valued it is (Froschl & Sprung, 2016). Further, to be able to make assumptions about whether one will persist in their study of mathematics, focusing on their identity-based motivation will help determine outcomes (Oyserman, 2009). Langer-Osuna and Esmonde (2017) discussed how the study of individual mathematical identities can look different based on these four varying theoretical approaches: discursive, positional, narrative, and psychoanalytic. In particular, narrative identities allow for individuals to express stories about their mathematical selves. Identities told from a narrative approach are, “human made; shaped by society; changeable across time, context, and narrator; and accessible to researchers through empirical methods such as interviews, observations, or collecting written biographies,” (Langer-Osuna & Esmonde, 2017; p. 641).

To better understand persistence issues related to the participation and engagement in mathematics, one must focus on how one’s mathematical identity is developed (Grootenboer & Zevenbergen, 2008). One’s perceptions of mathematics along with their desire to pursue mathematics work shows a strong positive correlation and cannot be considered as mutually
exclusive (Black et al., 2010). Experiences revolving around gender discourse and institutional practices heavily impact the development of one’s mathematical identity (Langer-Osuna & Esmonde, 2017). Negative experiences in the classroom can easily affect a students’ “fragile identity” while positive experiences can also alter one’s mathematical identity (Solemon et al., 2011). However, it remains to be a complex concept to explore as it includes the context of the learning environment and the individual qualities that a student brings to the classroom (Grootenboer & Zevenbergen, 2008). Thus, studying identity through a narrative approach is most helpful for the emergence of common experiences among groups of individuals and determining how one makes sense of their social experiences with mathematics (Langer-Osuna & Esmonde, 2017).

To promote positive mathematics identity growth in female students, educators need to be more aware of practices, attitudes, and beliefs that encourage strong identity development (Langer-Osuna, 2017). Parents and other support figures need to also provide positive encouragement so that females develop a positive mindset and see themselves as capable figures to successfully do mathematics (Froschl & Sprung, 2016). A stronger sense of positive self-efficacy in regard to mathematics will result in more students pursuing mathematics and believing they can be successful in a math-related career (Lent, Brown, & Larkin, 1986).

**Sociocultural issues.** Much research to date has begun to focus on the effect that sociocultural norms have on the development of mathematical skills and abilities (Schwartz & Hanson, 1993). Standing from a social-psychological stance, the research community has found that much of the gender differences in math performance lie with psychological issues rather than biological issues (Brown & Josephs, 1999). Coined as stereotype threat, generalizations made by society regarding gender roles have had a strong influence on female success in
mathematics (Spencer, Steele & Quinn, 1999). However, it is unknown how a person becomes more or less susceptible to these types of threats (Schmader, 2002).

According to the Social Identity Theory, individuals possess a personal identity as well as a social identity in respect to social groups. It is human nature to desire to maintain a positive personal and social identity. Therefore, if one’s personal or social identity is not strong, it will likely affect the other (Schmader, 2002). Schmader found that women will perform significantly worse on assessments when told that their results would be used to make generalizations for other females. Thus, when females are aware that they will be compared in respect to other students in the classroom, attitudes quickly shift and cause a diminished desire to participate and perform in the classroom setting (Nguyen & Ryan, 2008).

Common phrases such as “Mathematics has always been a lesson that has frightened me,” are not uncommon to hear even among preservice teachers and in-service educators. Common misconceptions have created strong anxieties towards mathematics. In fact, researchers have been trying to understand the root issue that feeds into the growing anxiety for decades. Math anxiety can be described as creating feelings of embarrassment, avoidance, panic, flurry, failing and fear (Bekdemir, 2012). Female students, especially at a young age, are extremely susceptible to recognizing these characteristics. Therefore, at a young age, female students begin allowing feelings of math anxiety they have viewed in others to create negative math attitudes for themselves (Beilock, Gunderson, Ramirez & Levine, 2010).

Another theory suggests sociocultural norms play a role in diminishing females’ interest in mathematics. Historically, females were given the role of home and child caregiver. Instead of displaying intelligence in academic areas, females were encouraged to instead broaden their knowledge on tasks such as cooking, sewing and being a mother (Schwartz & Hanson, 1993).
This type of gender stereotype is linked to traditional social roles that revolved around a constant power struggle between men and women (Prentice & Carranza, 2002). Thus, society has a tendency to motivate females towards academic and professional choices that it views as stereotypically feminine that include care taking roles such as nurse or elementary teacher.

**Role of parents.** Although many parental- based gender stereotypes originate from a teacher’s review of their child’s performance, parents have a tendency to also incorporate these stereotypes in the home life (Eccles, Jacobs & Harold, 1990). Whether done explicitly or implicitly, parents often direct their daughters’ interest toward non- math related activities (Schwartz & Hanson, 1993). Even when buying toys, parents are more likely to buy their son a math or science related toy and stereotypical toys, like dolls, for girls (James, 2009).

Much work has shown that parents have higher expectations for success in math from their sons than daughters (Schwartz & Hanson, 1993). Many believe that their daughters will face more difficulty when learning math, face more disappointment in achievements and have a much more difficult time pursuing a career related to math (Yee & Eccles, 1988). Further, success in boys will often be attributed to natural talent whereas success in girls will often be attributed to effort (Gunderson et al., 2012).

With all of these parent- based gender stereotype influences, parents are often shifting their child’s academic views (Eccles, Jacobs & Harold, 1990). Several studies have shown that girls at the middle and high school levels rate their parents as the most influential people in their decision to enroll in classes especially those pertaining to math (Yee & Eccles, 1988). Few studies have been conducted at the elementary level but some results have yielded that even here, parents possess math based gender stereotypes. Although many do not believe there is a cognitive difference between genders, many still believe that math is more applicable for boys
than girls (Gunderson et al., 2012). Therefore, when a parent shows a lack of confidence in their daughter’s math abilities, it will often affect her self-perception and later achievement in math (Tiedemann, 2000).

**Role of teachers.** Similar to parents, teachers often carry many gender based stereotypes into their teaching practices (Schwartz & Hanson, 1993). At the elementary level, many teachers believe their male students to possess logical and competitive characteristics more than girls, making it likely for boys to succeed in math (Carpenter, Fennema, Peterson & Chiang, 1989). Despite the lack of significant test score differences, teachers argue that boys are more talented and have greater math ability than girls at the middle grades level (Tiedemann, 2000). This belief continues through the secondary and post-secondary levels (Gunderson et al., 2012).

Starting as early as the elementary level, girls will take into account their teachers’ perceptions and allow it to influence their self-perceptions (Tiedemann, 2000). Beyond stereotypical views for student outcomes, teachers possess a view of their own mathematical abilities (Gunderson et al., 2012). At the elementary level, teachers possess the highest anxiety rates regarding their math abilities. With this field being dominated primarily by females, girls are more likely to be negatively impacted by these anxiety levels. Upon completion of several studies, it was concluded that having a “highly anxious female teacher” will steer girls to conform to the stereotype that females are not good at math (Beilock et al., 2010). Further, negative gender stereotypes often influence the instructional techniques and organization of material that teachers implement (Hyde, Fennema & Lamon, 1990).

Sfard and Prusak (2005) discuss identity in terms of the current state of professional identity as well as how a teacher describes their desires for professional growth. The perception one has in regards to their teaching career will also play a role in how they interact with students.
Further, the mathematical identity a teacher possesses will play a role in positively or negatively shaping a students’ math identity (Grootenboer & Zevenbergen, 2008). If a female mathematics teacher appears to be competent in her math abilities, female students are likely to perform more successfully (Marx & Roman, 2002). Through positively built relationships between teachers, administrators, and students, motivational development in a child can occur (Wigfield & Wagner, 2005). These relationships not only create a social context but also help a teacher better understand pedagogical practices that need to be implemented to encourage students to pursue mathematics and other STEM-related subjects (Grootenboer & Zevenbergen, 2008).

Some studies have suggested that teachers create a lesson around a predesigned “curriculum script” and make minor adjustments based on the needs of students. The continual assessment of what a student knows and is learning is not the main concern for teachers (Putnam, 1987). Conversely, Lampert (1986) argues that monitoring students’ understanding is a goal that all teachers have in mind. Either way, teachers have a tendency to overlook the needs of females and instead concentrate on males as they are more likely to aggressively seek information (Linn & Hyde, 1989). Due to their impulsive nature, males are more likely to be noticed in the classroom and thus given the reassurance and feedback needed for more practice opportunities (Linn & Hyde, 2009). Analyses of classroom discussions showed that boys will speak three times more than girls. Further, among college-aged students, males dominate discussions (Schwartz & Hanson, 2009). Further characteristics of competition may find itself embedded indirectly into a teachers’ pedagogical practices. Therefore, if classroom practices revolve around raising your hand, speedy responses and independent practice, female students are likely to feel pressured in the math classroom (James, 2009).
Many students find themselves struggling with math due to the way material is presented as a series of rules without opportunities to explore for conceptual understanding. Girls have a tendency to report higher levels of math anxiety and distaste for learning mathematics due to the lack of opportunities to conceptually master the material (Froschl & Sprung, 2016). Once a student begins advancing in mathematics, particularly at the high school level, students are forced to unlearn systematic rules they thought to be true (Yagi & Veneciano, 2017). Further, as class sizes get larger and instructional practices change, many students feel pressured to show strong performance and begin to lack the desire to learn as mastery is less focused on (Wigfield & Wagner, 2005). Thus, to positively affect students’ math identity, pedagogical methods used to implement the discipline must constantly be evaluated (Grootenboer & Zevenbergen, 2008). Mathematics educators must constantly work to create classroom environments that foster rich mathematical discourse (Cobb, McClain, & Whitenack, 1997). If math continues to be introduced as dry, meaningless, and abstract, students will not see purpose in learning (Froschl & Sprung, 2016). Without the belief that math is relevant, meaningful, and doable in one’s everyday life, students will not study mathematics nor pursue career fields associated with math (Hackett & Betz, 1989). Grootenboer and Zevenbergen (2008) argue that the way math is taught must be different than other subjects as the practices of math are fundamentally different. Thus, with teachers implementing more hands-on experiences, project-based curriculum, real-world applications and classroom collaborative activities, students are likely to be more successful in the math classroom resulting in positive math identity (Froschl & Sprung, 2016).

*Role of the classroom environment.* A large influence on positive academic identity in mathematics is the mathematics classroom (Langer-Osuna, 2017). The mathematics classroom is made up of three important aspects: the student, the classroom community, and the discipline
of math (Grootenboer & Zevenbergen, 2008). A safe classroom environment that supports collaborative learning and equitable opportunities will result in positive identity development (Langer-Osuna, 2017). Further, a classroom environment that reinforces and confirms positive behaviors will develop a willingness in students to engage in similar activities in the future (Urdan & Schoenfelder, 2006). Thus, the teacher plays a large role in molding the classroom into a safe learning environment (Grootenboer & Zevenbergen, 2008).

Those with a strong, positive math identity believe that not only can they do mathematics but that they have a place in the math community and math classroom (Froschl & Sprung, 2016). Wenger (2010) discusses a social theory of learning that revolves around the importance of belonging to a community of practice. In this context, the community of practice is the math classroom and when one feels they belong to it, their math identity is strengthened (Grootenboer & Zevenbergen, 2008). By giving students authority over their learning, one’s mathematical identity can be further positively affected (Siegler et al., 2012). The ways that math topics are introduced and the ways students are encouraged to interact with math will play a role in their achievement levels (Froschl & Sprung 2016). Classrooms designed around math identity development will give students the opportunity to develop a strong conceptual identity, take ownership of their ideas, and identify with mathematics (Langer-Osuna, 2017). When students have positive outlooks regarding their learning environment, which strengthens their self-efficacy beliefs, the potential for students to desire to pursue mathematics is increased (Fast et al., 2010).

Social group association, both within and outside of the classroom, can heavily impact one’s performance due to the linked societal social expectations and norms (Oyserman, 2009). Stereotype threat will often cause an individual to underperform in math especially when one
feels they are at risk for confirming a negative stereotype for their associated social group (Froschl & Sprung, 2016). This unfortunate phenomenon is noticeable when one identifies with a racial-ethnic group that has negative stereotypes associated with it (Oyserman, 2009). Many women also struggle with mathematics and choose to not pursue any math-related fields due to negative gender stereotypes (Langer-Osuna, 2017). By removing the barriers of stereotypical gender roles and shifting attitudes to one that sees females as able individuals, concrete efforts can be made to increase success and retention of females in mathematics (James, 2009).

Being a social environment, the mathematics classroom is a place for students to learn alongside their peers, often trying to imitate their peers’ positive qualities (Rogers, Smith, & Coleman, 1978). Thus, social comparisons come naturally and can have a large impact on a students’ sense of self-efficacy, motivation, and engagement (Ryan & Patrick, 2001). A child might believe they are good at math because they can count from 1 to 10. However, when at school, if other kids can count to 100, negative perceptions about one’s math abilities are likely to arise (Wigfield & Wagner, 2005). This change in belief about competence can affect one’s motivation in a negative direction and cause a disinterest for pursuing anything related to mathematics (Christy & Fox, 2014). Due to the strong impact of assessment and evaluation at higher grade levels, social comparison continues to have an impact and can continue to negatively affect self-efficacy beliefs (Wigfield & Wagner, 2005).

The way an individual regards their math abilities provides an idea of how students respond when put into a math setting (Zeldin & Pajares, 2000). Langer-Osuna (2017) discusses how student athletes are able to reason with statistical information in the context of basketball. However, when situated in a math classroom and given the same information, students lacking strong math identify could not respond. Further, the math teacher who also served as the coach,
spoke against the student-athletes’ math abilities. The argument stands to remain that strengthening and bridging the gap between authority over one’s learning coupled with opportunities for collaborative learning will positively impact one’s math identity (Froschl & Sprung, 2016).

**Role of self.** Psychologists are well aware of the growing self-consciousness in young girls and the desire to feel accepted by peers (James, 2009). In the mathematics classroom, little differences in confidence levels are evident at the elementary level but differences become substantial once in high school. One possible explanation can be linked to stereotypical gender roles. Male students are more likely to try alternative approaches to obtain solutions to problems, experiment with alternative methods and to persist in math courses (Linn & Hyde, 2009). However, the fear of failure forces girls to become unmotivated and uninterested in learning mathematics (Spencer, Steele & Quinn, 1999).

Many female students do not feel motivated to learn math as they do not understand the purpose it will serve for them (Linn & Hyde, 2009). Females become complacent solving word problems revolving mainly around measurement, sports and science, which further encourage their belief that math is not relatable. Females desire to learn and work in fields that focus on people. As girls develop, they are better able to identify emotional information from other people based off of facial expressions and gestures (McClure, 2000). Sociocultural stereotypes have categorized individuals who are successful at math as “being insensitive” thus deterring females away from math based activities (James 2009).

A study conducted by Park, Cook, and Greenwald (2001) showed that the first year of college often serves as a turning point within one’s STEM identity and by the second year of college, many women fail to persist in STEM-related majors due to a negative academic
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identity. Brainard and Carlin (1997) found similar results claiming that one’s self-concept was a better predictor of long-term persistence in mathematics than their academic GPA or grades. These personal attitudes all play a role in the ways a student perceives and pursues new knowledge (Lent, Brown, & Larkin, 1986). Bandura (1977) found that self-efficacy plays a major role in determining if a student will attempt a given task, the amount of effort a student contributes to a task and how much persistence they will exert when solving the task. Thus, encouraging constant reflection and self-evaluations in the math classroom is just as important as analyzing the actual performance (Hackett & Betz, 1989). If low self-efficacy is a predictor of one choosing to not pursue mathematics, the mathematics community must find ways to strengthen students’ belief in their personal mathematics skills (Drury, Siy, & Cheryan, 2011).

One of the most prevalent misconceptions that results in low female achievement in mathematics is the belief that females lack self-confidence. Girls, influenced by negative gender stereotypes, do not believe that they can be successful in math (James, 2009). Social stereotypes have convinced female students that males are superior in math performance and that achieving higher performance rates are unlikely (Linn & Hyde, 1989). Furthermore, the effects and experiences with other forms of assessments can have a negative impact as well. For example, if poor performance on the math portion on a standardized assessment occurs, it is likely that female students may feel that all future assessments may also result in negative outcomes (Brown & Josephs, 1999).

Roles of same gender role models. Since its origin in 1936, the recipient of the Nobel Prize of Math had always been a male (Hyde & Mertz, 2009). However, Maryam Mirzakhani would make the first female to be honored the award in 2009 for her work to “the dynamics and geometry of Riemann surfaces and their moduli spaces” (Winter, 2014). This action served as a
huge breakthrough for gender equity and proved that females too could be successful in a male dominated field (Bellos, 2014). Research has shown that role models can be inspirational, enhance self-evaluations and motivation, and possibly guide academic and career aspirations (Schwartz & Hanson, 1993). Specifically, same-gender relationships can be powerful in creating a sense of belonging as noticeable similarities become much more obvious (Lockwood, 2006).

Further, through the leadership of a female, such as an instructor, that appears competent in their math abilities, female students are likely to perform more successfully (Marx & Roman, 2002). Due to the negative stereotypes that exist, many females allow this to contribute to their identity causing a lack of successful performance, decline in one’s self-efficacy and possibly force a withdrawal from math coursework or field of study (Drury, Siy & Cheryan, 2011). By introducing influential women in the field of mathematics, educators can work to convince females that academic and career goals are attainable. In addition, with positive influences from other female peers, counselors and teachers, students’ views of math can shift (Armstrong, 1985). Although negative gender stereotypes may not disappear, implicit attitudes of mathematics success among females will likely improve (Stout, Dasgupta, Hunsinger & McManus, 2011).

**Role of programs promoting females in STEM.** Techbridge, launched by the Chabot Space and Science Center in 2000, provides STEM opportunities to middle school aged girls in underserved communities. Through after school and summer programs, females in this program are given the opportunities to engage in hands-on projects, career exploration opportunities and receive individual academic and career guidance (Mosatch, Nieves, Kekelis & Lawner, 2013). Other programs, like the Access for Young Women program, focus on gender equity within education to encourage female students to pursue and excel at science and math. This program
introduces female students to applications of math in the real world and teaches them the importance of conducting and using research. Many other programs exist with the same goals in mind to give female students opportunities to engage with mathematics, find ways to relate math concepts to real world applications, provide opportunities for exposure to STEM role models and motivate female students to reach the highest level of achievement (Honey, Pearson & Schweingruber, 2014). With contributions being made from various societal organizations and higher education institutions, awareness regarding needed educational opportunities for females in STEM continues to grow. More research is needed regarding the true effects of these programs and how they help reduce attrition rates (Kahveci & Southerland, 2006).

Beliefs, Attitudes, and Views of Mathematics

A person’s beliefs and attitudes towards the learning of mathematics plays a significant role in one’s increased interest to learn math and in turn pursue further mathematics learning and careers (Schoenfeld, 1989). A common deterring factor for pursuing mathematics is the idea that it is difficult, lacking emotion, theoretical in nature, not relevant, and more relatable to those with masculine interests (Ernest, 2006). Beyond the math topics taught in schools, math is perceived as not relatable to one’s daily concerns and routines (Young-Loveridge et al., 2005). Students continually enter the mathematics classroom and see no purpose in their learning of the material (Kitchen, 2016). Instead, many believe that math is simply a requirement to get through school and only involves a collection of rules and theories that rely on one’s memorization skills (Van de Walle, 2010). A student from a study conducted by Alan Schoenfeld (1989) stated, “You must know certain rules which are a part of all mathematics. Without knowing these rules, you cannot successfully solve a problem.” Other students went on to state, “Memorization of equations and formulas are essential in mathematics.” Results from the National NAEP
Assessment (1983) also shows that many students believed being successful in mathematics relied on learning and memorizing rules. Thus, without mathematical instruction that focuses on conceptual understanding, reasoning, problem solving, and making connections with real-world applications, students easily lose interest in the learning of mathematics (Sherman, Richardson, & Yard, 2014). Thus, by making stronger efforts to bridge the gap between mathematical content and mathematical understanding, the educational community can make strides to help address student attitudes towards mathematics.

It is to no surprise that when a person brings up mathematics, many people have feelings of anxiety. Math anxiety can begin impacting students as early as the first grade (Ashcraft, 2002). Fear of embarrassment and failure causes many to go to great lengths just to avoid any experiences with mathematics (Klinger, 2004). Aspects of the traditional math classroom such as timed tests, being asked questions on the spot, and large lecture halls also increases feelings of math anxiety (Curtain-Phillips, 2017). Further, many believe their performance in the math classroom speaks to their overall intelligence (Ashcraft, 2002). Thus, teachers at all grade levels must make efforts to reconsider teaching methods that focus on problem-based learning, collaborative learning processes, and conceptual understanding of topics to help alleviate mathematical anxiety (Curtain-Phillips, 2017).

Theoretical Framework

Underrepresentation issues of females in mathematics requires the action of more than just classroom teachers (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Literature has shown that many factors, including those in formal and informal educational settings, play a role in a woman’s interests and decisions to major in mathematics and thus, action must be taken (Shapiro & Sax, 2011). With the increase of feminist knowledge over the years, we must devise ways to
share the knowledge that we have gained through feminist research practices with more women in efforts to positively transform their lives and careers (hooks, 1990). Thus, by utilizing a feminist theoretical perspective when studying the mathematics classroom as well as successful female mathematicians, researchers can work together to positively affect the mathematics community and demolish the negative gender stereotypes that women cannot be successful at or pursue mathematics (Brabeck & Brabeck, 2013). Feminist theory has helped guide the approaches taken within this research study. The given theory and various experiences will support one another to address the need for increased persistence of females in STEM fields and the impact of positive personal experiences and perceptions of mathematics.

**Inquiry Worldview.** Feminist theory is a multifaceted and complex theoretical framework that aims to expose gender inequalities that have been socially constructed (Acker, 1987). Feminist scholars have brought light to many injustices imposed on females and have made many advancements regarding the feminist agenda, one being the introduction of Women and Gender Studies programs into the universities (Wyer, Barbercheck, Cookmeyer, Ozturk, & Wayne, 2013). These scholars have worked to conduct research and expand the boundaries of feminist theory to even focus on the intersectionality of other important demographic characteristics such as race, social class, and age, that all play a role in identity development (Mellstrom, 2014). Those engaging in feminist research ask questions that place women and other marginalized groups at the center of social inquiry (Hesse-Biber, 2007).

Although broad, feminist theory is a sector of social movement studies that has brought empirical rigor to the field of education by critiquing the gendered assumptions of society (Maddison, 2007). Feminist research has an underlying goal to disrupt the traditional status-quo and instead evoke recognition and discussions regarding the need for social change (Hesse-
Biber, 2007). Feminist researchers recognize that while men’s lives and achievements have been honored and documented for centuries, this is not the case for women (Brooks, 2007). Instead, women’s culture, history, achievements, and lives have remained private without proper recognition from their male counterparts (Hesse-Biber, 2013).

All feminist theorists agree that men and women should be equal politically, economically, and socially (Chafetz, 1997). Further, all feminist theorists also work to challenge the patriarchy, our social system, where men seem to repeatedly hold more power and value than women (Joseph, 2000). Many feminists describe the patriarchy system as one where it is man’s job to command and women’s role to obey (Ruiz, 2005). With such strong political and action oriented objectives, feminist researchers want to see equality achieved between men and women in both public and personal relationships (Ropers-Huilman, 1998). Feminists believe that this equality can be reached through radical transformations of current modes, frameworks, and institutions of knowledge (Ruiz, 2005). Within this transformation is a better understanding of how gender is defined, what is considered masculine or feminine, and how these ideas came to be (Eccles, 1987).

Although it would seem obvious to many, gender and the way it is perceived and constructed is a central concept to all types of feminist theory (Ruiz, 2005). Feminist researchers accept that gender goes beyond biological differences that exist between men and women and is instead a social construction of identities influencing how men and women’s behaviors are shaped (Nagel, 2003). Thus, these understandings allow feminists to explain how institutions reward and punish gendered practices (Carison & Ray, 2011). Further, feminists can begin understanding the institutional and psychological barriers prohibiting women’s socialization processes to find ways to resolve issues of gender inequality. These changes could in turn
positively affect women’s choices in education and occupational endeavors further diversifying
social environments (Eccles, 1987).

**Feminist Theory Methods of Data Collection and Data Analysis.** There is no one form
of feminist theory and thus it remains to be a complex and undefinable theoretical framework
(Grant, 2013). For many theorists, such a wide range of perspectives can cause disagreements for
how data should be collected, analyzed, and represented (Ruiz, 2005). However, all feminist
researchers agree that scientific research is deeply gender-biased and thus attempt to make the
experiences of women a central focal point in their research process (Crawford & Marecek,
1989). With many modes of inquiry, such as positivism, only focused on generalized findings,
feminist researchers seek methods that are more mindful of producing relatable and personal
findings (Hesse-Biber, 2007). Data methods that allow for this discussion and observation of
humans in their daily social contexts are heavily influenced by qualitative forms (Sprague,
2016). Thus, it is through these qualitative methods that feminist researchers bring attention to
social problems, trends, and issues that have been dominated by male perspectives (Crossman,
2017).

For this study, multiple structured and unstructured interviews will be utilized. The
individual interview is one of the most widely used methods for those conducting research under
a feminist theoretical perspective (Sprague, 2016). In the first six volumes of 77 empirical
reports published in the journal, *Feminism & Psychology*, 56% of studies relied primarily on data
collected through one-on-one interviews (Wilkinson, 1998). The use of in-depth individual
interviews allows one to recap personal experiences and interactions with the social world (Knox
& Burkard, 2009). It is through interviews that questions and discussions around a group’s
culture and practices can be had (Kitzinger, 1995). These discussions will be audiotaped, a
common practice seen with those working within this framework are generally either audiotaped or videotaped (DiCicco-Bloom & Crabtree, 2006). The researcher will later transcribe the data to conduct sound, qualitative analysis through a process of coding to make connections among the data (Easton, McComish, & Greenberg, 2000). Other forms of qualitative data collection by feminist researchers includes fieldwork, observations, and surveys (Liamputtong, 2013). By spending time in the environment in which women work, learn, and conduct their daily lives, one can piece together the social construct of gender.

**Issues that Feminist Theory will address.** Divisions among feminist theorists have grown as researchers choose to focus on different challenges that women face (Stanley, 2013). With the source of issues being debated on, the emergence of varying sectors of feminist thought have come about. It should be prefaced that although particular views of feminism are traditionally associated with specific areas to explore as one works to overcome gender differences and inequalities, one is not expected to utilize a set feminist lens (Eccles, 1987). Instead, various frameworks help one situate themselves in respect to who is to blame for the present gender inequalities. Questions regarding the best ways to organize the fight for women’s liberation are of main concern (Riley, 1999).

**Gender Differences.** One underlying assumption for many feminist modes of inquiry is the concept of established, normative gender differences in society (Eccles, 1987). Feminists focused on gender differences stress the importance of valuing the different characteristics and traits that women and men each possess. For example, traditional female behaviors focused on caring and cooperation often have a negative connotation but these behaviors can be useful for making society a more positive place to live, work, and thrive in (Lewis, 2017). However,
feminists caution that one’s gender should not be an automatic depiction of how a woman should act or be seen in society (Butler, 1988).

Highlighting the issues of societal gender differences, feminists often refer to Simone de Beauvoir’s (1949) claim that one is not born a woman but instead becomes a woman through personal experiences and socialization. The roles of males and females are learned through one’s experiences and interactions with parents, peers, and other surrounding environments (Mikkola, 2016). Thus, feminists focused on gender differences often work to find solutions to meet the needs of women in a way that does not challenge the current male-dominated patriarchy, a practice very different from other sectors of feminist theory (Alcoff, 1988). The primary objective is to instead adjust social norms so that women are not considered passive, helpless, and subordinate to males (Mikkola, 2016).

*Gender Inequality.* Gender inequality issues remain a critical aspect of most feminist theories (Glick & Fiske, 2001; Dollar & Gatti, 1999; Carrigan, Quinn, & Riskin, 2011). Gender inequality is the belief that women are often denied opportunities that are given to their male counterparts. Further, there is the belief that women are often suppressed in contemporary society because they suffer from discrimination (Rosser, 2007). Feminist theorists who argue issues of gender inequality are generally not seeking any type of special privileges for women but instead simply want to see that everyone receive equal consideration without gender discrimination (Bartels, Carnes, Kaatz & Kolehmainen, 2015; Prentice & Carranza, 2002). Feminists focused on issues of gender inequality challenge concepts such as, “Why is a woman automatically considered the caregiver of children in the family?” or “Why do parents motivate their male children to pursue careers in STEM but motivate their female children to be in nurturing fields while looking for a husband?” (Donovan, 2012). Further, many theorists fighting
for gender equality argue that current societal systems support white, middle or upper-class males (Johnson, 2011).

**Gender Oppression.** Another area of concern for feminist theorists revolves around gendered oppression and further understanding how individuals are privileged or disadvantaged because of their gender (Kumashiro, 2000). Feminists argue that people consciously and unconsciously accept gender stereotypes simply because they are viewed as being the norm (Weaver-Hightower, 2003). Feminists agree that gendered oppression is structured into society and often institutionalized through the way we speak and the gendered attitudes we possess. Thus, with a strong focus on gendered power differences, many feminists want to find ways to disrupt these differences so that equal rights and opportunities for women and men can be achieved (Weedon, 1999). Furthermore, feminist researchers work to eliminate gendered oppression with the concentration on the intersectionality of other types of discrimination based on race, sex, ability, class, age, and religion (Young, 1990).

Believing that societal systems are centered around males, only females falling in one of the categories of Caucasian, heterosexual, or middle-class are truly considered when discussing gender inequality (Brabeck & Brabeck, 2013). This creates a strong sense of privilege and ignores the intersectionality of classism, racism, and sexism (Campbell & Wasco, 2000). Thus, even in terms of gender oppression, one must consider attributes such as race, economic status and country of residency to truly understand how to create equal opportunities and end gendered oppression (Brabeck & Brabeck, 2013).

**Structural Oppression.** An important understood assumption among feminist theorists is the notion that by simply being a woman, all those who fit into this category have some type of shared experiences. However, this perspective also requires the recognition that each woman’s
experiences cover a vast and diverse range of complexities (Brabeck & Brabeck, 2013). The oppression that one faces is an individual experience that can only be understood by the person suffering it (MSF, 2014). Beyond its biological nature, gender has social and political constructs that can cause negative experiences in one’s daily life (Stanley & Wise, 1990). Many women even find themselves impacted by the “double bind” which categorizes women who hold multiple minority status. For example, a non-Caucasian woman may face difficulties due to her gender but also her race. It is important to distinguish that “double bind” does not mean that one group faces more or less trials than another but that one may face unique challenges simply due to the multiple identities they possess (Samuelson & Litzer, 2016). Particularly, understanding the varying experiences of those impacted by “double bind”, allows a researcher to take a direct look at the intersection of race, gender and social status (Campbell & Wasco, 2000).

**Theoretical Assumptions of Feminist Theory.** Over time, theory textbooks have begun to include discussions of feminist theory but the definitions, ideas, and nature of the theory varies widely (Chafetz, 1997). While progress has been made, there is still much work to be done. This section aims to explain the theoretical assumptions that undergird feminist theory. By understanding the core assumptions, one can begin to understand the importance and rich contribution that this theory brings to the research community. Furthermore, understanding of these core assumptions can help researchers continue and advance feminist work (Riley, 1999).

*Gender is an organizing principle of all societies.* As mentioned previously, a theoretical assumption that must occur when conducting feminist research is accepting that gender and sex are not the same thing (Riley, 1999). Sex is linked to anatomical structures which is something an individual is biologically born with. Gender on the other hand, is what an individual chooses to identify or what they feel society has labeled them (Deaux, 1985). One’s gender will impact
the interactions, characteristics, and behaviors that a person possesses. Further, gender organizes society in a way that sets preferences for gender specific types of work and available access to resources like money and power. Society uses one’s gender as a guideline for appropriate social roles that one can fulfill (Stoller, 1994). Feminist researchers acknowledge that gender is an important part of all social, economic, and political structures and relationships (Riley, 1999).

**Gender is a social construction.** Another central theoretical assumption about feminists is the recognition and acceptance of gender as a social construction (Riley, 1999). Gender is heavily influenced by cultures of varying societies as the interpretation and meaning of behaviors is regarded differently (Costa, Terracciano, & McCrae, 2001). Thus, one cannot create a standard definition of what gender is. Instead, proper research and investigation of societal and cultural norms must be examined first. Further, when focusing on the social measures and ideals regarding women’s’ status in society, opportunities in education, and rights in the work place, one can gain a stronger conceptual understanding of the operational construction of society (Riley, 1999). Researchers must accept that western notions of what gender is and what it should look like is not generalizable to other countries and cultures (Chafetz, 1997). Further, understanding that women from different places will act and respond differently based on how gender is organized in their society, will help one to better value the differences among women (Costa, Terracciano, & McCrae, 2001).

**Gender involves the politics of inequality.** The attentiveness to power and power inequities among varying societal groups is a very important theoretical assumption of feminist theories (Riley, 1999). The primary argument of a feminist researcher is to advocate for groups of individuals who are not considered equal or given equal opportunities, with a concentration on women (Maguire, 1987). Feminists agree that gender inequality issues are at the heart of
understanding how and why women feel restricted or underprivileged (Riley, 1999). With noticeable issues of social hierarchy attainment where women are often found in positions that have less power and regarded less important, feminists seek ways to break the gender barriers (Chafetz, 1997). Even among politics, it is rare for women to be elected into positions of power. Feminist researchers can explore inequity issues in a range of areas including but not limited to, politics, government, education, and even within the home (Ridgeway, 1997). Well known feminist issues revolve around government restrictions on women’s right to varying contraceptive methods, birthing options, and legal rights within marriage. Other social feminist researchers may focus on why women are not often seen in male-dominated fields such as STEM or politics.

**Subjectivity Statement.** The subjectivity statement is written so that all related experiences of the researcher are presented transparently. Although critically analyzing data without any form of bias is difficult to achieve in research, the subjectivity statement is an opportunity to for the researcher to make explicit the bias that he or she may bring to the research study. It is important to note prior to engaging in the research of female mathematicians experiences and persistence within STEM that all life experiences have shaped the researcher's view of education.

I, Angelina Knies, am a Japanese-American female pursuing a doctoral degree in mathematics education. I have conducted previous research regarding female participation in STEM and also have personal experiences from which to draw. Growing up near an American Army base, I was privileged with the opportunity to interact with diverse populations on a daily basis. As a first-generation college student, I was taught to value my education and was encouraged to pursue a field that I desired. Unfortunately, due to common stereotypes, my family viewed majors related to the medical field as being much more prestigious as the intended
careers offered higher salaries. Not knowing the opportunities that studying mathematics education could afford, my family could only offer verbal support with their respect for the field slowing growing as I continued through my education. In the classroom setting, I never faced any sort of obvious discrimination based on negative gender stereotypes. However, during my career as a student, I found myself to be one of very few females enrolled in upper level mathematics course. Materials and topics were frequently delivered in ways to appeal to my male counterparts and were often unrelatable to me. To overcome these challenges, I spent countless hours outside of the classroom independently strengthening my skills. Further, I made every effort to make connections between the mathematical content I was learning in class to real world applications that were relevant to my interests.

As a female mathematics education researcher, I am aware that interviewing female mathematicians requires a certain level of trust and empathy in order to provoke truthful responses and reactions relevant to the research topic at hand. Using my personal experiences, I feel confident that have made connections between the data gathered from the participants to the information already brought forth by the research community. Being aware of my personal experiences as a female, a female mathematics student, and a female mathematics faculty member, it my hope that I have not allowed these experiences to overshadow the unique stories my research participants had to share.

Summary

Over time, gender gaps in mathematics performance have become much smaller but gaps in self-concept and aspiration remain large (Dasgupta & Stout, 2014). As defined from the American Association of University Women report in 2010, there is still need for females to pursue advanced degrees and continue to the workplace in math-related fields (Hill, Corbett, &
Rose, 2010; James, 2009). Called the “leaky pipeline”, this metaphor provides a visual of the processes women in mathematics studies face while going through high school, college and onto a career (Blickenstaff, 2005). Unfortunately, women are much more likely to leak out than their male counterparts (Gasser & Shaffer, 2014). Not only does this pose an issue of equality in the mathematics classroom but it is also a disadvantage to the mathematics field as diverse experiences and perspectives of women are scarce (Blickenstaff, 2005). Believing that mathematics success is not an option for them, many women choose to not pursue mathematics studies and instead use their talents and skills to benefit other fields of work (Dasgupta & Stout, 2014).

The discussion of female persistence issues related to participation and engagement in mathematics goes hand in hand with the discussion of mathematical identity development (Grootenboer & Zevenbergen, 2008). Understanding how a student views their abilities and chances for success in mathematics is a good predictor of their future career decisions in respect to mathematics (Hackett & Betz, 1981). As outlined in this literature review, not only do we need to concentrate on improving the confidence that females feel in their abilities to succeed in math related fields but we must also focus on external factors. By removing the barriers of stereotypical gender roles and shifting attitudes to one that see’s females as able individuals, concrete efforts can be made to increase success and retention of females in mathematics (Spencer, Steele & Quinn, 1999). Further, through the alteration of classroom practices, teachers can advocate for all learning styles and offer classroom discourse opportunities that are accommodating to females and their academic needs (Schwartz & Hanson, 1993).

This study aims to provide a narrative of female faculty members who pursued and remained dedicated to serving in a mathematics or math-related field. Through these stories and
testimonials, this study brings to light perceptions, qualities, and experiences that all influence a female to be confident in her math abilities to pursue a mathematics field. It is important to note that each participant’s experiences are unique and thus, there is no single intervention that can solve our leaky pipeline issues. However, with the breaking down of these negative hurdles and efforts made toward eliminating gender barriers, this study provides implications for how to positively influence the number of females who pursue and succeed in the field of mathematics (Dasgupta & Stout, 2014).
Chapter 3: Methods

The aims of this study were to: 1) understand what experiences or personal attributes female mathematicians attribute their success to, 2) understand what perceptions female mathematicians have about mathematics and their mathematical abilities and what role these perceptions play in their success, 3) understand how participants view themselves as mathematicians? A qualitative methods study design was utilized.

Research Method

For the nature of this study, a qualitative narrative research study with a heuristic approach was implemented. With the use of this type of approach, one can discover structural relationships and patterns (Kleining & Witt, 2000). Qualitative methods are generally going to provide more detailed and in-depth data. Thus, with a heuristic approach, the research must recognize that as new concepts emerge, one may need to shift preconceptions if that data does not agree with them (Djuraskovic & Arthur, 2010). Further, as data is gathered, new themes may emerge and preliminary themes may disappear. These sorts of changes are a positive sign of the accumulation of new knowledge and can positively impact the research study (Kleining & Witt, 2000).

According to Greene (2007), a research study must also consider the role of philosophical lenses to address social inquiry. This study will be conducted through a feminist lens, which assumes that women are at a disadvantage compared to their male counterparts (Davis, 2008). The feminist perspective is one that regards personal narratives as integral to understanding cultural and gender analysis. It is important to understand that the use of the term “feminist” does not suggest that we are only concerned with issues that women face but by using a feminist lens,
the community can create a more inclusive organizational structure that considers the concerns of women and others facing discrimination (Calas & Smircich, 1999).

Under a narrative research design, this study employed traditional narrative methods such as interviews as well as analysis of stories and artifacts. The use of these qualitative methods allows for the emergence of stories regarding individual events and experiences in one’s lives that will help to make sense of the experiences of women in mathematics (Creswell, 2003). A narrative approach of analyzing data highlights similarities and differences in experiences, actions, and perceptions from the viewpoint of a woman in mathematics (Mitchell & Egudo, 2003). To answer the aforementioned research questions, a narrative research approach utilizing the description of narrative research proposed by Clandinin & Connelly (2000) was used:

“Inquiry into narrative. By this we mean that narrative is both phenomenon and method. Narrative names the structured quality of experience to be studied, and it names the patterns of inquiry for its study. To preserve this distinction, we use the reasonably well-established device of calling the phenomenon ‘story’ and the inquiry ‘narrative.’ Thus, we say that people by nature lead storied lives and tell stories by those lives, whereas narrative researchers describe such lives, collect and tell stories of them, and write narratives of experience.” (p. 2)

Narrative research allows the research to gather in-depth information regarding women mathematicians’ perceptions of mathematics and the attributes needed to be successful. Individual stories provide perceptions of what is valued in their experiences growing up as a child, as a student, and as a professional. Stories told are subjective, personal, and emotional. These stories are integral and powerful to the findings of this research study as they have provided insight on their experiences with mathematics throughout their lives.
Selection of Participants

To select participants, the researcher began by identifying mathematics departments within universities. Four universities were the focus for selection of participants. Each university will be coded as University A, University B, University C, and University D to avoid disclosing any information that could help identify the participants of this study. University D is a public higher education system while the other three schools are private institutions.

As a private institution, University A is committed to academics within the traditional liberal arts and sciences offering both undergraduate and graduate courses. University A has a large range of degree offerings spanning various mathematical and statistical majors. Minors in mathematics and statistics are also available for individuals pursuing other degree areas. Faculty members are devoted to their teaching but also have diverse research interests. Of 20 professor and instructor positions, 11 are held by females in roles as Senior Lecturer, Assistant and Associate Professor. The position of Chair for the Department of Mathematics and Statistics is held by a female.

University B represents a nationally ranked women’s liberal arts college that serves over 2,000 students. Students attending University B have the option of pursuing a B.A. in mathematics, a B.S. in mathematics, minoring in mathematics, statistics, or mathematics and computer applications. Consisting of 7 full time faculty members, 5 are female mathematicians with the department head position also being held by a female. Despite not being a research-intensive school, the institution prides itself on the opportunities it provides for students to engage with mathematical research during the year and in the summer.

Ranked as one of the top 20 math graduate programs by US News and World Report, University C’s Department of Mathematics can be found within the College of Arts and Science.
Separate departments for those involved in statistics or math education work do not exist at University C. Of approximately 65 faculty members, only 12 positions are held by females. Primarily focused on research, faculty at University C within this department study a wide range of topics to include probability, topology, geometry, computational mathematics, algebra and combinatorics.

University D serves as a co-educational, public university offering students a diverse experience to bring together new ways of thinking. This institution prides itself on admitting students who are dedicated to their academics and seeking challenging programs with engaged faculty and a campus culture preparing the 21st century professional. Housed in the College of the Arts and Sciences, the Department of Mathematical Sciences offers both undergraduate and graduate degrees in Mathematics, mathematics education, statistics, and actuarial science. With 27 tenure track positions, 16 positions are held by females.

Participants for this study included five female mathematicians. This number was chosen to gain unique perspectives based on working within different departmental cultures. Selecting participants who are eager to tell their story at great length and detail will yield a significant amount of data. Given the multiple and extensive methods of data collection, a large amount of data was collected without need for a larger sample (Morse, 2000). Mathematicians included in this sample are all currently teaching a course in mathematics and/or conducting research in mathematics. All instructors were expected to participate in all aspects of this study and no participants expressed ever being uncomfortable or wishing to stop their participation at any point.

**Recruitment.** Participants for this study were solicited voluntarily. All female tenure-track mathematicians at the universities described above were contacted via their official employee email address. Within this email, mathematicians received a brief description of the issues at hand
and the reason for the study being conducted. Further, participants were ensured that voluntary participation in this study would not affect their status as an employee in any manner. A total of 80 female mathematicians were contacted and a response to either accept or decline participation was received from only 21 of the 80 contacted. Of the 21 that responded to the original invitation, only 8 female mathematicians agreed to participate. Once a mathematician accepted the invitation to participate, the researcher responded with an email to set-up interview times at the participant’s earliest convenience. Of the 8 that received an email to set-up interview times, only 5 responded with their schedules. Each of the 5 participants reside in different cities than one another and the research. Thus, once interviews were scheduled with the 5 participants, all interviews were scheduled as virtual sessions via the use of the video conferencing tool, Zoom. Participants were asked to conduct the virtual interview in a location of their choice that they felt most comfortable discussing matters pertaining to their career. Participants all chose to conduct the interviews in either their homes or personal work office. See Proposal Appendix A for a copy of the recruitment letter.

All five participants remained in the study. Prior studies using this approach were also successful in retaining their sample without the need of special retention strategies (Harrison, 2003). Interviews were conducted over the span of two months. Communication with participants via email or Zoom video conferencing software occurred over the span of four months.

**Protection of human subjects.** The original proposal for this study was sent to the Institutional Review Board (IRB) at North Carolina State University. No informants were involved in this study prior to the completion of the IRB review. This study was identified as having minimal risks associated for participants in this study. After being reviewed and approved
by the IRB, the study was given exempt status based on the policy outlined in the Code of Federal Regulations (Exemption: 46.101. Exempt b.2).

Due to questions within the interview discussing perceptions of gender and how these experiences relate to the mathematics classroom, some participants may have felt uncomfortable discussing this topic, but no participants openly expressed these sorts of feelings. If any questions initiated any strong types of emotional trauma, I was not informed. However, all participants were informed at the beginning of each interview that if at any point they felt uncomfortable, rescheduling a meeting or dropping from the study was allowed. To attempt to create the most comfortable environment for participants during interviews, participants were informed that they could refuse to answer any question, talk about any topic or end the interview whenever they wished. However, no participants took advantage of any of these options. Inconvenience was reduced by allowing the participants to determine the time and place for meetings. Three of the five participants asked the researcher to send text reminders on the day of the interview. Interviews were scheduled for one hour each. All interviews lasted the entire hour duration except for one interview that ended fifteen minutes short due to the participant having an unplanned obligation to attend to. No invasive procedures were included in this study.

All participants were cognitively able to consent to participate in this research. No information regarding one’s age, marital status, socioeconomic status or religion were considered when selecting participants. In addition, no incentives were provided to any participants. Ensuring that employment status at the university will remain despite participation in this study served as an important aspect of obtaining open and honest responses from participants. Thus, confidentiality of participant names has been maintained by changing names to pseudonyms. All
written documents have used the pseudonyms and only the researcher has access to the actual names via a password protected computer.

**Data Collection**

This section serves to provide readers with the modes of data collection that were used in this study. The modes of data collection fall under qualitative approaches to include interviews, personal photos and artifacts, and participants’ curriculum vitae. The researcher began by asking participants to schedule three meetings to conduct semi-structured interviews. Personal artifacts or photos of artifacts were brought by participants during each interview session. All participants emailed the researcher their curriculum vitae. The use of these three data collection methods allowed the researcher to analyze and write a final narrative of each participant’s experiences in chronological order and express reoccurring themes that emerged from these experiences. Research conducted for this study was initiated upon approval from the Institutional Review Board. Data collection began in January of 2018 and concluded in March of 2018. Analysis and findings of data were conducted in the remaining months to conclude in July of 2018.

**Interviews.** Narrative research allows for emerging themes and stories with a particular interest in personal lived experiences. This type of research embraces individual stories and highlights how these experiences impact the way one views life (Woodiwiss, Smith, & Lockwood, 2017). Guided by research questions presented in this study, a semi-structured interview guide was prepared. Interviewing is a fundamental activity and seems to be crucial for people to make sense of their lives (Patton, 2015). The use of interviews in this study helped the researcher to better understand the participants’ experiences and provided an opportunity for participants to speak about their perceptions of women in STEM. The questions were formulated in an open-ended manner to give participants the opportunity to take the discussion in any
direction they choose. Since the study has a narrative research design, the interviews were a way for the researcher to learn about the personal and impactful experiences the female mathematicians have had. In turn, the questions were designed to help elicit useful information that helped guide the researcher in answering the research questions (Forsey et al., 2012). It was clear from the interviews that perspectives were unique due to various life experiences and ages of participants. However, there were also some clear and similar themes among the participants as some perspectives overlapped simply due to the common STEM-career and gender characteristic among all participants.

The interview protocol contains an introductory protocol, greeting, description of the purpose of the research, interview questions, and a space for reflection once the interview concludes. Guided by the research questions of this study, I developed open-ended questions to probe for deeper meaning. The questions were designed with a narrative research methodology in mind to evoke personally meaningful experiences, descriptions of role models, explanations, and beliefs of learning and being successful in mathematics (Lutovac & Kaasila, 2007). The initial interview questions focused on the participant spending time reflecting on their experiences over the course of their life. The questions further led the participant to consider how their perceptions towards mathematics and their mathematical abilities have changed over time. The final question of the interview asked the participants to share any photos or other personal experiences that were not brought about in the interview. Data collected from the initial interview has helped to address the first research question.

The second set of interview questions focused on the experiences of each participant in respect to their role as an instructor, the impact of gender in their personal experiences, as well as their perceptions of how gender plays a role in the mathematics abilities and success of their
students. The interview ended with participants being encouraged to share any photos or stories not discussed within the interview. Data collected from the second interview has helped address the second research question.

The final set of interview questions were adapted from a study conducted by Usher and Pajares (2009) regarding the sources of self-efficacy in mathematics. The interview questions are guided by Bandura’s (1997) idea that self-efficacy beliefs are influenced by one’s previous attainments, through the experience of observing others, social persuasions, and one’s emotional and physiological state. Self-efficacy expectations will in turn affect behavioral activities, amount of effort towards an activity, and persistence in the face of obstacles (Lent, Lopen, & Bieschke, 1991). Thus, the questions presented in the third interview helped the researcher better understand the narrative of personal experiences participants faced in and outside of the math classroom. Further, responses to these questions provided a stronger idea of how one’s self-efficacy beliefs played a role in their academic and career choices towards becoming a successful female mathematician. Data collected from the final interview helped to fill any gaps within the narrative. Further, the use of direct quotes and real examples has provided powerful statements to help address the research questions at hand.

All interviews were audio-recorded using a digital recording device. Further, all interviews were screen recorded which allowed for the recording of both the visual and audible parts of the interview. See Proposal Appendix B for the Interview Protocol.

**Personal photos and artifacts.** “A picture speaks more than a thousand words,” is a quote we have all heard far too often. Thus, its meaningful contribution to qualitative research cannot go unrecognized. Visual images can evoke emotions, abstract ideas, and help connect individuals through shared experiences (Hodges, Keeley, & Grier, 2000). Further, photos and
artifacts can be a form of storytelling that allow for the exploration of a story by provoking the memory of events, giving insight to a participants’ history (Harrison, 2002). In 2002, Harper wrote, “Images evoke deeper elements of human consciousness than do words; exchanges based on words alone utilize less of the brain’s capacity than do exchanges in which the brain is processing images as well as words,” (p.13).

The use of personal photos and artifacts was appropriate for this study as it helped the researcher narrate experiences and come to an understanding of what these experiences mean (Harrison, 2002). Utilizing visual images allows for topics to be explored differently than the use of language alone. The brain processes language differently than visual information which can allow the use of photographs and artifacts to introduce a new way of knowing and telling (Miller, 2015). The claim is not that photographs will be better than words alone but instead that these photographs will provide a different, holistic perspective on individual experiences.

Participants were asked to contribute photos and artifacts to the study that they felt comfortable sharing. No photos or artifacts were kept by the researcher in any form. Instead, the use of the photos and artifacts served to extend discussions revolving around the participants’ experiences. Participants were asked to bring any photos or artifacts that they wished to share during interview sessions regarding their experiences and journey to becoming a successful mathematician. Participants were reassured that sharing photos and artifacts was an option and not a requirement to participate in the study.

**Curriculum Vitae.** Each of the participants was asked to share their curriculum vitae as a means of verifying chronological information and dates discussed in the interview. The curriculum vitae was used to triangulate data collected and to confirm details, titles, and dates discussed.
Analysis

All data analysis for this study is considered independent of one another. However, the results have been mixed once overall interpretation of findings occurred (Wittink et al., 2006). The researcher has looked for convergence, divergence, contradictions and relationships among the three sources of data to make strong, relevant conclusions (Feldon et al., 2008). This section serves to describe the analysis process and how validity and reliability of data has been assured.

**Analysis of interviews.** Audio and video recorded data from the interviews were transcribed by the researcher. Transcribing was used to decipher audio and visual recordings into written format to make a large amount of data more meaningful and useful (Johnston & Christensen, 2000). With three separate interviews, the process of transcribing data also helped the researcher find an organized method to divide information based on turning points in one’s life. The researcher utilized four different colors of post-it notes in order to organize the data in chronological order. When transcribing a particular phrase or idea, the researcher labeled the post-it note with the interview number as well as the time the phrase was being said. Blue post-it notes were used to represent anything that occurred or related to one’s childhood. Pink post-it notes were used for anything related to the participant’s undergraduate career. Orange post-it notes were used to represent anything that was discussed regarding one’s graduate career. Green post-it notes were used to transcribe parts of the interview that discussed information regarding the participants in respect to their profession. After all data had been transcribed on its respective colored post-it note, the researcher began to organize all the notes within a specific color set to chronologically put the information in order. The researcher utilized poster boards as a means for keeping the data organized. The process was repeated for each of the five participants and their three respective
interviews. This visual representation of the transcriptions will be referred to as transcription boards for the remainder of this paper. See Image 1 in Appendix C.

The transcription boards served as a means for the researcher to organize information to write up the narratives of each participant. Having all the interview data transcribed and placed in chronological order helped the researcher to write up the narratives in a way that would make sense to the reader. Since the post-it notes were broken into four categories, the researcher decided to write the narratives in a similar way. Each narrative begins by discussing a participants’ childhood experiences, then their undergraduate careers to their graduate career and lastly their professional experiences. Several of the participants also had in-depth conversations about their views on females in mathematics or about student comprehension of mathematics that did not fall in one of the above categories. Thus, the researcher created an additional section as needed that allowed for the write-up of the discussions that went beyond personal experiences.

While transcribing interviews, the researcher took notes in a journal of themes that would arise between participant interviews. These notes were ongoing and the researcher constantly added evidence of reoccurring themes to the journal while transcribing each participant’s interviews. Once all interviews had been transcribed, the researcher reviewed the transcription boards and used this data to generate codes for reoccurring themes. Themes were developed based on similar events that participants had and on key words used by multiple participants. Coding is a process of assigning tags or labels that assist to gather information learned into similar categories (Basit, 2003). From a narrative perspective, the coding process allows for the describing, classification, and interpretation of data as emerging themes make way for the construction of individual narratives (Jeong-hee, 2015). A major area of concern for the narrative researcher is to avoid having any preconceived notions of what is expected to be heard in the interview sessions.
(Saldana, 2015). For this reason, *a priori* codes were not produced but instead, initial coding of the raw interview data allowed for emerging themes and categories based off the participants’ experiences. These categories had no specific requirements and varied in size. All codes were written in a way that was helpful to the researcher (Miles & Hubberman, 1994). This process aligns with the recommendation of narrative researchers who urge researchers to focus on emergent, data-driven coding to eliminate researcher bias (Saldana, 2015).

Using the transcription boards, the researcher was able to organize and code the data as a means of better understanding and categorizing the themes that emerge from the participants’ stories (Gibbs, 2014). A combination of open, prefigured and thematic coding were used for best analysis (Flick & Graham, 2014). All qualitative data was analyzed through a feminist theory perspective. The researcher analyzed all interview data with the notion that females are at a disadvantage when it comes to their success and access to resources in mathematics due to inequalities that have been socially constructed (Acker, 1987). The researcher specifically looked for events and phrases that placed women at the center of social inquiry pointing to any issues revolving around females in mathematics fields (Hesse-Biber, 2007). The researcher also aimed to better understand the perceptions that each of the participants held towards gender as it was an assumption of the researcher through the feminist lens that gender is a social construction that influences how men and women behave in society (Nagel, 2003). In the final chapter of this paper, the researcher aimed to provide possible solutions and ideas for future studies that seek improved methods for ensuring equal consideration without gender discrimination for females in mathematics fields (Bartles, Carnes, Kaatz & Kolehmainen, 2015).

**Analysis of personal photos and artifacts.** To protect the confidentiality of all participants, photos were used solely for extending and guiding discussions during each interview
session. During the interviews, participants would discuss events and experiences that were significant in their lives. Some participants would show photos and artifacts to help the researcher better understand the experience being described. On most occasions, this allowed the researcher to develop additional open-ended questions to dig further into the details of these experiences. No process of data analysis of the photos or artifacts has been done as the researcher did not keep any copies of the photos for confidentiality purposes. Verbal descriptions and notes of the photos and artifacts were made by the researcher and served as the only form of data used when writing participants’ narratives. On several occasions, participants explained that they were willing to share photos and artifacts with the researcher but that they did not want the details included in the write up of the study. For this reason, no use of the photos or artifacts have been included in the write up of this study nor will they be included in any future publications or documents.

**Analysis of curriculum vitae.** The use of each of the curriculum vitae for each participant was used to verify information that was unclear through interviews. When writing the narratives of each participant, there were moments that the researcher had difficulty organizing the timeline of when events occurred and the specific details of these events. Further, participants tended to mention involvements or publications but did not have the opportunity to expound on these experiences. The researcher used information from the curriculum vitae to look up publications and involvements to better understand what was being discussed in the interviews. Several participants briefly discussed their research experiences but were unable to provide the researcher with enough detail to gain an understanding of what they had accomplished. The use of the curriculum vitae allowed the researcher to explore the participants’ research further in order to make stronger connections between discussions held in interviews. Further, the curriculum vitae
served as a way for the researcher to verify and ensure all information being presented in the write-up of the study was accurate.

**Trustworthiness and credibility.** Trustworthiness and credibility refer to the truths and correctness of arguments and conjectures made. Conclusions made based off data analysis should be sound, well-grounded, justifiable, strong and convincing (Kvale, 1995). Further, a researcher must be concerned with ensuring that the tools and assessments used to measure the intended constructs, are actually doing so (Vogt et al., 2004). To address these concerns, the notion of triangulation of data was integrated into data analysis. Denzin (1978) was the first researcher to outline the specific details regarding how and why to triangulate data methods. He argued that three outcomes arise: convergence, inconsistency, and contradiction. These outcomes will assist a researcher in constructing explanations of the observed findings. Further, “the bias inherent in any particular data sources, investigators, and particular method will be canceled out when used in conjunction with other data sources, investigators, and methods” (p. 14). For the purpose of this study, triangulation of qualitative data was completed in order to lead to thicker, richer data, lead to the synthesis of theories, uncover any contradictions, and allow for the researcher to be confident in the results and findings from the study. Further, with the addition of member checks and comparing various data sources, the researcher was able to reduce bias and improve credibility (Delamont et al., 2012). Once all narratives had been written, the researcher shared them with all the participants asking that each look over their respective narrative. Each participant was asked to ensure that the researcher had interpreted their stories correctly and that no information was included that the participant did not want to share. Participants were asked to highlight in yellow anything they wanted deleted. The participants were asked to also highlight in orange anything
that they felt was missing and wanted to add to their narrative. Each participant followed these guidelines and sent back their personal revisions to the researcher.

Issues of trustworthiness and credibility are of particular importance in respect to narrative research as personal experiences and claims are given scientific merit (Polkinghorne, 2007). It is critical that the researcher bases any conjectures on evidence and arguments made through statements given by the participants. For this reason, each participant’s narratives contain several quotes to show evidence of claims the researcher is making. The researcher considered the force and soundness of an argument made and constantly evaluated the data as a whole to see if any similar claims were being made among other participants (Lieblich et al., 1998). The researcher made a conscious effort to not put in her own emotions which can be difficult as the researcher is having a personal experience with the telling of someone else’s experience (Clandinin & Connelly, 2000). The researcher made connections between internal and external coherence to ensure reliability of the data. Internal coherence refers to how the data from the study fits together whereas external coherence factors how the research data compares to previous studies and theories (Lieblich et al., 1998).
Chapter 4: Findings

The participants selected for this research study were women across various southeastern public and private universities and colleges. All participants in this study were identified as women who had overcome challenges and continue to be successful within the field of mathematics. Each of the five women has a Ph.D. in mathematics or mathematics education along with several years of experience in higher education. However, the selected participants each have diverse backgrounds and experiences as well as varying educational paths that led them to their current jobs. The purpose of this section is to share the narratives of each participant. All five participants were eager to share their stories and were open to share details of their experiences. All participants were quick to respond and engage in dialogue that allowed the interview to progress smoothly. Pseudonyms will be used for all participants and any noun identifiers they spoke about.

**Individual Participants’ Narratives**

**Sara**

**Childhood Experiences**

Growing up as a child in the Northeast, Sara’s interests were not in the mathematics classroom. Instead, she found her passion to be embedded within sports. Enjoying the opportunity to try out new things, Sara found herself involved with every sport she could get into starting at a young age all the way through high school. Around third grade, Sara began taking saxophone lessons and would later participate in the jazz and concert bands at her school. Thinking about other opportunities that presented itself to her, she found that she did not enjoy activities such as journalism, yearbook committee, or key club. She could not remember what it was about her hobbies that interested her but feels like she just “fell into things.” She remembers
always thinking about how she could use her hobbies to benefit her in college. If she did not see a connection, she generally did not pursue it. Between the influence of sports games and music competitions, Sara found herself to be a competitive child growing up. “In general, I’ve always been super competitive and really motivated to give everything my all, all the time. I’ve grown more into that role now.” When discussing how this competitive nature affected her personality, she shared that she did not feel she was either girly nor tomboy in nature.

Sara never imagined herself to pursue the world of academia let alone in mathematics. “As a kid, I didn’t do anything math related.” Thinking back to her middle school experiences, mathematics was always her weakest subject. She discussed feelings of frustration as she never quite understood the mathematics she was learning at the time. When retrospectively thinking about her attitudes towards mathematics, she remembers adopting her mother’s mindset. “As long as I could see somebody do it, I would be able to mimic it.” After stating this, Sara chuckled as she shared she believes now as an educator, that this is a terrible attitude to have towards learning mathematics.

When asked to recall on her experiences in the mathematics classroom, her earliest memory was the difficulties she would face understanding the concepts in her middle grades mathematics classroom. These challenges followed her into high school but slowly mathematics became easier as she continued to work hard at it. “I was never someone that could just go to class and just understand it. It always took more than that.”

Thinking about her mathematics experiences in high school, Sara could not recall much. The only memory she had from her freshman mathematics course was a 100% score she received on a mathematics test. As her first 100% on a mathematics test, she was overwhelmed with excitement as she began to see the rewards of her hard work paying off. When discussing her
sophomore and junior year, she could only recall her teachers’ personalities. Having two very different experiences, she enjoyed her male mathematics instructor her sophomore year but found her young, female teacher in her junior year to be “horrible.” Advancing to AP Calculus in her senior year, she discussed similar feelings towards her female teacher claiming that she was “very rigid” and “very cold.” Again, this time in AP Calculus, Sara recalled receiving a 100% on her midterm and the excitement she felt because she was not one of the “usual smart kids that always got 100’s.”

Nearing the end of her senior year, Sara began to think about college. Coming from a long family line of doctors, there was no question that Sara was expected to go to college. In fact, she assumed that she too, wanted to follow the family tradition. Growing up and watching her mother and grandmother be successful as female doctors, Sara never considered that a science related field was not something she could handle or do. “I can’t remember any instance where I thought, ‘Oh, I’m a girl and this means something.’” Further, coming from an encouraging family, she stated, “They did a lot to support me.”

Undergraduate Experiences

Choosing to not go to college was never an option for Sara. Her parents always stressed the importance of obtaining a bachelors as well as some sort of graduate degree. With both of her parents and grandparents being doctors, Sara decided she would follow in the family path. Sara always thought that her family wanted her to go to medical school but as she got older, she realized that was never true. When thinking about schools to apply to for college, Sara knew she wanted to attend a small, liberal arts institution. Agreeing with her mother’s viewpoint, Sara did not want to attend a large institution that was over five hours away from home. Upon being accepted, Sara chose to go to a small, private liberal arts college that was not far from home. She
entered as a pre-med neuroscience major, but quickly learned in her first semester that this career did not interest her. Finding herself enjoying her calculus 2 and general chemistry class, she decided she would choose to pursue either science or mathematics. Sara does not recall thinking about how she would use each of these degrees in assisting her decision but instead solely based her decision on the fact that she did not want to take 8am general chemistry labs.

Thinking back to her social experiences growing up, Sara would have never considered herself to be a popular person at school. She participated in Greek life on her campus, but slowly became disconnected socially from this group as she began to grow as an individual. Unfortunately, Sara did not have friends within her major either, as many of the students worked individually. A lot of her classes were small with upper level mathematics courses having less than 10 students in it. The number of female faculty members was also smaller with white males representing most of the 15-20 faculty members. Sara distinctly remembers noticing how the three women faculty were outnumbered in the department. This would be the first time when she became most aware of the lack of females in STEM. Further, Sara felt like the women in the department were not like her. “They were super smart, super mathy, and I felt normal.”

Sara fondly remembers her undergraduate professors creating a warm and welcoming environment that was encouraging of her success. Anytime she had questions, she felt comfortable going to her professors for help. She spoke fondly of the instructors who were approachable, wrote clear and organized lectures, and that had a lot of energy. These characteristics were critical for her success as she really struggled in some of her courses. Although she always ended with a grade of B+ or higher, she knew her academic success was attributed to her work and study ethic. Sara recalled thinking that she was the only student who was always lost. “Like most undergrads, probably specifically women, I always thought I was
the dumbest one in the room and everyone else just got things like magically.” No matter what, Sara would always try her hardest to succeed. “That’s not a normal thing to think. That general attitude pushed me to do anything.” Various professor mentors were there to tell her she was good at mathematics and encouraged her to pursue more opportunities to work with mathematics including going to graduate school. “I think the mentorship I received at my undergraduate institution was really great. I’m not sure I would have ended up in graduate school if they weren’t quite as helpful on all of that.”

Despite her good grades, Sara still found her classes challenging. “I always felt like I had to do more, I had to study more than everyone else, work more problems. This is probably why I did better than everyone else because I studied more.” Sara recalled her real analysis course being one of the most challenging classes that she took in college. She remembered it being the first time she had to think abstractly and write technical, dense proofs. Getting C’s on the majority of her assignments, Sara often felt frustrated as the material “just wasn’t clicking.” However, she continued to work hard and push through the class and about halfway through the semester, her grades started to improve. At the end of the semester, she ended the course with an A-.

For most of her undergraduate career, Sara did not really know how she was going to use her degree. Instead, knowing her parents expected her to go to graduate school, she assumed “I could just figure it out from there.” She did notice her professors and their job seemed “cool”. “The more I saw of my professors, the more I wanted to be like them.” Additionally, the more she saw women mathematicians that supported that “mathy woman” stereotype, the more that propelled her to desire to go to graduate school to become something different. However, Sara also admitted that she did not really know what other professional options she could pursue with
a mathematics degree. Knowing that she was attending graduate school, Sara stated, “I could just figure it out there.”

**Graduate Experiences**

Pursuing a five-year doctoral program at a large, mid-eastern, public research university, Sara quickly found herself in a comparable department to her undergraduate institution. Of about 20-25 faculty members, women only represented 3 positions while white males dominated the other positions. Sara worked within a teaching assistant (TA) position throughout her graduate experience. She served as a recitation instructor for a calculus course and later became the primary calculus instructor for several sections. She was given a lot of freedom in her teaching and had the chance to find her own style. She continued to grow a love for teaching and desired to be a college professor.

Socially, Sara had a much better experience in graduate school. Outside of her department, Sara was as a member of the ultimate Frisbee team at the school. For the first time, Sara had found a group of women that she felt shared common personality traits as herself. Sara would also meet her now husband at her graduate school along with her best friend. In her department, Sara found a group of four other individuals whom she grew close with allowing her to avoid the feelings of isolation. The group consisted of 2 males and 2 females. The group would collaborate and assist one another with coursework. This quickly became her support system when she faced obstacles in graduate school.

Looking back on her graduate experiences, Sara stated that she often felt she did not belong. “Of course, I wouldn’t identify with anyone. These people were so far out of my league with their fancy pants, R1 institution doing incredible math research. There’s no way I could identify with that.” Sara and her best friend would often go to professional conferences and feel
like “stupid little girls together.” Sara also discussed feeling out of place as she noticed she was one of few females at many of the conferences she would attend.

Sara continued to feel like she had to work harder than her peers to understand concepts. She recalled her first year being very difficult as she was transitioning to graduate student life and responsibilities. Her final year was also challenging as she was facing the stress of job searching while finishing up her graduate work. Looking back however, she realizes it was not that bad. “I got through it. I worked hard and I got good grades. I liked working hard at math. I liked trying to understand these weird and abstract topics. I thought it was fun.” For the first time, Sara’s perspective of mathematics began to shift in graduate school and she saw it as an interesting subject to learn.

When it came time to do research in mathematics, Sara felt extremely underprepared. She began looking for an advisor whom she felt would be approachable and that “wouldn’t make me feel super dumb all the time.” She was fortunate to have a male advisor that was a well-respected mathematician in her field but she often felt he was so smart that his conceptual knowledge far exceeded what she could understand. In fact, Sara still does not fully understand all the details of the area she pursued to this day. Rather unconventionally, Sara put together a defense committee two weeks before her presentation and has continued to work on publishing her work for over four years. Overall, graduate school was her opportunity to grow.

Those were my formative mathematical years. There was a lot I had to overcome in terms of imposter syndrome and anxiety about math and being the dumbest one there and all that’s in grad school that I had to learn about, internalize, grow from and take that into my teaching.
Professional Experiences

Once on the job market, Sara found herself in a one year visiting assistant professor position back at her undergraduate institution. Here, she was given the opportunity to teach small sections of upper level calculus courses. Although enjoyable, Sara was overwhelmed with the everyday responsibilities of the classroom and multiple courses to prepare for. With much support from her department, she quickly overcame the feelings of being unprepared. Once her year ended, she was offered a new professor position at a private liberal arts university in the mid- east where she has continued to grow professionally at. Secondary to her teaching responsibilities, she is expected to contribute to research and participate in professional service. Sara helps advise undergraduate students in her department, sometimes works with undergraduate research students and serves as a first- year advisor to freshman students at her institution while teaching an introduction to college course.

Reflecting on her decision to accept her current position, Sara stated that it had a lot to do with location. Her now husband, was living in the area at the time and she knew she wanted to move closer to him. She also appreciated coming to a smaller school where she would be able to focus on creating strong relationships with students in the mathematics classroom. Looking at her current experiences, she still appreciates the institution and hopes to continue to grow as a professional. Offering her several professional development opportunities, Sara feels her institution provides ample opportunities to engage within the mathematical community. Although she does not conduct a lot of research, she still finds ways to engage in various, smaller- scale projects to better determine where her research interest lie.

With teaching as her main priority, Sara has been able to become more confident in the classroom. She spends a lot of time planning her classes hoping to help her undergraduate
students learn and appreciate mathematics. She mentions that her daily goal is to help her students understand the mathematics and not to just memorize it. She believes that in order to be a successful mathematics student, one must care about more than just the answer. Instead, students must learn to love the process, enjoy discovering new ideas, and reflect on their learning. For this reason, Sara makes an effort to help her students think about mathematics differently. She attempts to stress the transferrable skills that you can develop in a mathematics classroom such as problem solving skills, critical thinking skills, strong communication skills, and learning to pay attention to detail. “We need to let students know that the skills you gain from mathematics can make you marketable.”

She likened teaching to a puzzle in that every day she is trying to get her students to learn and realize their mistakes. Further, she wants students to see that facing challenges and making mistakes is a good thing as it produces learning. “Don’t be afraid to make mistakes. Don’t be afraid to try something and do it wrong. That’s ok. That’s great.” Thinking back to her teaching experiences a few years ago, she used to be scared that “people would see right through me and realize I knew nothing.” This caused her teaching to be extremely rigid to the point where she would have to often remind herself to smile. However, she later realized that being the professor did not mean having all the answers and that it was ok to not know the answer to something. She often shares this story along with the other challenges she faced with her students to inspire them to keep pushing to learn when the material gets difficult.

**Personal Reflections**

Sara still does not feel that mathematics comes easy to her but “it would be hard to argue that I haven’t been successful with it.” When asked what success meant to her, Sara described feelings of being in a job where she does math, teaches math, and enjoys it. She believes she is
putting her best efforts in when she continually works hard to be successful in and out of the classroom. Sara stated that the day she stops doing active research or looking for the best teaching practices, will be the day she needs to retire. Still having a lot of room for professional opportunities, Sara is not sure what the future holds for her. However, she would love to continue to advance in her career at her current institution.

Sara believes there have been several “micro-impacts” throughout her life that propelled her to be successful in the mathematics field. Sara discussed the role that parents have on what a child pursues and even how parents influence a child to take on a growth mindset or appreciate education. She discussed the importance of role models. In particular, she mentioned her female department chair saying, “She’s strong, a vibrant example of what I want to be like.” Sara also believes her own personality has driven her to success as well. She does not consider herself an extrovert but teaching is not a social setting that requires extroverted skills. Instead, being “very type A, punctual, and having a strong work ethic” which she describes as always giving her best, all impact the way she carries herself within her profession.

When asked if she world consider herself a mathematician, Sara responded, “Yes, but more of a teacher mathematician. Like, I think of a heavy researcher but I’m definitely a teacher.” She went on to describe that she believes there is a difference between a mathematics educator and a mathematician. Mathematicians focus a lot on research and teach on the side. A mathematics educator is concerned about their teaching.

Through all her interviews, there was no denying that Sara has a love for teaching and creating a classroom environment where students can collaborate as they discover mathematics. She enjoys the challenge of helping students understand concepts and helping them to realize that it is ok to make mistakes in math. Sara describes the opportunity to impact undergraduate
students and to create relationships as being the biggest contribution she makes daily to the mathematics community. By using her personal experiences, she can show her students that anyone can do mathematics.

Math is going to be hard. You are going to try something and it’s not going to necessarily work and that can actually be a really positive thing. To be a strong math student, you have to be open to making mistakes. Be open to working hard and be open to overcoming these challenges. If it [math] was easy, it would be boring.

Tara

Childhood Experiences

Like a lot of young girls, Tara loved to play with Barbie dolls. However, coming from a family that did not have a lot of money, she found herself spending most of her time outdoors. As an 80’s kid, technology was not a part of her life and instead she occupied her time playing jump rope, swimming in the pool, or playing with her friends. She always felt like a tomboy.

Tara explained:

I would always get so dirty. I have really curly hair and my mom hated to wash and brush it so I always had really short hair. I was called a lesbian multiple times growing up, which now that’s fine but as a child that’s traumatizing. It was the 80’s and they weren’t as open back then as they are today.” Being a female who did not fit the traditional stereotypes of young girls in the 80’s, she found herself facing many challenges and bullies that would continue throughout her teenage years.

Tara grew up in a home in the suburbs outside of Cleveland with her mother, father, and older brother. Her parents placed a strong emphasis on school that provided motivation for both Tara and her brother to work hard. Tara’s parents taught their children that the traditional path in
life was to go to high school and graduate, then go off to college and finish school before getting married and having a family of your own. When recalling this, Tara chuckled and said, “I guess I took that to heart. I literally finished school and I’m getting married six months later.” Tara’s dad never went to college. His parents were German immigrants and did not have a lot of money. This created a strong work ethic in her father and desire to save money. He did his best to always encourage her in school, but once she got to a certain level, he did not know how to best help her anymore. Her mom on the other hand, had a heavy influence on her academically. Tara’s mom had a way of making learning fun. She provided opportunities to turn learning into play and even taught Tara mathematics in a game-like format. When Tara was in first grade, her mom went back to college for an accounting degree and would go on to be a community college professor. Tara can remember life being much different as her mom pursued her degree. She found herself in extended care after school and saw her dad take on a lot of domestic duties around the house. However, Tara states that seeing her mom work so hard and then go on to graduate was a very proud moment. Her pride continued as her mom began to flourish in her career. One year in elementary school, Tara’s class had a special event where parents could come in to share information about their careers. Tara’s mom came to class with a huge calculator and shared what it was like to be an accountant.

“I remember being so proud that my mom could come to school and share her career with my class and give that perspective to my classmates and it also gave my class perspective on me. I’m really proud of her. I can’t believe she went back to school when I was in first grade.”

Tara spent a lot of time with her brother and developed a healthy, competitive relationship with him. When they were young, people would often mistake the two as twins
despite the fact that they were two and a half years apart in age. As two individuals that had several talents, they found themselves competing with one another in just about everything. Tara stated that if they could find something to make into a competition, they definitely would! Academics was one area that Tara and her brother competed in often and still compete in to this day. Tara recalls her brother always being very smart. “My brother, super super smart, like genius level scale, made it really hard to compete with him academically. He would bring home his genius friends which would influence me too.” Looking back, she believes her competitive nature started as something innocent but continued to grow and plays a significant role in how she got to her current position in life. In respect to her brother, he openly tells her, “that I can’t even hold a candle to you academically anymore.”

Tara remembers first becoming interested in mathematics during first grade. In class, the students played a game called Around the World. The game consisted of several flashcards and you would have to “knock out” everyone in the class. Part of the process required pattern memorization and the ability to answer quickly. “I rocked at that game.” Her recognition for patterns continued and in third grade, she was able to show her pattern recognition skills through a classroom game called Four Corners. All the students would have to pick a corner of the room to go to while a person with their head down would have to say a number corresponding to a corner. The goal was to say the number that most students would go in. While Tara’s peers would yell out random numbers, Tara quickly saw that students would go to the corner corresponding to the number that had just been called. Thus, when it was her turn, she would keep calling out the same number. Very quickly, she would win by calling the corner that had all of her classmates in it. In the same grade level, she remembers having to do practice problems in class. Her teacher would give the students thirty questions to complete in three minutes. Tara
loved this activity as she saw it as a game to be won and was motivated by the adrenaline rush. She noticed similar feelings when she would have to complete mathematics tests. Her mathematics performance was strong when she was young and she always did well on all her math assignments. “There was never anybody that could tell me that I was not good at math.”

One summer, Tara vividly recalls a relator coming to her parents’ house and seeing her working on a logic puzzle. “I was thinking nothing of it and she came up to me and said, ‘I wish I could get my daughter to do this.’ Apparently, that was strange. I know now that it was strange.” Math was always fun for Tara and it came easy to her. “I knew that math gave us answers to things. It was easy and it’s useful.” The thought that she was a girl interested in math never seemed to be issue that she was aware of. She attributes this to her tomboy and competitive nature. Her elementary years would pave the way for her interests in math to grow. “Once I figured out that I was good at it [math], it became my favorite subject.” From the classroom games to having fond memories of her classroom experiences, she knew she would grow up to be a mathematics teacher.

After elementary school, Tara continued to play sports. She loved athletics and found it to be a great way to express her competitiveness. In eighth grade, she decided she wanted to try out for football. She remembers not having yet hit puberty and being stockier in than most of the boys in her class. She also felt confident of her strength as she and her brother would often play fight. To be admitted to the team, she was required to get a physical but the doctor would not approve her to play. “He told me because I was a female, I could not play. Now my mom certainly could have made him tell me this because she did not want me to play at all.” Although angry that she had faced this sort of gender discrimination, she chose to try out and gained a position on the cheerleading squad instead.
Her competitive nature also continued to shine in the mathematics classroom. Anytime a teacher asked a question, she would shoot her hand up to answer the question as quick as she could. “I think it was a big part of me to be able to show off and show how smart I was. That’s how I could compete with other people.” Tara chuckled as she went on to say that her doctoral program taught her that it could “no longer be the Tara show” and that sometimes she needed to keep her hand down.

Mathematically, Tara was on an “accelerated track.” She took Pre-Algebra in 7th grade, Algebra I in 8th, Algebra 2 and Trigonometry in 9th, Geometry in 10th, Pre-calculus in 11th and AP Calculus in 12th. Looking back, she wishes her school would have offered AP Statistics as she knows that would have been something she would have been interested in taking. She loved her algebra related courses as she really saw the concepts as puzzles. “I could look at a problem and then the solution in the back of the book and figure out the steps to get me there.” Tara appreciated when mathematics challenged her. “I hated proofs. There was no sense of a puzzle. It was just a bunch of rules and steps to follow. It lacked the challenge.” Without the challenge, she found class to be boring.

Outside of the classroom, Tara’s parents also gave her opportunities to participate in mathematics-related clubs and activities. Tara participated in summer math camps twice. She applied and was invited to participate in a summer honors institute. Here, she took an introduction to abstract algebra course the summer before her 10th grade year. She loved learning about concepts such as sets and rings. “I thought it was so cool.” Her second camp experience focused on problem solving. Here, she was able to work with other teenagers all from Ohio that she described as “a version of me.” “All of us were in this room, like a think tank, and I felt really connected with these people.” In fact, Tara made one friend in particular that she still
communicates with to this day. Tara also participated on the state’s Math League in her high school. She remembers having to solve five difficult math problems and as long as she would make a score of 4 or 5, she would win a math prize. “I won a Pi mug. I was excited because I got it the same time my brother won the mug and he was three grades ahead of me!”

In her AP Calculus class, Tara remembers having to study concepts more thoroughly than her previous math classes. However, she still performed exceptionally well. In fact, it got to the point that her peers would stop asking the teacher who had the highest score on assignments and instead ask who had the second highest score. “That sort of thing really drove me.” She went on to take the AP calculus exam and scored the highest score possible, a 5. Despite her mathematical achievements, she did not like high school.

“I think it was just my goal to get out of high school and go to college. I knew it was going to be difficult for me [socially]. It was difficult for my brother who was also super smart and I just kept telling myself if you can get past this, you can go to college. Once I got to college, life was great.”

Tara faced a lot of bullying in high school due to her intelligence and tomboy nature. “I was a conscientious student and didn’t want to be late to class so I would carry all of my books to class. I got ‘booked’ on several occasions.” Tara described “being booked” as somebody coming and slapping all her books in her arms to the floor which would create a hallway commotion. In particular, one boy would always give her a hard time. He would make fun of her short haircut and accused her of faking a sprained ankle. “I got bullied pretty bad in school.”

Despite her difficulties socially in high school, Tara still found a group of friends with whom she felt she could fit in well. “I had a very eclectic group of friends but we were all interested in succeeding in school.” Despite being involved in athletics, Tara never felt like she
could fit in with the athletes the way she could with this group of four girls. “We were the nerds. We cared about school.” When asking her to describe what she characterized as a nerd, she broke it down into three categories.

“There are dorks, nerds and geeks. Dorks are the people who are lame and lack social skills. If you are a nerd, you are smart. You go out of your way to gain more information. Geeks are the people who like to play dungeons and dragons. They are just weird.” She proceeded to chuckle and said, “If you’re getting a Ph.D., you are a nerd. So you and I are nerds.”

Looking at how her friend group pursued opportunities after high school, it was clear they had all chosen very different paths. Friend #1 who was good at English in high school went to college, but became a mom immediately after. Friend #2 who was good at both math and English in high school went into the Navy. Friend #3 had a passion for learning even though she did not make stellar grades in high school. She was the only member of the group that did not get a four-year degree. Friend #4 was good at both English and math and went to college. She currently works as an editor for textbook companies. Tara expressed her respect for the paths that all her friends chose but also noted that a clear distinction between her and the group was the opportunity to experience graduate school and to obtain a Masters and Ph.D.

**Undergraduate Experiences**

When Tara graduated from high school, there was no question that she was expected to go to college. However, unlike most students, her process was not something that overwhelmed her. Tara was not worried about which school she would go to nor about what major she would pursue. In fact, she did not even make any campus visits. She considered applying to a private research university in Ohio as it was the same school her brother attended. She was well aware of
its positive reputation for being a respected and rigorous school for engineering in the northern part of the state. “It’s a very nerdy school and my mom actually thought it was too nerdy for me and discouraged me from applying.” Tara later states that her mom thought socially, she would not fit in. So instead, she chose to pursue her education at a public university in the state with a much more social reputation.

Upon selecting her undergraduate university, Tara only knew about its reputation and nothing about what campus life would look like or what her department culture would be like. She had heard that this university was often labeled as a party school, but that reputation did not bother her as she knew it was an accredited institution. After being admitted into the school and being told to select her desired residence hall, she chose a living-learning community focused on academics. With this choice, she assumed she would be with other students who were also aware of the social aspects of the institution, but also valued their academics. Unfortunately, the living-learning community was selected by a small percentage of students that could only fill up one and a half floors of the hall. The remaining floors were occupied by students who had registered late. While most of the living-learning students were neighbors to one another, Tara and two other individuals were put in an area with the “stoners and partiers.” “It actually turned out to be fun. They never bothered me. They weren’t mean to me. They actually would ask for help on their homework.” Tara went on to describe how the environment was positive for her development as a young adult. “I felt like the university really fit my personality. I had a lot of people around me that wanted to study. They might not have been as good as me at things but I also had people around me that were much stronger in humanities and science. They were able to help me in my classes too and they also helped me come out of my shell. It really opened me up.”
Tara knew she wanted to major in mathematics but was not sure what area she wanted to concentrate on. When asked about how she finally made her decision she stated, “I read down the list of different choices and I was like, ‘Actuarial Science, well that one looks interesting’. I literally just rolled with it.” Thinking back, she realizes how risky her decision was because she did not know anything about the field. In addition, she had never had any statistics experience in high school. Her major was within the mathematics department but with the addition of three other courses, she was able to minor in Business as well. At one point, she considered double majoring in Computer Science, but the lack of female representation deterred her from this decision. “I decided I didn’t want to be in a program with only four other women. This was the only time my gender stopped me.”

Tara had similar feelings about her mathematical abilities as she did in high school. She often felt she was much stronger at mathematics than her peers and “I still felt like I was at least in the top five percent. Even in undergrad, math still came easy to me.” Tara played an active part in her learning and often participated in class discussions. She was not scared to answer questions and would stay engaged in mathematical dialogue in the classroom. “It wasn’t a strange thing for me in a math class to work in groups and be the leader of the group.” Tara simply felt that very few people understood mathematics the way she did. “In that regard, I kind of wish I had gone to a more challenging school so that I could have had somebody there to challenge me but it worked out. My very first semester I got to tutor calculus.”

Thinking back to the number of female professors in the department, Tara could only recall two. The other instructors were male with a large percentage of Indian males. “I think with the breakdown of more females in my classes, I didn’t notice the lack of women professors.” Most of the lower level math courses were taught by doctoral graduate students while professors
taught the upper level courses. Upon reflection, Tara felt like she had a good relationship with
the majority of her professors, but nobody in particular was impactful on her academic career.
“When I had good teachers, I think I did pretty good and I didn’t have any trouble with math in
general.” As far as the breakdown of gender representation among Actuarial Science majors,
about eighty percent were female and twenty percent were male. Tara explained that this was not
the case for other areas within the mathematics department which would be evident from her
pure mathematics classes. Actuarial Science was a mixture of applied and theoretical math with
the majority of students also working on a minor in Business.

“I wonder if the aspect of Business made women more comfortable going into this. Like
they wanted to do math but didn’t want to be purely theoretical or purely applied. They
wanted something with business in it. I don’t know, that’s just my hypothetical thinking.
I do know it was a different composition of course than applied or pure math for sure.”

Tara faced a few personal challenges outside of the classroom that she doesn’t like to
think about but overall, she had a positive experience. Socially, she made two friends that she
keeps in touch with to this day. Friend #1 was an individual she had met in her residence hall as
a freshman. Friend #1 was an Accounting major who cared a lot about her academic success.
Tara and her friend chose to live together for all their years of undergrad. “Even though she
wasn’t a math person, she was like my rock in undergrad.” Friend #2 was a gentleman that Tara
had met during her third Calculus sequence course. Like her, he was a top student
mathematically but was a Computer Science major. Once their friendship was formed, they
continued to take classes they both needed together including math and non-math courses. In
graduate school, they made the decision to live together and were often able to assist one another
with coursework. “He was probably one of the best influences I had even though he wasn’t a math person.”

When asked about negative experiences that Tara had in college, she distinctly remembers one male professor that gave her a difficult time. She remembers learning the topic of convergence in one of her probability sequence courses and making an advanced connection to other mathematical knowledge she knew. Unfortunately, her professor told her she was wrong. “I wasn’t wrong, I just didn’t do what he told me to do. In graduate school, when I explored the topic further, I saw what I had been saying back then wasn’t wrong.” Tara remembers this instructor making her cry in class on more than one occasion. She described him as being extremely blunt and rude. His behavior bothered her as she was not used to her math teachers not liking her. “Math is so much a part of me that when a math teacher didn’t like me, then I really took it personally.” Bothered with the way she was being treated, she went to voice her concerns to the department head. During their discussion, Tara recalls the department head saying to her,

“You have to understand that he is Russian. In Russia, their way of challenging the best students in the class is to pick on them like he’s doing to you. I haven’t seen the way he does this to you but I would assume he’s trying to challenge you and doesn’t realize the cultural differences.”

Although this response seemed reasonable, Tara never agreed that this was why she was being treated poorly in class.

“I think one reason I reacted so harshly to him was because of the way he made me feel. I knew I was good at math and if somebody was going to treat me like that, I was going to take it out on them. That wasn’t cool of him to do. I knew I was good at math and he would make me feel like an idiot.”
Frustrated with her experience, Tara opted to not take the final probability sequence course with this instructor and threatened the department head that if a new instructor was not assigned to teach the course, that should would transfer to a competing institution. To her surprise, the department granted her request.

In her senior year, Tara only had to take her last probability sequence course. Thus, she decided to begin taking graduate level mathematics courses. At the time, she was beginning to take her actuary exams as well as job search. As an actuary, there were eight exams that candidates could take but it was not required to pass all eight to get a job in the field. Tara attempted to take her first actuary exam hoping to get at least a passing score of 6 out of 10 but was only able to obtain a 4 out of 10. Although she would later reattempt and pass the exam, her original scores made her job search challenging. In addition, Tara was involved in an actuary shadowing experience at the time that gave her practical insight to what an actuary job position would be like.

“It wasn’t necessarily that it was difficult. It was that I shadowed somebody and I was like, this would be a boring job. You just sit there all day, not talking to other people, always crunching numbers. It just seemed like a very isolated position. It didn’t seem like the right fit for me.”

Tara began researching other options to pursue and decided that since she was already taking graduate level courses, she could just continue to graduate school and obtain a master’s in math at the same institution. “I would be able to complete my masters in math in a year and a summer quarter. I knew this would buy me time to pass the actuary exam and figure out if this is what I wanted to do.” Tara graduated from undergrad in the spring of 2006 and immediately began her master’s program in the summer of 2006.
Master’s Graduate Experiences

Going into the master’s program, Tara decided that she wanted to do a special concentration in education. At the time, her institution had a master’s in math education degree and a mathematics degree with a concentration in education. Choosing the mathematics degree with a concentration in education only required three additional education focused classes outside of the math department. When Tara filled out her application, she searched for the appropriate code that went with this major and concentration. Seeing a code labeled “education-math”, it made sense for her too choose this code to indicate her interest with mathematics and education as there were no other codes listed. After being accepted and preparing for her classes as an official graduate student in the fall, she approached the department head to inquire about a TA position. To her surprise, the department head informed her that since she was not part of the pure mathematics department, she would not receive a TA position. Explaining that she chose the appropriate code to pursue mathematics with an education concentration, she quickly learned that the code she had chosen was actually for the mathematics education department. Explaining the coding issue to the department head, she was able to convince the department to switch her major within a week. “Luckily, since they knew me and he knew I was a good student, he had no problem admitting me into the department and offering me a TA position.”

In the fall of 2006, she was offered a TA position for college algebra. In proceeding semesters, she would end up teaching sections of algebra, geometry, and statistics. “They gave me all my materials. I didn’t have to prep anything.” Tara was also made the instructor of mathematics courses that were designed specifically for preservice teachers. “I was teaching teachers how to teach during my master’s degree and I had no idea how to teach myself. So, I thought that was a little strange but also cool at the same time.” When teaching the geometry
class, the institution required the use of Geometer’s Sketchpad which would be her first time using this software. “It gave me a different perspective to geometry and made me think that I could actually teach this stuff.” Going into the master’s program, Tara originally thought she was just trying to buy herself time to pass the actuary exam and to find a job. Little did she know, that her TA position would positively impact her views on teaching and in turn affect her future career decisions.

For degree completion, Tara was expected to successfully pass her mathematics courses, three education courses, and complete a thesis project. Like her undergraduate experience, Tara did not face any difficulties in her mathematics classes. Likewise, she did not find the education components of her major to be difficult. She took education classes revolving around diversity, how to teach high school students, and how to teach statistics. She found her diversity class to be particularly interesting as her instructor was from Africa and would bring a plethora of possible classroom scenarios into his teaching. However, Tara stated that she does not recall her other two methods courses being very impactful.

For her thesis, Tara chose to work with one of the two female professors in the department that focused on mathematics education. Beginning her thesis, Tara stated, “I didn’t know how to write. I told you, English was not my favorite subject. Luckily, my brother was actually able to help me a lot and help me learn the parts of a research paper.” Tara completed her thesis project on the effects of teaching with contextual understanding. For this project, she wanted to better understand if students were more successful when given problems that related to things they were interested in. She continued to teach all her students in the same way but for tests, students were randomly assigned problems with different contexts. After learning what their interests were (sports, drama, cars, etc.), she analyzed the differences between student
scores in relation to the context of the questions they did or did not know about. “I knew very little about actual research design at that point. I went back and read it a month ago and YIKES! My school was a research institution but it did not produce the same caliber as some of the top research schools in other states. Maybe I could have picked a more rigorous school but I mean, I had fun. I was social, I got a degree, and I got a Ph.D. I mean it didn’t stop me from doing that so I try not to second guess that choice too much.” Tara completed her Master’s degree in the spring of 2007 and began seeking a community college instructor position.

First Professional Experience

Tara’s TA position had such a positive impact on her professionally, that she decided she wanted to begin looking for community college instructor positions. She had a friend currently living in North Carolina and she was fond of the area. Even though Tara really wanted to live in an urban area of North Carolina so she began applying to all the community colleges in the state that had an open position for a mathematics instructor. The only position she could obtain was located in a very small, rural area of North Carolina. She moved to the area a week before classes started and was assigned developmental math courses. Tara found it challenging to teach such low-level mathematics courses but was never given the opportunity to teach anything higher than an introduction to statistics course. Professionally, she was provided an experience that prepared her for future teaching positions. On average, she would be expected to teach four sections of developmental math which were 5 credit hours each. In addition, she would often be assigned an overload class which brought her up to 24 credit hours of teaching per semester. She would later learn that this type of load at other institutions would be assigned to faculty over the course of a year, not per semester.
In a rather small department consisting of six females and two males, Tara stated, “I always felt like I was supported by my colleagues.” However, she still felt disconnected from the faculty on a personal level because she could not relate to having children. Although she did not see this as a reason for disconnect, faculty members would often say things such as, “You don’t understand because you don’t have kids. I don’t know why, just because I didn’t have kids didn’t mean I couldn’t understand.” Tara also discussed on several accounts feelings of culture shock and adjustment to southern ways. These feelings were translated into her classroom as well. Tara shared an experience she had with a student on her very first day of class.

“I wasn’t expecting to get any personal questions about myself on the first day of class. This girl raised her hand and asked, ‘Are you married?’ I’m like, ‘No, I’m not married. I just got out of school.’ She goes, ‘Well do you have any kids?’ I’m thinking like, ok this is really weird but I respond, ‘No, I’m not married, no kids.’ She literally says, ‘Well what’s wrong with you?’”

Tara laughed as she shared this story and expressed that she immediately began to pick up on the southern ways of thinking. In her student reviews, many students would call her mean and flirty. Tara attributed this to her northern ways of communicating. She described herself as being really sarcastic and blunt but, that students in the south saw this as mean. Further, she described having positive connections with male students and how in the south, communicating with males on a friendly basis was interpreted as being flirty. “I feel like being female and trying to fit into a culture that doesn’t normally have as many male/female friendship connections is difficult for me.” She later clarifies that it actually was not difficult but an idea that was foreign and required her to get adjusted to.
Tara could only account for one negative experience that occurred with her department head. Tara described the department head as being a very strict and a rigid woman. Tara had missed two Monday courses in the same semester due to a funeral and becoming ill with the flu. On her return, the department head came to her and said, “You are not allowed to miss anymore classes. I have to cover your classes when you are gone and I have two small kids that I have to take care of.” Tara remembers being angry with such comments and thinking thoughts along the lines of, “Who’s fault is it that you decided to have kids? Not my problem.”

Later in the summer semester, Tara developed kidney stones. Remembering what her department head had said, Tara came to instruct her classes despite being on heavy pain medications. Her dean, who was also a female, inquired about why Tara was at work. Once the dean learned of what the department head had said, she found it ridiculous and sent Tara home.

Tara continued working at the community college until August 2010. After having experience in the classroom, she decided she loved to learn and wanted to continue her education to pursue a Ph.D. in statistics.

**Doctoral Graduate Experiences**

Starting in the fall of 2010, Tara began a Ph.D. program at a competitive research institution in North Carolina. As her previous decisions, her school of choice was a spur of the moment decision. She did not know much of anything about the school or department, but was very familiar with the city it was located in. She knew she loved the area and decided it was where she wanted to be. She came into the department of statistics as part of a cohort of 30 students. “This school very deliberately makes it half Chinese and half American. There are huge gaps of competency levels between the Chinese and Americans. That already made me feel like whoa, I’m already in the lower half. I’m under the median at this point. This has never happened
to me.” In her previous institution, she had always felt like she was in the top five percent of her class. She was also aware that she was one of a handful of students in the math department that graduated with Magna Cum Laude honors. Going to this doctoral institution, she began to doubt her previous institution decisions for the first time. “I had to remember I had graduated, been out of school for three years, and they just came out of undergrad so of course they had all this stuff fresh in their minds. That kept me going.”

For the first time in her life, Tara faced several challenges within the mathematics classroom. She felt extremely underprepared for her classes and felt she was missing a lot of prerequisite knowledge to be successful. She would often ask questions in class and her peers would look shocked that she did not know various concepts. “I would feel like a complete idiot.” Tara described feelings of frustration. “People would look at me like how do you not get this but I mean if you skip the base level on something, how do you build on top of it?” Although her peers and professors were willing to help, “I felt so stupid asking questions that it made it really difficult for me to get myself caught up.” Although she found herself academically struggling compared to her peers,

“I loved it. I know I was a very competitive person, but I loved the fact that I had people I could ask my questions of that weren’t my faculty members and get help with all of that. I was probably still top fifteen percent, maybe twenty percent, but I really liked having the collaborative ability with my classmates. We weren’t competing with each other.”

While Tara struggled in some statistics courses, she found herself very successful at her probability course. This served as an opportunity for her to trade knowledge with her peers. She would always help her classmates with probability homework and they would help her with statistics homework. She also found her statistics instructor to be very helpful. “He would be
surprised that I didn’t know something and would make it known but he wasn’t trying to be
mean about it. He would just be surprised but then help me figure it out.”

As part of the requirements of her program, Tara was expected to complete classes within
the 1st year, take an exam called the basic exam which judged how well you could handle Ph.D.
level courses, and then complete a dissertation. After finishing her classes and taking the exam,
she failed by three points. Given a second opportunity at the exam, she failed again by two and a
half points. Disagreeing with the way her exam was scored, Tara argued her results and was
granted back two points. “It was almost like salt in the wound. Yes, we’ll give you back these
two points but you are still half a point from the cutoff so you still don’t get it.” With this, she
was allowed to finish up courses to obtain a Master’s in statistics but was then asked to leave the
Ph.D. program in spring of 2012. She was informed that she was no longer continuing the
program on Valentine’s Day and remembers telling people,

“I feel like I just got dumped. I had poured my heart and soul into this program for one
and a half years and then they are like nope, you missed it by half a point. Goodbye. That
was really hurtful. Thinking back, it still is really hurtful. I’m happy with where I ended
up but it’s just the way they did it that was so hurtful.”

Since her experience with the Ph.D. program, she knows that the department has changed
the way they evaluate their potential students. In her cohort which consisted of about sixty
percent females and forty percent males, “None of the American females from my cohort earned
a Ph.D. in statistics. Not one. Some people failed the exam like me, some left after they got their
masters to get married, while others left because they were offered jobs paying good salaries
with just a master’s degree.” Looking back, Tara can note that there were clear gender divides
within the department. The department head at the time was a female and aware of the issues of
female success in the department. She attempted to make strides to better the situation but was recruited by another school as dean which left the department with a new male department head. Since leaving the institution, Tara receives alumni newsletters and invitations expressing opportunities to serve as a panelist speaker to encourage women in STEM. “The institution has started programs for women in the statistics department to come chat, eat pizza, and listen to other women that have been successful and things like that. So they have begun to try to start doing stuff like that.”

Knowing that she would now have to leave the program, Tara began to job search. Her advisor knew that a local private college was looking to hire an individual in the mathematics department. “He was really looking out for me. He didn’t want me to let this get me down and not do anything. She began teaching for a year but also took classes at various schools to continue learning mathematics and non-mathematics related topics. “I can’t stop learning. I love learning.”

A year later in the fall of 2014, she decided she would go back to the same institution but instead apply for the mathematics education Ph.D. program. She was extremely successful in her Ph.D. education classes. While completing her degree, she continued working in her private college and began conducting research outside of the classroom. “I was terrified of doing research going into the Ph.D. I did not feel like my thesis had really prepared me.” To provide herself developmental research opportunities, Tara served on a research team to explore student responses to questions on randomization tests while utilizing technology and physical manipulatives. In the fall of 2017, she completed her Ph.D. in mathematics education and was granted a tenure-track position at the private college she worked at. “At the time [when she was
asked to leave the statistics Ph.D. program] I was so pissed off. I was like ‘half a point, it’s half a point!’ so I was ticked off about that but I’m ok now. I really am because I like where I’m at.”

**Second Professional Experiences**

Tara began her professor position at a private college on a year to year contract. She was hired as a full-time mathematics and statistics professor. Coming into the position, Tara felt confident about her abilities and knew she would do well in the classroom based on her previous professional experience. In this position, she was expected to instruct eight classes per year. However, if she opted to do some sort of service to the college, one class would be removed from her teaching load. Enjoying the aspect of service, Tara has involved herself in freshman advising, performing statistical analysis on retention data, hosting a freshman/sophomore mathematics exam, and sending students to a well-known statistics competition at a neighboring university. After being at the college for five years, she was promoted to a tenure-track position after obtaining her Ph.D. Tara had a smooth transition as the only changes were teaching only seven courses, being required to advise, and serving on two committees.

Tara currently teaches six statistics courses including all of the upper level statistics courses in the department as well as introductory statistics for majors and non-majors. In her teaching, she uses guided notes as she believes it “helps to put everyone on an even level.”

Looking back, she realizes a lot of teachers she had, inspired her as to what not to do in the classroom. She uses all her experiences, good and bad, to direct her pedagogical methods. She also will often discuss her challenging moments in her educational background with her students to inspire them and show them that it is ok when you do not perform well the first time. “Look at me, I struggled but overcame it and look where I’m at now.”
The department challenged Tara with the task of developing a topics class related to statistics. “This has been most valuable for me because I get to interact with my students that are super interested in statistics and I try to guide them in their career for that but also, I’m learning as I go. I’m even learning new techniques.” Tara discussed how teaching new classes can serve as a source of professional development. She gave an example of a class that required coding in R which was not a program she had ever used in her teaching before. This gave her an opportunity to look at R in a different way. In respect to a new designs experiments class she is teaching, she stated, “I won’t tell them this but I have no idea how to do these experiments. I’m literally reading the book, making guided notes, coming up with ideas as I go and teaching it to them. And they are doing great. They are, well at least I am learning a lot.”

Beyond the classroom, Tara has involved herself in some research opportunities. “The research that I’ve done, they [the administrators and her department head] are like yeah, that’s great. We are happy to support you in that. I even got a research stipend because I was working on my dissertation and published under the college’s name.” Luckily, with teaching being her passion and the focus at her institution, the pressure to conduct research and publish is not something she worries about.

Tara’s place of work represents one of several all-women’s colleges in the state of North Carolina. As a four-year, private liberal arts college, the school focuses on providing unique and real-world applications to learning for female students. When asked about the challenges and differences she’s faced working at an all-female school, Tara expressed that she surprisingly enjoyed it. “At first, I thought it was going to be really weird not having any guys in my class but I ended up really liking it.” She went on to express that there are conversations that occur in her mathematics classrooms that never occurred when there were male students in the room. “It
creates an open, comfortable environment. There isn’t this idea that being a woman is an excuse because there are others in the class doing it and doing it well.” Tara went on to speak about the differences she has noticed among male and female students when it comes to raising their hands in class or speaking out. “Females feel much more comfortable without the men around to be able to answer questions. From what I remember in teaching young men, they are very quick to answer questions. If right or wrong, they’re quick. I think there are students that will never answer because of the fact that somebody else already answered or they know somebody will answer relatively quickly. I think that can shake their confidence. ‘Oh, I’m not getting it as fast as he is. Therefore, something is off about me.’” Noticing this, Tara has made conscious efforts in her teaching to learn all of her students’ names and to call on individuals each class. She has even taken opportunities to ask her students how they feel about their classroom experiences and has heard positive feedback. “They say I don’t have to worry about the distraction of males. I don’t have to have my makeup done every day just to look presentable for males. So there’s this social stigma that you have to look good in front of males and that takes up time for when they could be studying.”

In respect to her role as a female educator in mathematics, Tara feels like she can be an example and role model for her students and particularly her female students. “It takes somebody believing in them to be able to do it. If they don’t believe in themselves but have a person who knows how to do math saying you can do this. This isn’t bad This is like when you did blank. Just instilling that confidence is what it takes. As a female teacher, I think I can do this well because they say oh I can’t do this because I’m a girl and I can say well I’m a girl and I did it!”

However, beyond only females, Tara explained that all students need more confidence in their abilities. She recalled having a male student in the community college who had been out of
the classroom for many decades. He was terrified of math and was convinced that there was no way he would pass her class. Tara continued to encourage him and by the end of the semester, he met the passing requirements. “You just got to keep telling people they can do it and eventually they will believe it.” Many students have approached Tara and inquired about necessary skills they need to develop in order to be a stronger math student. “I just tell them that no matter what people have told them about math, the don’t need to be afraid of math. If they are already afraid of math, they need to try and get over that fear because it’s not as bad as it seems. You need a little bit of logic, a lot of perseverance and you need to have faith that you can do it. I think anybody can do math. Maybe not at our level but anybody can do it.”

**Personal Reflection and Views**

When asked if she regarded herself as a successful mathematician, she quickly answered yes. In fact, she took the description further and said, “I consider myself a successful statistician.” With respect to people in her statistics Ph.D program, “They would all say I would deserve it just as much as they did; even though I don’t have a Ph.D. in statistics, I am worthy of their level because they know how much hard work and effort I put in. They got to know me as opposed to just seeing on paper what my degree is.” In contrast, she described how she feels she has a lot to prove to colleagues who only know her credentials. Unfortunately, she believes in her field that some programs do not always pay attention to math and statistics educators that do not have pure degrees in the fields. “However, programs are really starting to see an advantage. Statistics educators have proven themselves competent of the material along with teaching.”

With respect to what she attributes her success to, Tara was not able to identify specific areas. “I don’t know how my confidence was built but I really think it was a lot of micro-
impacts.” She brought up experiences such as her mom going to school to obtain her accounting degree and her competitive nature with her brother as being examples of those micro-impacts.

“Thinking of math and learning as a game too. It’s not a task. Not something you have to do. It’s fun. I’ve always tried to look at everything as fun and it makes it more bearable to do. My competition aspect too. Since I’m so competitive, I can make anything into a game. Then there’s my confidence. Since I thought math was a game, it was fun, I practiced and did it well and was able to beat others, that gave me confidence. I think that shows through because I only applied to one institution at each level and only college to work at. I’m so confident in my abilities, I don’t have back-up plans. The love of learning, finding it fun, competition, and confidence all made me successful.”

Tara also discussed that she always had a strong sense of self-motivation. She remembers her parents always fussing at her brother to do his homework but she would already have hers done. “Even a professor in Ph.D. school told me I know how to get things done.” With all of her accomplishments, Tara stated that she does not feel any different but she is definitely proud of herself. “It is still a subject that comes easily to me and looking back on that case [undergraduate teacher disagreement] and reflecting on it, I don’t think it didn’t come easy to me then but he was just being a jerk.”

Tara has recently gotten engaged and accepted a new position in an applied mathematics and statistics department at a prestigious liberal arts college in the Midwest. Although excited for the opportunity, she knows she will be a unique addition to the department as she is the only person with an education degree instead of a pure mathematics or statistics degree. “I feel like this next year, I’m going to have a lot to prove. I have to prove to others.” Despite the challenges
she may face ahead, she knows she will get through them as past experiences have prepared her for what is to come.

“When I think about that half a point in statistics, I’m a very religious person, and I keep thinking to myself that it was God’s way of telling me you’re good at statistics. You are good enough to get in that program even though they didn’t give you that half a point but you know you want to teach. You know you need to be in a statistics education program. Go and do that.”

Tara is thankful for where she is at today and her wall of student thank-you cards reminds her each day that she is living in her purpose.

Linda

Childhood Experiences

Growing up on a farm in southern Mississippi, Linda found herself appreciative of the great outdoors. Throughout her youth, she loved to be outside and play with the animals. “I was a little bit of a tomboy. I always wanted to be out on the tractor or feeding the cows. I got a horse when I was 11 and nothing after that mattered.” She chuckled as she said, “I don’t know how many pictures exist of me inside a house when I was little. I always had a cat in one arm. I had a pet skunk for a while. I was always bringing random animals home.” Linda, as the oldest of four, grew up on the farm with her siblings and parents. Her grandparents from her father’s side also lived on the same farm. Her family did not own the farm, but instead worked the farm for another family. In exchange, they were given acres of land to raise their own food or “whatever they needed to do.” Linda and her family renovated the barn and lived there even though it did not have electricity or running water until sometime later. Despite the simplicity of her lifestyle, Linda enjoyed farm life. “I think I liked that a lot of the work that you put in was very concrete
and at the end of every day you could see what you had accomplished.” She went on to discuss how working on the farm was very rewarding and she appreciated the opportunity to work in groups and solve issues that would arise.

Linda’s family did not have the traditional educational background of children in the United States today. Linda’s grandparents on her father’s side both attended school up through third grade. Her grandmother from her mother’s side graduated high school but her grandfather dropped out of school to work on his family’s farm after his father became ill. Linda’s father completed high school and started a few college classes, but worked on the farm his whole life. “He’s not academic at all. I never saw my dad hold a book that wasn’t the Bible.” Linda’s mother, growing up as a preacher’s daughter, also finished high school. “She thought your most important job was to be a mother and a wife and that when you were a wife, the big question in your life and in your household were determined by the father, your husband. Very traditional.”

When going off to college, Linda would be the first person in her family to do so and graduate. Her father had started a class but quickly decided that working and having a family was more important. Her mother had considered college but ended up getting married and having kids instead.

When speaking about her grandparents, it was clear that Linda highly respected them. She mentioned that her maternal grandfather had a strong influence on her academically. He was extremely open minded and would talk to Linda about her future goals. He loved to read and would always save magazines for her. She can recall him going to the doctor’s office and bringing home all of the old copies of National Geographic that he could find. “I would stare at maps for hours. I was just fascinated by this idea of geography.” Her other set of grandparents had copies of encyclopedias in their home that Linda loved to flip through. “I started reading
early. I think I read every piece of literature that was near me at that point.” She went on to say, “I think I have always loved to learn and one thing that was true was that even though a lot of my family members were not particularly well educated, they were incredibly bright.” Linda knew she could always gain practical and useful knowledge from her family.

Living out there on the farm, the feeling that I felt most of the time was very free. I wasn’t stuck in some of the teenage drama that my friends were. MY family was so tightly bound by the everyday of things that I always felt accepted and I always felt loved, no questions asked. I always felt space to be creative. There wasn’t this idea that you could be thinking too far outside of the box because we didn’t live in the normal box. Despite feeling valued and appreciated while growing up, Linda went on the discuss how life was not easy living on the farm. Financially, her family struggled her entire life. “You’re just one tragedy away from losing everything.” This financial struggle molded her monetary decisions that she makes even to this day. “I was so used to making short term decisions that I had to learn that you could make long term decisions.” She can remember when her family was forced to leave the farm because the owner had sold it and her family of six moved into a small camper. After school, she and her siblings would sit outside to do their homework because there was not enough room for all of them to sit inside the camper. She recalled a memory of her mother crying at the television when she saw their old barn home burning down because it had been donated to the local fire station for testing. “I can definitely remember moments where I was having to take care of things that were probably better fixed by adults but I was having to handle it because of the circumstances.” It was in these moments that she knew she would bring change to her family’s situation.
A lot of people in my family felt like we were doomed to be the poor branch of the family forever. ‘Wow, we’re stuck like this,’ that was the mentality. I had such a stubborn idea that I was going to change something about the cycle. That nobody was going to stop me from doing something to change things for my family. That’s what I developed not because of anything around me but just because of that stubbornness and my deciding to do this in spite of what was around me.

When talking about her interest in mathematics, Linda remembers noticing applications of mathematics at a young age in her home life.

A lot of that [farm life] is how I got interested in history and math too. When I would hear my various family members talking about the history of the farm and the history of some of the things that happened in that area, that’s actually what sparked some of my interest in social studies and in history. Then, there were so many juxtapositions. Problems that we would solve on the farm that were mathematical in nature but I knew that my grandpa had not gone past third grade so to see him thinking through mathematical problems, knowing what background he had, knowing that I was currently in precalculus and what techniques we would have used to solve similar problems, I found that really interesting.

She proceeded to recall an example. Her family was faced with the task of making a water trough for the animals. However, several factors had to be considered. They needed to think about the number of cattle and how much water the trough needed to hold for that group, the amount of water that would drip from the filling line to maintain the water level, and how much water would evaporate dependent on the size of the hole they cut. She remembers listening to the conversations and thinking there had to be some sort of precalculus equation or methods that
could be used but she watched as they just reasoned through it. She knew it may not have been the optimal solution but somehow it still worked.

It’s funny now when I see things about the growth mindset versus the fixed mindset. My family never kind of equated being able to solve something in relation to their education. So to me, there was never that delineation. So I think I had a drive to just get stuff done that came from the practicality from being on the farm and it was never defined by schooling.

Linda constantly attempted to make connections from material she was learning in class to what she was seeing on the farm.

Sometimes, when I would listen to their language, sometimes it would be clear to me that this was absolutely directed to things I was learning in class. Other times it wasn’t. It wasn’t until later when I was thinking about it that it would dawn on me that ‘You know what? That was exactly the type of thing we solved on so and so day when we had to fix this.’

Linda’s love for mathematical ideas continued throughout her childhood. She found herself particularly interested in the problem solving and mathematical reasoning aspects of mathematics.

I’ve always been interested in how they [her family on the farm] were reasoning through it, always. Even when I was a little kid and the difference was in the sizes of the wrenches they were using or the air pressure in tractor tire and why you would lower it sometimes during the season and increase it in other times of the season. I always thought all of that was fascinating and I soaked it up like a sponge.”
Linda appreciated the real-world applications of mathematics and struggled to find the same joy in her math classes at school. “There was nothing in the math classroom that was keeping my interest. Math was just a part of the day. It was something we had to do.” Linda went on to discuss that connections to real-world applications were not being made in her classes. “The making connections piece was entirely something that I myself have just always naturally done. I can’t pinpoint where that started and I certainly can’t pinpoint a teacher at all who ever knew to make those connections.” Frustrated, Linda expressed that she wished her teachers had been more mindful of relating content to the experiences her and her peers were having outside of the classroom.

Thinking about what experiences led her to a profession in education, Linda stated, “It was the way that math was taught that sparked my interest.” Linda recalled in third grade having a substitute teacher lead “mad minute” multiplication drills. The students were given one minute to write down all their multiplication numbers for each set from 0 to 12. Linda quickly got all of hers correct and was told she could play the rest of the day. All the other students had to continue to work on their drills for the entire day.

No practice in between. No re-teaching. No nothing. At the end of the day, she lined up all the kids in the back of the room who had not successfully finished. Only 2 of us out of 22 had successfully finished. She lined up the other 20 kids and paddled them. Every single one of them. For how ever many you didn’t pass yet, that was the number of licks you got.

Linda continued,

I was absolutely horrified at age 8 that this was what was happening and I couldn’t fathom that this was an ok way to teach. So, I distinctly remember this being really the
first time I thought about what it meant to be a teacher and what should have happened that day and how I would have done it differently.

This memory in the mathematics classroom is the only one Linda could recall prior to seventh grade “and that to me says a lot because I’ve always loved math and been interested in math and absolutely nothing else really stands out to me.”

K-12 mathematics never posed any challenges for Linda growing up.

It all just came so easily to me. Everything they asked in school, I could just do. In fact, some of my teachers had to create these other types of opportunities to keep me busy because I’d plow through all of the work we were doing so quickly.

Beyond excelling in class, Linda was recommended for gifted and talented programs in her middle and high school years. She was placed on the “advanced track” for math classes and took algebra 1 in eighth grade. In middle school, she was also invited to join the Math Counts team. She discussed how this stood out to her as a memory related to math that went beyond worksheets and pure memorization. In high school, she continued to be in advanced classes. She ended up graduating high school as the Valedictorian of her class as well as a National Merit Scholar. Being recognized on many different levels, “I knew I had to do something.”

Unlike a lot of her peers, Linda’s family did not push her to go to college. “I never had that pressure from my parents to be ready for college or to go to college, to choose a career that involved college. That was never something I experienced.” Linda shared that she honestly had not even really considered college until she took a trip with her friend’s family to a well-known institution in Mississippi.

When I realized that when you got to college that you could learn more, knowing that I would already read and soak up anything I came in contact with, I think being in college
just gave me the opportunity to take whatever I wanted, learn whatever I wanted, and it just launched from there.

She took the PSAT during her tenth grade year and did extremely well. In fact, she did so well that schools across the country were sending her mail to consider their institution for her undergraduate degree.

For me, some back woods hick who was walking bare footed down from the house down to go get the mail to reach into the box and have six or seven things addressed to me from other states, I started to think ‘What in the world is this? What are they offering me? Who am I that they would have my name on their mailing list?’” She went on to say, “That progression of receiving cards from these college campuses and phone calls and letters, to realize that I had something that they thought would make me successful in college, it was enough to make me think, ‘Well let me see what this is all about then.’”

Despite the successes Linda was facing in her academics, she still struggled with the reality of her financial situation.

I knew my parents would never be able to pay for anything related to college and so I would say that probably added another layer of figuring out ok, if they can’t pay for anything, what are the other pathways to get money? One of those of course is to knock the roof off every test you take and make good grades, do leadership stuff.”

Linda worked diligently to ensure she was making herself a strong candidate for financial assistance but that would not be enough. As a first-generation college student in her family, Linda was learning how to navigate the world of higher education on her own.

Because I was growing up on the farm and because I came with such an impoverished background, like my family of six lived in one room in a converted barn with no running
water, no electricity for a long time, all these different things, we were basically share
croppers. When I started applying for college and even thinking forward, my family
didn’t even know how to do those types of things. So I blew a lot of opportunities for
scholarship money by just not knowing how to go about it.

Linda discussed the role her gender had on her life in her younger years. Her family had
very strong perceptions on the right and wrong ways for a woman to carry herself. “He [her dad]
thinks hardworking men are not questioned. Women should support their men in whatever it is
they do.” Her mom was also very opinionated on how a lady should act.

I remember when I got to a certain age like eleven or twelve years old, all of a sudden
climbing the trees, playing tackle football, some of these kinds of things, my mom was
like, ‘You can’t do those types of things with the boys anymore.’ She started to kind of
hint to those sort of things.

Linda continued sharing an experience,

I remember standing outside of the school building one day and she came to pick me up
and I was standing out there talking to two guys I had gone to school with my entire
life…She said you can’t stand that way in front of boys anymore.”

Linda struggled with understanding why her mom would not allow her to do things that
boys did or play with the boys the way she did when she was younger.

I always felt like I had to balance those two sides [tomboy and girly]. One reason was
because on my dad’s side, that was the norm for the girls. You had to work on the farm.
You had to help. My grandma slaughtered hogs, killed chickens. You know, she was the
one who did a lot of that type of work and there was never this idea that the women were
in some way separate. That was not the case. On my mom’s side though, it’s interesting
because they still come from a farm background but the girls were treated very differently. It was never expected that the girls would be outside working. Never working with the animals. That was a completely different thing. They were raised to keep their skin perfect, not in the sun. They were raised to keep their hands protected and nails done. The idea of being a southern lady was very much a part of that side of the family.

Linda chuckled as she said, “It was clear that my mom’s family looked upon my dad’s family in a different way, as lower class.” Seeing how the women conducted themselves on both sides of the family, Linda could see the tension between the different expectations of women.

It’s funny because on one side, I had a grandma who toted a pistol in her robe while she was walking around the house and on the other I had a great grandma who I clearly remember when I was twelve years old started explaining to me how to take care of my skin, how to interact with a group of men if I were to find myself in class or in a room or meeting. There were a lot of gender traditional types of things that came from that side of the family. That would include careers and vanity and what girls were supposed to do.

Linda laughed as she remembered her grandma encouraging her to learn how to type in high school to prepare her for a career as a secretary.

If I had been asked what I envisioned my family expected me to do, I probably would of thought I’d finish college, become a teacher and marry somebody that was a lawyer locally. Maybe somebody who also owned land. That I would also be a very good pianist so that I could sub for my mother at church, have kids, buy flowers for the sanctuary at church, do the helping type of stuff.
Undergraduate Experiences

Due to her academic success in high school, Linda had several institutions to choose from in regards to where she would go to college. Unfortunately, she had not completed her applications properly for the schools that she wanted to go to. Being a first-generation college student, she could not get assistance from her family and the guidance counselor at her high school was not much help either. “Sometimes, I wonder if that was a lack of resources or if I just didn’t know where to look for resources.” Luckily, one offer she received came from the institution she had originally visited with her friend back in high school. As a well-known, public research university in the state of Mississippi, the school offered her a full ride including tuition and housing. “After spending just a few hours there, I called my parents at night and I told them I missed my horse. I missed the farm and I didn’t tell them but the other thing was that I didn’t feel like I could be in a building with running water, heat, air conditioning, and carpet and them not. So I ended up living at home for college.” Upon going back home, Linda decided she was not going to go straight to college that year. Instead, she took time off to work on the farm with her family and she sold Avon on the side. Time away from school also gave her a chance to be more involved in her church.

The following fall, she decided she wanted to go back to college. Still in a position where she would need financial assistance, she knew her choices would be much more limited. She decided to consider a private, Southern Baptist liberal arts college in Mississippi that had offered her a full-ride the year before. All on the same day, she visited the college, was offered a full scholarship, and signed her paperwork to be admitted. She knew this college would be a much better fit for her as she could commute and live at home. In addition, she had a family member
that had attended the same college. Additionally, this college was small with only about 2500 students.

Upon entering college, Linda declared a history major, but held a work-study position within the mathematics department. She did not choose this position but was instead assigned to the department based on their request for work-study students. “I was just doing the job. I really didn’t love it [math] at that point.” Meanwhile, she continued taking her needed curriculum classes, which included a precalculus course. The professor from this course saw her mathematical abilities and recommended she pursue a minor in mathematics. After declaring a minor that spring, she later declared a double major in history and mathematics in the following winter term. “I was going through those first few classes, everything was easy. It was fine but it wasn’t sparking anything. When I got to my Abstract Algebra class though, I thought, ‘Oh wow! This is pretty interesting stuff.’” She continued, “I keep this [Abstract Algebra textbook] on my shelf [in her office] because I liked that class so much.” When asked what made that class different than all her other math courses, she discussed that her interest was sparked with the way material was presented.

My brain likes to look for overarching ideas and to tie together nuances and look for connectivity in ideas. Nothing else had been presented that way in the math material.

Everything was set up to be well you do it this way when you’re in this area and this way in this area. There wasn’t a lot of tie togetherness.

This course motivated her to begin exploring mathematics in a new way. “I started reading more books with code breaking because I never knew that there could possibly be applications of math other than, you know, some of the things that I had seen.”
While completing her double major, Linda decided to add on a teacher education minor through the school of education. The institution was known for producing good teachers. In fact, at the time, it was the largest producer of teachers in the entire state. Despite this add-on, she still shared classes with pure mathematics and mathematics education majors. Thinking back, she explained that about three-fourths of all mathematics majors added on the teaching minor and became teachers. The mathematics department, with respect to the number of faculty and students, was very small. She could only recall two full-time faculty members and about three to four adjunct instructors who taught primarily night classes. One of the full-time faculty members was a white male while the other was a white female.

My undergrad experience was very good. I wouldn’t have known at the time how good she was in the way she presented material, lectured on content, or the way she chose problems and things for us to do. At the time, I just assumed that was the way everyone experiences undergraduate mathematics because she was so masterful at it.

She continued that the female instructor “did a really good job of helping trying to find things, like problems, that I would find interesting.” The male instructor on the other hand led a class “that was much less engaging. That’s probably more typical of a math experience.”

With respect to students, the department served only undergraduate students with 90% of the population white and half female. Since the school was in southern Mississippi, racial tensions still existed and “you could tell some students were not used to being in mixed environments.” Linda’s classes were all very small. “It was exactly what I needed. Small, focused, personalized, and presented very well.” With such small classes, the students had the opportunity to spend time with one another and get to know each other.
We became a tight knit kind of group. It was not unusual for us to have class together and then for almost all of us to go eat lunch together, to work on homework together, whatever it might be. There wasn’t a lot of competition. There wasn’t a lot of tension.

Linda went on to explain that her experience felt a lot like high school. After classes, the group would often go hang out together or go to support one another’s extracurricular activities.

Nearing her senior year, Linda had no idea how she planned to utilize her degree. She had considered some sort of data analysis position on a federal or state level but still was not quite sure.

I really didn’t know what else you could do with a math degree. It had not crossed my mind at all at that point to go into academia. I had no idea that people could do research in math education or teaching.

With one of her friends in the department, she went on an experience at a Tennessee university geared for females in mathematics. During this experience, she was able to meet several female mathematicians, shadow a female mathematicians work, and complete various math-related activities over the course of two days. The woman that Linda shadowed worked as an epidemiologist and loved horses.

We clicked from the first minute because I was just enamored with the idea that she had found a way to have animals and do something as cool as be an epidemiologist which I had never heard of until that day.

Linda quickly became inspired with this woman’s career choices. “I saw something in her that was similar to what I wanted to balance one day.” Linda went on, “Seeing her work with a team for a day was interesting. Seeing the problem-solving aspect of what she did was interesting.” After leaving the experience, Linda knew immediately that she wanted to go to
graduate school. She could not get past the fact that the women she had met worked hard but still had hobbies. “I thought I was going to have make some either or choices. Here were these women making lots of balances.” Upon returning to her institution for her senior year, Linda was expected to complete her student teaching experience for her teaching minor. However, Linda decided she wanted to take more mathematics content classes to ensure she could better prepare herself for graduate school. Linda completed her undergraduate degree earning a bachelors in mathematics and in history.

First Graduate Experiences

After graduating with her undergraduate degrees, Linda went on into a graduate program at a public university in Tennessee to pursue a masters degree in math. Missing fall enrollment, she began in the second semester. Unfortunately, because she started in the spring semester, she was placed into second semester courses. “

It was at that time that I started thinking about advising, teaching, and how my faculty members were responding to me when I would explain the situation and ask questions or ask for guidance or ask how can I make up the gap?

Linda quickly found herself very overwhelmed and frustrated with her classes. For the first time, she was having a really difficult time with the mathematics material because she had missed the first course in the sequence. Linda attempted to help her situation by finding new ways to engage in class.

I think I became more intentional in the way that I took notes because in high school, the teachers tended to present things so that they were naturally fitted in note format and in the math classes, I started to find new ways to organize when I was writing and taking notes so that I was not only processing while I did it but I began to realize how to
organize and highlight things so that when I went back to study, that it was easier and that there was a natural flow.

However, adjusting her style of learning did not help. She went to several members in her department and her advisor, but they did not offer much help either. “I think he [math advisor] really thought I was just complaining about it rather than actually trying to have a discussion about what to do. He wasn’t very responsive.” Concerned with the experience of her first semester, she began to realize the impact that professionals in the world of academia can have on students. She decided to switch to pursuing a masters degree in the math education program in the fall.

As Linda reflected on the experiences in her mathematics classes, she shared that she did not feel like her undergraduate institution had prepared her for graduate school. “I didn’t actually get as rigorous of a content as would have been helpful for going to the graduate school that I did.” Acknowledging that her undergraduate did not fully prepare her, she also made it a note to stress how appreciative she was of her undergraduate experience as she believed it helped her develop a love for math. “I think it was maybe not presented as rigorously for people expecting to go to graduate school because it was primarily for prepping teachers but at the same time because it was presented that way with connections as a centerpiece, it got me more interested in the mathematics itself.” Linda continued to discuss the transitions she had to make in graduate school even with “small things”. “I had never had trouble with anything, so I never went to office hours with questions. That was a weird thing for me to think, ‘Oh, you take your questions and go find the faculty member in their office and sit down and go through them.’ I think I came across as either incredibly naïve or stupid and ignorant about it.” Linda also felt like her relationship with the faculty members looked a lot different than her experience in undergrad. “I
felt like the faculty members preferred the students who were the TAs or RAs because they thought if you were working outside the department, you weren’t really prioritizing your education. That was another thing that was kind of awkward I would say.” Despite these feelings, Linda had no choice but to continue employment elsewhere as she did not have a family that could financially support her education.

Culturally, Linda also faced several challenges. Graduate school was the first time she had ever been away from her family for more than three nights. “That was all just a lot.” Linda found herself facing huge adjustments going from a rural lifestyle to a now urban lifestyle. She went from living on a farm her entire life to now being in a small, one bedroom apartment. She was forced to use public transportation. Even concepts of “lounge spaces” were new. Seeing how students interacted with professors also seemed very strange to her. “Why are those students calling that faculty member by their first name? Nobody in my family would call an adult by their first name.” Linda chuckled as she began to share a story.

I do distinctly remember this one moment I was walking out of the bookstore and there was a male student ahead of me who plowed through the door and went on and I remember standing there for about five seconds in front of that door. I thought, ‘What kind of savage place have I come to where I’m about to have to open the door for myself when a man just walked through it.’”

Linda went on to describe her feelings. “Feeling like you don’t belong is exactly how it felt.” Beyond the urban culture adjustments, she also found herself noticing gender differences from the women back home to the women she was now having encounters with.

The gender thing definitely came out sometimes because I’d go whole days and I’d be the only person I saw wearing makeup in the math department. I remember one day at lunch
when I finally decided I was going to go sit in the shared room and take my little lunch. I had my stuff with a fashion magazine actually. I went in and sat down and was flipping through my Vogue magazine and was having my lunch. I thought, ‘Ok, you’re doing it! This is what you are supposed to be like.’ I’m there playing the role. Then, one of the algebraists walked in and he stopped and look and he said, ‘That’s the first time that’s ever happened.’ I was like ‘What’s that?’ He said, ‘I have never seen a fashion magazine in this room in my entire career.’ In that moment, I thought I was doing it and I wasn’t.

This experience made her realize that she was set apart from a lot of the women at the university. I had to figure out the way that I dressed and present myself because, I don’t even go running without mascara and lipgloss on, like that’s not going to happen. So that’s the way I always was but that’s not the way any of these students in math were. That was one of the gender things that clashed the most for me.

Linda continued to notice gender differences with respect to the distribution of peers. In the mathematics department, about two-thirds of the students were male and one-third female. Racially, the student population was about half white and half international students. In comparison, the mathematics education students were about two-thirds female with only one-third male. Racially, the department was 75% white. She noticed big differences in how the females of both departments portrayed themselves as well. Most of the females in the mathematics department did not come to class in makeup and wore extremely casual clothing. “T-shirt, jeans, and Birkenstocks, that sort of thing was fairly common for them.” The females in the mathematics education department “wore more teachery types of clothes.” She went on to describe how it was clear that mathematics education students dressed more professionally as if they were foreshadowing themselves in administrative roles. Linda saw similar patterns among
the female faculty members. “I began to realize that the ones who dressed more like I did, wore their makeup, those sorts of things, were the lecturers, not the tenure track faculty. So it was a clear distinction that I started to see.” As an undergraduate, she had always seen her female professor in pearls, heels, and dresses. “I never thought femininity was something to be removed from mathematics.” As she started to notice these differences in graduate school, her outlook on fashion and looks “made me cling on to that more.” On the other hand, she also noticed a lot of differences in how women acted and responded to various situations that went against the values she was raised upon.

In graduate school, I met a lot of women who didn’t care at all about all of those rules [that her mom had taught her growing up] and so it made me start thinking back on them and re-compartmentalizing some of that instead of letting it be integrated in the way I thought about things.

Going to graduate school, Linda anticipated not having much of a social life. In high school and as an undergraduate, she often found it difficult to be involved in social activities that had monetary aspects because she knew she needed to make wise decisions about how she used her money. However, on her very first day at her graduate institution, Linda made a lasting relationship that would change her life forever.

On my very first day on that campus, I met my now husband and we just clicked. We went out that first week together and if I had not met him, I really think I would have packed up and went back to Mississippi within the first month.” Unlike her, he went to graduate school very grounded in what he wanted to do, what types of research projects he wanted to be involved with, and even which faculty he wanted to work with.
He became my go-to for understanding how academia worked. Then, I felt like I had a translator almost. I didn’t realize that’s part of what I had needed. When I didn’t know where to go for a certain question or I didn’t know which university office did so and so, or whatever it might be, then he knew all of those different things.”

Having a social network, her husband introduced her to his friends.

I didn’t know it at the time but I had found my tribe basically. This group of people who were so interested in learning absolutely everything there was to know, who loved meeting other people and finding out more about what they did. That spark, that’s actually what kept me in graduate school.

**First Professional Experiences**

After completing her masters degree, Linda took one year away from academia to work. At that point, her intentions were not to pursue a Ph.D. and instead, she began working for an education center in Tennessee. An apartment company owned three subsidized house projects and asked her to help develop and run an education center. Coming into the position, she was required to apply for grant funds to develop the center. Once completed, her responsibilities included managing and organizing the centers components to include computer labs and tutoring services. She also had the opportunity to work with various community officials such as police officers and government departments. “It became a big motivator for what I do now.”

Although Linda enjoyed this job, as it provided opportunities to work with people from low socioeconomic backgrounds, she found it very emotionally draining. After facing a heartbreaking encounter with a young boy she had become particularly close to, she decided she could not continue in this position for her own emotional health. Linda also discussed how she noticed odd gender patterns that she did not know how to internalize.
I took that job, working in the education center there and there was one day where we were going to have a large meeting of all of the people who staffed all of their properties and I walk into the room and I realize of the twenty-five people in the room, they were all very similar to me in age, all female, all had blonde hair, all weighed about the same. There was this remarkable kind of obvious preference for what kind of person this company liked to have staffing their offices.

Linda could not deny the very obvious gender preferences at her job.

I started to think about this more often. I was contrasting that with what I had seen as a graduate student. When I went off to my doctoral program, I was really looking for some of those clues as to what the understandings were or what the assumptions were about how you were to present yourself and how that was going to come across.

Upon deciding to leave the education center, Linda was offered a position as an undergraduate lecturer in the mathematics department at the same institution she had received her masters degree at. Excited for the opportunity, Linda began working as an instructor teaching four to five classes each semester in the mathematics department. “I found that I loved chatting with the lecturers and we had a lot in common in terms of backgrounds.”

**Second Graduate Experiences**

While still teaching a full-time load at the Tennessee institution, faculty began to recommend her to consider taking courses within the mathematics education Ph.D. program. After taking a few classes and finding them enjoyable, she decided to apply to the program and was admitted. “After a semester or two of working, I realized my husband was in no hurry to finish his doctorate degree and so I said, ‘Oh well, I’ll just get one too.’” While in doctoral school, she was required to complete eighteen hours of pure math courses while her other
courses revolved around mathematics education and pedagogy. She was also offered a position within the mathematics education department to help run a rural practicum experience for pre-service teachers of all grade levels. Although she did not have a TA or RA position, “I felt I was getting really great experiences.” Beyond her participation in the rural mathematics education program, she continued working as a full-time instructor in the mathematics department. Despite being a mathematics education student, the mathematics department continued to allow her increased professional experiences within their department. “I was a team player and I pulled my share of the weight.” By the end of her Ph.D., she had been involved in several department committees including a textbook selection committee, and had helped with several grant projects. “I felt like I was playing a role.” Linda expressed that she had to learn how to conduct herself in a way that did not reflect herself as a student. “It was emotionally and mentally draining.” To ensure moments of self-care, she would often take visits back home every few weeks to “recharge.” She also found that running the rural education program helped her feel connected to her home even when she was away. “I was able to find things that bridged my identity as an academic with my identity as a rural South Mississippian.”

Coming back to the same institution she had completed her masters at, she was able to see the changes in faculty demographics. The number of female faculty had increased within the mathematics department but it was still predominantly male. In fact, Linda could not recall ever having a female professor for any of her doctoral level courses in mathematics. The mathematics education department had grown, but the female to male ratio had not changed. In general, she felt like the faculty were approachable. Several of the faculty knew her from her career as a masters student while others knew her based on her instructor position within the department. Despite her rapport with the members of the department, she was unable to make any personal
connections. “I can’t say that I ever found somebody that could serve as a mentor to me at a point when I needed that.” Linda spoke of one female faculty member that had a similar socioeconomic background as her. Linda thought this could be the foundation for a mentorship relationship until Linda saw that instead of embracing her background, this faculty member tried to hide it. “She became a representation of what I thought of what a faculty member could be.” In a sense, this taught Linda what not to do. Linda wanted to use her personal experiences to answer questions such as: “What is it about my background that maybe we can address in earlier schooling to prepare other students like more for this kind of situation?” Linda also shared an encounter with a male faculty member who had a tendency to take credit for the work she did within the department.

I think that was partly due to gender. There’s the idea that when you are a female that you’re going to just be nice about things. As a southern woman, we are thought to be a little more nice and docile too. So I think all of that played into it. I don’t think he ever would have done that to a male student or male colleague in the department.

Second Professional Experiences

Linda currently works at a university in the western part of North Carolina as a professor in the Department of Mathematical Sciences. Within this position, she teaches one class per semester and completes her scholarship expectations within the mathematics department. This position is expected to take up half of her time. She holds a second position at the school as the Director of Teacher Education and Engagement for the College of Arts and Sciences. This position takes up the other 50% of her time. Her position as Director is multifaceted and allows her to serve as the liaison between several different departments at the institution. She works with the College of Education, departments within the College of Arts and Sciences, and even
with the Department of Education on a state level for issues related to mathematics or STEM. This position also allows her to assist with community outreach projects, help with teacher recruitment, serve on program assessment committees, assist with writing grant proposals, and give presentations for the Dean’s office. Linda spoke highly of her two positions and expressed that she found a way to integrate her love for mathematics and love for equity research into her profession. “I do feel like I have a core group of women that I can share those ideas with and talk through issues related to gender and sustainability and socioeconomic status and so on.” One work that she is most proud of are the two courses she developed for preservice mathematics secondary teachers that contains several elements revolving around equity issues and equity in the classroom. “It’s not the job title that I go for but it’s about what will give me access to doing what it is that I’m interested in.”

Linda went on to discuss the opportunities she has to work with students and influence their views on mathematics.

A lot of times, students come in and they are anxious because of whatever has happened in their past but I always try to let students know that if you come to me with an open mind about learning mathematics and a willingness to work, then we’ll get them there.”

Linda continued stating that most people lack the confidence in their math abilities which attributes to poor retention of students in mathematics courses. “People can do math and they just never know it.”

While working in her position at the North Carolina institution, Linda had two children, one girl and one boy. She talked about having kids and how it can pose several challenges in relation to your career. To defeat those challenges, she said women must be willing to push the status quo. “I had my daughter and two weeks later, I had her in a carrier teaching a class. I never
asked permission for those things. I just did it.” Her headstrong attitude and undeniably strong work ethic made nobody, not even her boss, ever question her. “Our institution actually assumes that women will want to stop the tenure clock when they are pregnant or when they take a maternity leave. You actually have to write a letter saying you don’t want your clock to stop in exchange. They make that assumption. They assume you aren’t going to work at all.”

The brunt of family life, the brunt of department service, all fall on women. Because of that, I think that those things that do happen in family life do happen in times that are pivotal to women in their careers. We have these processes of promotion and tenure that are very rigid. They don’t really allow for there to be a problem in your family, whether it’s having children or it’s your parents or those sorts of things, but I think that falls heavily on women.

She went on discussing examples that she has seen repeatedly where females in the department had to step up “to pick up the slack.” “Those aren’t the types of things that get you promoted. They aren’t even the types of things people notice.” She continued saying that it is easy for women to get burnt-out in departments due to the department culture and lack of respect for women. “There’s plenty of times I can think of where we’re in a meeting with other men and you may speak your ideas and five minutes later, a man says the same thing. They’re the one that gets applauded for the idea. It happens. It really does.”

**Personal Reflection**

“If you had stopped me and said, ‘Hey, picture a mathematician,’ it would have been a white guy, just like most people have been shown to do in research. It wouldn’t have been a woman. It wouldn’t have been a person of color. It wouldn’t have been any sort of thing.” Her experiences with math departments played into that expectation. However, when asking the role
of her gender on her success as a mathematician, Linda stated her gender did not have the largest impact. “When I think about my own identity, I’m thinking more of the low socioeconomic ruralness, Mississippiness than the gender aspect. I know those are intersectional to use one of our favorite feminist words but I think for me those other ones are the ones I tend to look at first.” She began to think about moments in the classroom where her economic situation played a role in her experiences. She remembered back in high school how she made efforts to keep her family’s socioeconomic status very private. “I kept a lot of that hidden. Most people who weren’t super close to me never knew what our circumstances were.” In graduate school, she could recall a classmate saying, “Wow. I didn’t know anybody who got their high school degree in Mississippi was allowed to go to graduate school.” She even discussed how her professors would join in on the jokes seeing them as harmless.

I called out people because it seemed like hillbillies, rednecks, and country bumpkins were the group could still make fun of. They wouldn’t have ever said something that was racially inappropriate or even gender inappropriate in a way but it was still funny to make fun of poor hillbillies and they didn’t think they would encounter those types of people in their classes.”

When asked how she was able to break the cycle in her family and be successful in academia, she stated, “I have no idea”. She continued to discuss how those looking in from the outside will often get it wrong. “What I hate is when some well-meaning person says at the end of a talk something like, ‘Well how did you get out? How did you work harder?’ To me, I worked less hard than anyone in my family. It’s just that what they are doing doesn’t produce what people want to see as the normal indicators of success.” Instead, she attributes her current success to many of her character traits. “I never stay in the boundaries. I think if I had to word it,
I never knew what I wasn’t supposed to do.” Linda expressed that every time she faced obstacles, especially those related to financial crisis, she refused to give up and was not going to allow it to define her success.

Success in respect to somebody in their career, is to feel happy and to feel fulfilled.

Things are better off when they left them or when they found it. I definitely am happy. I definitely find a lot of fulfillment in what I do and I think for the most part all the projects and things I’ve done, things are better off when we finish a project than they were before we started.

Looking back, Linda expressed that her interest in equity issues and desire to learn how to reach low socioeconomic areas is evident in all her work. Thinking back to why she chose to obtain degrees in mathematics education, she knew that she would not have opportunities to explore these concepts in pure mathematics. She recalled a question on her doctoral written exams where she found a way to discuss equity issues. “I don’t know that there was ever a time when that wasn’t my focus. Any assignment we had, I usually ended up transforming it into something like that.” Linda’s determination to stop her family’s financial cycle has led her to conduct research and help many who come from a background like hers.

I’ve always been kind of defiant in that way. So it’s almost like well, if you think I can’t do this just because I’m a whatever, redneck, woman, whatever it may be, then it just makes me more determined to do it. To prove to somebody you know, we can do these things.

She continued,

From an early age, I think my mom recognized how head strong I was in absolutely everything and she knew that whatever I wanted to do, I was just going to do it. I don’t
know that I would say she was the strongest impact on that actually because I don’t think she ever directly…Once she realized that I was going to be different, she never really tried to herd me in one direction or another.

Linda views her professional role as a mathematics educator and not of a mathematician. I don’t know why. I guess because I don’t have that doctorate in mathematics that it’s one of those things that separates me from my colleagues upstairs. If I called myself a mathematician, I would be assuming to take on something that’s probably a part of their identity and wrapped up in some definition that I don’t have. It works the other way too when mathematicians say they are math educators just because they teach and they’ve never had any preparation in math education. I think we get touchy where our disciplines are.

She went on to say, “I don’t think most people look at me as a mathematician.” Further discussing the world of academia and mathematics, she later tweaked her response asking if the applied form of mathematics could be included in the definition of a mathematician. “Most people don’t think of math education as an applied mathematics but if you will grant me that, then yes, I am a mathematician.”

Cindy

Childhood Experiences

Cindy was born in the midwest, but spent most of her life growing up in the Pacific Northwest. She lived in a small, rural area that was not heavily populated. She grew up with her mother, father, and younger brother. Reflecting on her childhood, she used positive adjectives and described memories fondly. “My parents are wonderful. We are still very close. I got them to move out here.”
Being adopted, Cindy’s mother never knew exactly where she was from. For a long time, she identified as Native American based on the way she looked and the color of her skin. However, after recently taking a DNA test, she learned that she is from the British Isles. Her mother had started college, but never finished a degree program. Instead, she ended up marrying Cindy’s father and worked as a medical transcriptionist. The income that she would bring to the family helped pay for Cindy’s father’s college education. Once Cindy’s father graduated from college, Cindy’s mother stopped working and focused on raising Cindy and her brother. Cindy valued that her mother took care of so much around the home as well as she and her brother. As Cindy has aged, she realizes how helpful it was to have a mother at home to rely on for “life things.” Cindy discussed how, “Raising a family and taking care of a home is an enormous amount of work and it’s a real luxury when there’s someone in the family who can make that their job, their contribution.” Cindy expressed her mother being very influential on her life in respect to the way she carries herself:

“I think it was my mom’s influence. In the sense that...there are a lot of stupid things about being a kid and she didn’t have any tolerance for brainless, thoughtless, or...the things you might try to do because of peer pressure or to conform or to fit in, she had...she just thought that was terrible. That you had to be true to yourself. That you had a moral code and I understood what she was saying and I agree with it but it was also just really inflexible.”

Cindy went on to say, “I inherited from her this rigidity.” Cindy’s father, a man of Scottish and Mexican decent, obtained his Bachelor’s and Master’s degree in Engineering. Cindy went on to discuss how racial pressures exists within her family on her father’s side. Her
grandfather, born in Mexico, came to the United States when he was two years old. Facing a lot of discrimination, he worked to fit in with American culture.

“My grandpa was the oldest child in his family and he dealt with the brunt of the discrimination that they faced when they came to the United States and he had some pretty ugly experiences. He worked very hard to assimilate. In fact, he married a woman whose family was from Scotland. My father and oldest aunt and uncles are close in age. They all say [my last name in an English accent]. I have younger aunt and uncles and they say [my last name in a Spanish accent]. There’s, I don’t want to say tension in the family, but do you choose to respect grandpa’s decision to assimilate or do you show that heritage is valuable and respected. I’m neutral on this issue.”

Despite the pronunciation of her last name, when asked how she racially identifies, she said American.

“I think to some extent to say things like Native American, which isn’t accurate anymore, or Mexican but I don’t have that cultural experience. I basically grew up as a white, middle class kid regardless of what my ethnic background is. It just seems disingenuous to say Mexican- American because I think that must include the experience of growing up in the US and being viewed as Mexican- American which for the most part my brother and I were not.”

She went on to discuss that she never faced any racial discrimination in her life so identifying as Caucasian was “just how I saw myself.”

Cindy’s brother is four years younger than her. Growing up, they were very competitive with one another. She discussed feelings of frustration because it always seemed like her brother was better at everything compared to her. “He’s the good looking one. The athletic one. The
socially adept one. I can’t think of a single area in which he hasn’t consistently kicked my butt by a significant margin.” She quickly learned that there was no point in competing with her brother or anybody else. Instead, she began to focus on competing with herself. “I am enormously competitive with myself in the sense that I want to be better than I am. I want to beat myself.” Her brother has a degree in History from a top institution in the United States and obtained a Master’s degree. He now works abroad.

Thinking back to the things she was interested in as a kid, she stated that she considered herself to be boring. “Culturally, in retrospect, it wasn’t that great because of where I grew up. It was a rural place. I spent my summers running around back in the woods or reading.” She went on to say that if you were ever looking for her, you would probably find her in a bean bag reading a fiction book. She believes her love for reading developed organically. Her parents had a lot of books in the house with a solid library consisting of classic fiction novels. Although Cindy does not recall seeing her parents read often, reading was encouraged specifically by her father. Each summer, he would assign one book to read. Several of the books in the library also consisted of Anthropology books from Cindy’s mother’s college experience. Cindy found these particularly enjoyable to read as well.

As a child, Cindy was very shy. Her shyness became increasingly worse in high school, but not as the result of anything in particular. “I think this fear was completely irrational. I was shy to the point of it being debilitating.” Cindy would often feel overwhelmed in social settings and face fears of being rejected. “In social situations, I would just freeze up or withdraw.” Cindy went on to discuss how she saw being shy as a negative trait to possess. “It was a problem professionally because I’d go to conferences to interact with people, talk about math, and
network and I would just be a silent wallflower. I could not engage.” Over time she was able to get past her shyness. She would often think about her grandfather who was a very social man.

“I would psych myself up to channel him, like get the engine really revved up. I could fake it but if I slipped and fell into that shyness pattern at a conference or event, I just could not get myself out of it. Around the age of 35, it just went away.”

Having had experiences of being shy, she is now more aware of those around her who show signs of being shy. To help them adjust, she will often be welcoming and outgoing around them in hopes of making the individuals feel comfortable. “For the longest time I had to fake it to interact and had to get myself psyched up and revved up to fake it. Now, it’s like you play the role long enough and it becomes natural.”

Reflecting on her high school memories, Cindy did not have many positive things to say. “I didn’t like high school. I wasn’t really comfortable there. I got to about my sophomore year and I just had this feeling that I had gotten everything out of it that I was going to get.” Academically, she was strong at physics and mathematics. She did not enjoy chemistry or biology. History required too much memorization and although she liked reading, writing was not a skill with which she felt strong. “It took me a long time to feel like I could write an essay. By the end of my senior year of college, I finally understood how to write but it wasn’t something that ever came easily to me.” Cindy remembers taking a vocational high school course and finding it “fun, interesting and different.” The two- hour lab on electronics would focus on learning theory and then building things such as circuits. Looking back, she found vocational classes to be applicable to life and wishes she had taken an auto shop course. Socially, Cindy never found lasting connections as her shyness and fear of being judged stopped her from
being social. “In high school, I never had close friends. I never had a sense of community or my people or my tribe. It’s hard to say which is cause and which is effect."

When reflecting on her mathematical experiences, Cindy could not remember much. She began to think about the various classes she took in high school and could not remember all the names of the courses. However, she did remember taking and enjoying trigonometry. She also made it a point to state that she had not enrolled in Calculus. Cindy only remembers two math teachers from high school “because I actually interacted with them.” Both teachers were very young. One was a male and she liked the way he ran the class. The other teacher was a female who had a side business to use mathematics and computers to design prosthetics for veterans and athletes. Cindy remembers being enrolled in this woman’s class but there being a lot of busy work. Cindy made a deal with the teacher that she would assign her own problems, which would always be the ones that Cindy deemed as interesting. “By the end of the semester, she [the teacher] said I ended up doing more work than the other students but to me, it’s not wasteful if it’s not busy work.” One last standout memory that Cindy shared from her senior mathematics class revolved around day-dreaming out the window. She chuckled as she said that to this day, she cannot stand to do mathematics or give a mathematics talk in a room without a window. “It’s irrational but I think ‘how can anybody learn math without having a window to look out?’”

**Undergraduate Experiences**

When applying to college, Cindy considered and applied to six different schools. Of those six, approximately four were women’s colleges. “He [Cindy’s father] was very keen of the idea of sending me to a women’s college because he had read the research and how successful students coming out of those schools were relative to peers at co-ed schools.” Of the schools she was accepted into, she chose a small, private women’s college on the east coast. With this
choice, she had the ability to take classes at neighboring school campuses as well which really appealed to her. Since it was a private school, she did not receive much financial assistance. Thus, her parents took out a second mortgage to send her to college. Upon first going to college, she did not declare a major. “I had absolutely no idea what I wanted to do. One of my two goals was to figure that out.” During her first year, she thought through several different options which appealed to her including: physics, philosophy, religion, literature, and Spanish/languages. It was not until the middle of her second year of college that she declared a major in mathematics.

“If I was having a bad day in college or if I wanted to relax, I would put on some classical music and do math. It’s very soothing and comforting.” Cindy could always do mathematics and do it well but it was not something that she truly appreciated until later in her college career. However, upon deciding to study abroad, she was required to declare a major. “I declared a math major because it was easy and I didn’t have to write essays.” Cindy went on to discuss how her second goal in college was to become a better writer. “To write an essay, I would basically have to chain myself to the computer and just…it would take a ridiculously long time compared to my friends that were English literature majors.” Thus, not needing to write an essay, she chose to pursue a mathematics degree. She was not sure exactly how she would end up utilizing her degree but, “I was aware that it’s not hard to get hired when you’re a mathematician.”

Cindy was already familiar with the mathematics department and faculty as she had taken several mathematics classes prior to declaring her major. The department had about ten instructors with half of those being women. The faculty members were highly focused on their teaching and led very engaging classes. “I think I was very well regarded by the faculty.” Cindy discussed how at the end of her senior year of college, she was chosen as a recipient of a
department awarded for being a top student. Beyond the classroom, “I didn’t really have any faculty members that stood out as mentors. I had good relationships with many of them.” She went on to discuss how many of her instructors were encouraging but she did not try to create strong relationships with any of them. “I learned very late in life, as in within the last couple of years, the importance of mentors and that you have to go out and recruit your own mentors and form those connections.”

Cindy found her entire undergraduate career to be very easy. She never had to study but could go to class, do her homework, and would just understand the material. She mentioned that this created a poor study work ethic which is probably why graduate school was difficult. Differing from her peers, Cindy never procrastinated on her work. “That’s never worked for me.” Instead, she would go to a lecture, do her homework right after, and if she had any questions she would go to faculty office hours to address her concerns prior to the next class meeting.

During her fall semester of her Junior year, Cindy studied abroad. Her experiences in the mathematics classroom were not much different that when she was in the United States. “I interacted with my classmates less there. I also don’t have any memories of the faculty there. They didn’t interact with us. They were primarily lecturers.”

When asked about her overall experience at her undergraduate institution, Cindy expressed frustrations regarding the rigor of the department and the way faculty interacted with the mathematics students. “They were too concerned with always making sure we felt good about ourselves and not concerned enough with the opportunity to struggle with something that was difficult.” She continued to discuss an example of an instructor stopping instruction because some students were lost.
“The class would grind to a halt. My feeling was that it wasn’t fair. I understand that you want to help people that are struggling, but it wasn’t fair to the students that were not having those difficulties because all of a sudden they couldn’t get out of the course what they could of.”

She could only remember one instructor in the department who was not “easy” on her students. “I valued the fact that she showed enough respect for us to push us but she was not popular with the other students.”

The majority of the challenges that Cindy faced in college revolved around social encounters because she was so shy. She had very few friends and was often homesick. She did not like working in groups in class so if she ever had questions, she would rely on the faculty members for help. “It’s not really clear that I had a very strong identification as a math student. It was more of this is what I’m doing that amused me.” She clarified that this did not mean she felt uncomfortable in her department, but that it just meant she did not make strong connections.

“I can’t say I felt at home or that I was team math. I knew some people in college who were primarily hanging out with people only in their major and I enjoyed talking math with my classmates but my friends were not usually mathematicians. I’ve always been socially attracted to people in the humanities. I think the reason for that is for me one of the values of close relationships is the opportunity to live vicariously through somebody else.”

She also stated that her gender never impacted any of her college experiences in or outside of the classroom. “I was at an all-women’s college. I think that may have made a difference. I didn’t see faculty react to men versus women.”
In the spring of her Junior year, Cindy took a class that sparked her interest. That summer after, she was working at a job that had a lot of down time. Here, she began to play with some of the mathematics concepts that the spring course had covered. “By the end of the summer, I went back in the fall and I was talking to the professor and it had turned out that I had proven some theorems.” Almost immediately, she decided to apply to graduate school as she could not believe “that people get paid to do this stuff.” This would be the first moment she began to consider academia as a possible professional career to pursue. “I pretty much applied at the last moment.”

“The math degree wasn’t hard. I didn’t find the institution difficult. I never studied for exams. I would attend the lecture and do the homework right after. If I didn’t understand something, I’d go talk to the faculty. I absorbed everything in small chunks and just retained it.”

Cindy went on to discuss how the department did not offer a wide selection of mathematics courses. Lacking the strong mathematics classes, Cindy felt like her undergraduate institution did not really give her a solid idea of what it meant to do mathematics. “I don’t think I began to understand that until I was in graduate school. I got a hint of it with the work I did that summer before my senior year.” In addition, Cindy discussed how the faculty were teaching and mentoring in a way as to prepare students for academia and not nonacademic positions which affected students who went on to graduate school. “This school was not the best choice for somebody going to graduate school for mathematics. I should have chosen a school with a better curriculum for mathematics.” However, she stated, “It was a really great fit for me. I had no idea I was going to get a Ph.D. in math. It was the right choice to make at the time I made it. I don’t regret going there.”
First Graduate Experiences

Upon making her decision to go to graduate school, Cindy felt very ignorant as nobody in her family had attended graduate school. “I was really clueless. I had no idea what I wanted to do and had no idea how to choose a good graduate school. I didn’t even know what the questions to ask were.” Despite feeling lost, she knew she had fallen in love with mathematics and wanted to go to graduate school to pursue a Ph.D. in mathematics. “It’s like being paid to solve puzzles.” As she began thinking about different options for schools, she knew she wanted to go to a tier 1 research department, but was not sure what area of mathematics she wanted to specialize in. Knowing that she wanted to go back to the west coast, her options for schools to select from were limited. She ended up selecting a large, public institution in the Pacific Northwest. “It was really all about location.”

“The experience was a combination of awful and wonderful. It was awful in the sense that I was grossly unprepared. I was all of a sudden the worse student in my class. I basically got B’s in all of my first year classes which in that graduate program is the equivalent of failing.” Cindy quickly began to realize how her lack of mathematics experiences as an undergraduate were affecting her graduate experiences. She felt that it was very clear from her performance in the mathematics classroom that she did not know what she was doing. “Numeric grades showed it but also interactions with my peers talking about math.” Cindy realized, “It was the real world. At undergrad I was just a fish in a really tiny puddle.”

After taking classes for the first year, Cindy was required by the department to complete qualifying exams to test mathematical competency in order to determine if she could remain in the Ph.D. program.
“I definitely bombed them. In fact, I did so badly that the end of that first summer right before the fall of my second year, I got a letter from the department saying that they didn’t think I could clear the Ph.D. hurdle and they would support me one more year to get a master’s as a consolation prize.”

Thinking about how this affected her, she shared,

“It was the most painful and humiliating period of my life, but in many respects it was wonderful because I discovered how much I love math. I first began to understand what mathematics really is and what it meant to do mathematics and it was beautiful and I wanted to do it. It wasn’t that I didn’t believe them. I did believe and continued to believe for a long time that they were right and I wasn’t good enough. I had the arrogance to think I could be great at a lot of things but I decided I would rather be a mediocre mathematician if I possibly could than be a great anything else. As long as the broader community wouldn’t out right kick me out, I was going to try.”

She continued to work diligently in her classes during her second year and significantly brought up her grades. Nearing the end of the second year, she received a letter from her department revoking their statement to expel her out of the Ph.D. program “but at that point I had applied to a Ph.D. program at another university and I wanted to start over.”

Second Graduate Experiences

Upon leaving her institution in the Pacific Northwest, Cindy moved to a large, public research institution in California. Asking her about her experiences here, she did not have much to say. “It was a good fit and I had a wonderful time.” The majority of all of her classes were in lecture format. If she had questions she would still rely on faculty for help. However, Cindy did mention that she talked to her peers more in graduate school than undergrad.
In her first year at her new institution, she fell in love with Differential Geometry. When she went to pick an advisor, the professor she wanted to work with was leaving for a new school and all of the other advisors with expertise on the area were on sabbatical.

“And again, as an illustration of just how clueless I was at navigating these things, I couldn’t really figure out what to do and I remembered a lecture I had heard a distinguished mathematician give at an institution. He said all you young people interested in geometry, you should study this subject.”

She decided she in fact did want to pursue a Ph.D. The same lecturer wrote a book with several co-authors. She reached out to one of the co-authors inquiring about her interest in the subject and asked if she could visit his university for a semester. She ended up going and staying at his institution for a year and when she returned to California, the instructor supervised her Ph.D. from a distance. Once she obtained her Ph.D., her advisor and colleagues encouraged her to leave the field because it was attracting little interest and attention. She decided to pursue a post-doc in upstate New York and worked for three years in a new field.

During her post-doc experience, Cindy began working in a new field. “It was beautiful and looked broadly applicable to problems in geometry so I learned this.” She began collaborating with a professor of the field at another school and even had the opportunity to visit his institution and work with him. “By luck, the chair of his department attended my talk and afterwards asked my host institution if I was on the job market and I was in fact about to apply for places.” This would lead Cindy to her first tenure track position.

Listening to Cindy discuss the meaning of math, it was clear that the subject area holds a special place in her life. “I love dance. I love ballet. I love museums. I love art. Hands down the most beautiful structure and constructions I’ve ever seen are in mathematics. It’s hard,
stimulating, engaging. It’s frustrating and aggravating and beautiful and satisfying when you
win. The way I categorize solving certain problems is that it’s really satisfying. Really
wonderful.”

Throughout Cindy’s interview, she discussed how her love for the beauty of math
continued to grow throughout her graduate experiences. Furthermore, she loved the idea of doing
research in mathematics.

“One of the things I love about math is that it is so difficult. I am more interested in the
problems I’m not sure I can solve than the one’s I know how to solve. Those are boring. I
like the challenge of I’m not sure I can do this.”

She attributes this love for math as one reason for her success. “You could kind of tell
who would stop at a master’s and who would continue. It’s not enough to get a Ph.D. It’s not
enough to be smart. You have to love it enough.”

Thinking back to her involvements outside of the classroom, she quickly said she didn’t
have any. “It takes too much time to get a Ph.D. in math. They [students] are working 60 hours a
week at a minimum in math if they are going to be successful. It’s just enormously difficult and
it takes a lot of time to master.” She continued saying, “When you’re a graduate student in math
that’s all you’re doing. That is your whole world. People…interesting people who have hobbies
don’t get Ph.D.’s. You are in that world and spending all that time in the math department.”

**Professional Experiences**

Cindy’s first tenure track position was a great experience for her. “I really felt like a
member of my academic and professional community.” Being in her first tenure track position,
she told herself that she had to overcome her shyness. She continued to see it as a negative trait
saying,
“It was entirely fear based and it inhibited me from pursuing opportunities and interactions. There was just no way that was to my advantage. It was certainly to my disadvantage. It’s one thing to be reserved by choice or stepping back so you can listen to people and observe. It’s another thing to be just so rigidly locked with fear that you can’t function or perform. That’s not good.”

She does not attribute her personality traits changing due to her profession, because she “beat it out” of herself at this point in her life. She continued to develop and remained in her position for several years. However, although having a positive experience professionally, she did not intend to stay at the institution. Mathematically, it was a great fit but the location was a poor fit. A few years after receiving tenure, she moved to her current institution.

Upon being recruited to her current well-respected research university, she immediately fell in love with her new opportunity. “The working atmosphere in this department is wonderful. It’s incredibly collegial and charming and friendly and open.” Furthermore, she felt as if she was living in an area that offered her a lot with respect to culture and the arts. Cindy’s position requires her to be involved with research, teaching and service. “I’m getting paid for doing what I would do without getting paid. I just think that’s luxury that society can support academics and free inquiry…it’s awesome.” Cindy stated that to her research means being involved with new and independent work in mathematics that gets published in peer reviewed journals. She mentioned that she also often applies for NSF grants. She also believes that teaching goes beyond just the classroom setting to include mentoring. She runs several working seminars where the target audience is her colleagues, graduate students and post-doctoral students. She considers this teaching as she often will give a series of lectures through the semester on a topic that not only educates her but also her audience. Cindy described acts of service in two
categories to include departmental service as well as university level service. “The reason why I’m here is for the research. So, to some extent that’s what has priority for me.” She explained that some semesters are more focused on her teaching if she has a heavy teaching load, but she is normally able to go back to focusing on research the next semester. Finding it the best form of professional development, Cindy stated, “It’s certainly what I’m most enthusiastic about.”

Reflecting on her educational journey, Cindy has felt that she has been successful at her career for quite some time.

“The first reason that I would say I feel successful is I have done work that I was proud of. To feel like you have made a contribution to your field of study. Now, I’m a tenured professor in one of the best math departments in the country. There’s no reasonable standard by which I’m not successful.”

Regarding her research as the most important aspect of her profession, she has allowed her interests to evolve and develop over time.

“One of my strengths is...the subjects are really interconnected and a lot of times people only know their own subject and because of that they’re not aware of tools they could apply to the problems they are interested in. I can use tools in different areas.”

Cindy also attributes her success to her internal self- competitive nature. “I always want to improve. To not be satisfied with where I am.” Even when she faced obstacles such as her first graduate institution giving her a letter to dismiss her from the Ph.D. program, she did not allow it to stop her. “I just wanted to stay in as long as I could. I managed to stay in long enough for doors to open. I would say it’s some combination of persistence and luck.”

Cindy discussed the importance of understanding that success should also be defined outside of personal growth.
“Success is not only your academic contributions but also how you interact with students. Not just those in your classroom but those you interact with outside too. Part of your obligations and how you meet your responsibilities to the people in your life…is your community…it’s important to help the next generation.”

In speaking about her mentor at the institution of her first tenure track position, she commented, “He was really great about offering me all types of advice and feedback. I haven’t really had a great many in the way of mentor relationships…he was a wonderful mentor.”

Looking back and now understanding the importance of mentor relationships, she encourages her students to form those relationships. “I think for a long time it was hard for me to admit not knowing and being unsure. I thought it would look weak.” She discussed that she learned a lot from those who did not help or reach out in an approachable manner. She uses her experience to give back to her community by helping run a mentoring program in the mathematics department. “I didn’t have anyone outside my immediate academic experience like my family or friends of family that had gone to graduate school and then into academia that I was close to.” Facing the world of academia without guidance, she often felt like she had to figure things out as she went. “One of the things that has been difficult for me professionally, particularly professionally developing from graduate to post doc to professional was that I was really clueless. I didn’t know how any of this work and I didn’t have people telling me.”

Cindy does not define her success in the context of her gender. “I think I’ve been lucky. You have to work very hard. I’ve seen people who are smart and worked very hard that just didn’t have the right door open for them at the right time. I’ve been very lucky that those doors have been there to step through. I think I made it to those doors just because I didn’t leave when maybe I should have. After I had this
feedback from the university that I couldn’t clear the Ph.D. hurdle and then I finished at the other school and got a teaching postdoc which is not what you would want if you were going to continue on in a research line and those would have been good points to consider getting out of academic and considering something else.”

However, Cindy shared that she just cannot get past her feelings towards math. “Working out details” such as those in computational math problems brings her peace and a sense of tranquility. She particularly enjoys algebra and geometry related problems as they make her feel like she is solving a puzzle. “They contain structures I like to engage with. They are fun to tinker with. How do you take something apart, put it back together, and build these things?” “Part of it is not just the problem itself but the way you approach the problems in your subject that is for me engaging.” Referring to the feelings that math brings her, “that’s one of the things that lets me know I actually am a mathematician”. Unlike a lot of individuals, Cindy appreciates being challenged by mathematics. “I don’t like to be thwarted,” and thus, Cindy does not give up when faced with mathematical challenges. “I know from experience that you can go a long darn way on sheer stubbornness. If you keep trying and whacking away at it, it’s worthwhile.”

Despite her feelings of success, Cindy still acknowledges that she has room for improvement.

“I’m not what you would call a true mathematician. These are the people that eat, breathe, sleep mathematics. Who read history of mathematics and read popular books about mathematics and they are just brilliant. I have always envied them because I’m really just more dilettantish. I don’t have that breadth or depth of interest. At the same time, while I have envied them that, I have not gone so far as to feeling inadequate about
it. To some sense because there’s no point. That’s just not who I am. That’s not how I was built.”

Looking at her colleagues around her, she sees the ones “that are more disciplined, more talented than I am, that are smarter than I am.” As she looks at their achievements, she feels they are so much better than her. “Oh, they’re just so good. They’re more disciplined. They work hard. They’re naturally more talented. They have greater insight to the problems.” She chuckled as she thought about her jealousy and said, “I’m grateful that we have these brilliant people in our lives to serve as this motivation and inspiration and role models.”

Cindy discussed why she chose to go into academia and the importance of the various roles that instructors take on outside of teaching.

“The drive behind my going into academia is a love of research. I think that research is just one side of the scholarship coin. The other side is education, interpreted widely of course. I really enjoy interacting with the students. I value education in math in part because it’s one side of that scholarship coin but also because I’ve benefited from good teachers and there’s really no way to thank them. You can’t thank the individuals. All you can do to express your appreciation is to pay it forward. To make your own contribution to the community by helping students.”

Cindy makes efforts to get to know her students and propel them towards success by gaining a better understanding of why they are pursuing mathematics and what their interest are.

“When someone goes to grad school in math, as a faculty member, I see them very differently than an undergrad. They have sort of put up their flag and said they want to join a tribe. They said they possibly want to become a professional mathematician and colleague.”
Cindy commented on the academic skills of most of her students stating, “They are much more sophisticated. They have done more than I did at this stage in their career. They work harder.” Cindy feels that the mathematics community as a whole needs to do a better job of supporting and guiding graduate students who wish to pursue career opportunities outside academia. “Too often there is an attitude within the academic community that “success” means becoming a professor. Cindy argued that students should not feel that they are getting “second prize” if they choose to pursue industry. “It doesn’t serve the students well if something in industry would be a better fit for them. We don’t make it easy for people to say, ‘I’d like to consider options outside of academia’.”

Issues of gender representation in mathematics never played a role in Cindy’s life until she began working within her career.

“None of these gender issues I was particularly aware of in grad school, not as an undergraduate either because it was all women, but not in graduate school because there were a fair amount of women at my school and my office mate was a woman. My experience was I became more aware and appreciative of these issues the farther I went up the ladder because the women became scarcer and scarcer.”

She mentioned that it is not uncommon for graduate classes that she teaches to be predominantly male. She also knows that when she goes to a professional conference, she is likely to be one of the few female attendees. “The teaching faculty in the math department, the lecturers and professors of the practice, the people whose responsibilities are more heavily weighted towards teaching and service, they’re disproportionately women. What’s the message? It’s things like that.” Sounding frustrated she continued, “It’s the accumulation after years and
years that you or I begin to ask, What’s the message here? What is the community saying to
me?’ More importantly what are my peers hearing? What are my colleagues hearing?”

Despite the underrepresentation of women in math, Cindy never has feelings of
discouragement. “I don’t have this sensation of needing to prove something.” She continued,
“My individual experiences have always been good. I certainly feel like my opinion is respected
here.” However, Cindy knows that her story is not the case for many women.

“I do think women get looked over more. I think that the issue is that there aren’t women
in STEM and I mean that is both the issue and the problem and the solution in the sense
that I think to gain and retain women, we probably need to get more women faculty, more
women postdocs and all the way down. When people talk about addressing the STEM
pipeline, they always think about working from the bottom up which is the only think you
can do but when these women come up, they need to see they have a home. They’re more
likely to see that if they see a community of women around them. In some sense, I think
individual departments can address this by building up their female faculty but the overall
community, it’s not clear.”

She went on to discuss that her current institution is conscientious about bringing in
female faculty members. Furthermore, she assists with a program geared towards freshman
students in STEM who are from underrepresented communities to include but not limited to:
women, minorities, first generation college students, etc. The goal within this committee is to
offer opportunities to help make students feel they have a community and faculty mentors they
can rely on. “Being able to find your tribe. At various times I’ve considered leaving academia
and going into industry…it’s just undeniable that this is the life and type of work I am ideally
suited for. My colleagues…these are my people. This is my tribe. But I don’t always feel it’s my community because of the underrepresentation of women.”

**Marissa**

**Childhood Experiences**

Marissa was born in a large city of North Carolina and lived with her mom, dad, and sister. Family was always important to Marissa as her extended family was very large. “Holidays were really reserved for family.” She went on to discuss how she had a good relationship with her family and an especially healthy relationship with her parents. She discussed her parents being very kind, supportive, and encouraging. Several members of her family worked in the field of education including her parents. Her mother served as an elementary educator with a concentration in mathematics while her father worked as a middle grades educator with a concentration in science. “I saw they both really liked working with people. They were both good at what they did and found enjoyment in what they did.” Growing up, Marissa’s mother was the elementary math specialist at her elementary school for many years until she advanced to a state level position.

She would try to do problems with me, talk about problems together, and then I also helped her as she was organizing things for workshops. She did a lot of professional development for teachers and I can remember working at night with her to collate papers and put together things for her workshops.

Marissa discussed how around the age of nine or ten, her mother began to travel for work and this would make Marissa worry a lot. She chuckled as she said her mom was never in any real danger as all her travel was in the United States. She simply just missed her mom. Marissa’s mother continued to work throughout Marissa’s childhood. “In contrast to other families, I
noticed my mom was the breadwinner. She made more money than my father for most of my life.” Marissa’s mother even continued working long after retirement. “She’s got a pretty intense work ethic that drives her and I think that’s had a lot of influence on me and my sister.”

During the school year, Marissa’s father worked as a middle grades science teacher. During the summers, he served as a Director of a 4H camp. As a child, Marissa would always go with her father and spend her summers in the mountains of North Carolina. “I also considered the Western part of the state, you know, part of my, as a place I grew up.” Marissa expanded on her love for the mountain region and explained that this later impacted her decision on which college to attend. She went on to discuss that her father’s personality and work ethic is much different than her mother’s. “His influence balances that.” Marissa explained that she does not want to work 24-7 nor does she want to fill up all of her time with responsibilities. Instead, she desires to have time for herself and find time to do the things she loves. “I attribute these to my dad’s style of doing things.”

As a young child, Marissa wanted to be a veterinarian. “As I got older, I began to think about teaching. That was really what I went to college for, to become a teacher.” She discussed how, “watching them engage with kids and work with people made it seem like something that was really doable and enjoyable.” In addition to her interest in teaching, Marissa loved animals and had several pets growing up. She spent a lot of time outdoors with her sister. With a playground nearby, the two would often ride their bikes, climb trees, or play in the creek. When inside, she loved to read. She remembers enjoying reading fiction, sci-fi, and murder mystery stories. “I think it was just something everybody in the house jut did so it was something I did too.” Her love for literature continued even into college. “I was interested in southern authors. I enjoyed people that would write about life in the south or life in a region that I sort of identified
as a region I grew up.” She also enjoyed music and singing. She played piano for a little bit but her main concentration was on singing. She was a part of several choirs in middle and high school. She also did voice lessons outside of school. She recalled the joy she found in being a part of her high school show choir and performing at several different choir competitions.

“I think a lot of those interest I mentioned haven’t really changed that much. Well, no, I guess I shouldn’t say that. It evolved but I still have the same interests. I think now, I still have an interest in being outside and going hiking and being able to appreciate all that we have in the region that we live in. I’ve started to become more active like taking up running and cycling and that’s something that’s been easy up here in this neck of the woods. I think I kind of expanded my friend group with people that like those same kinds of things. However, so much of my time is taken up with my job and raising children and being a mother that a lot of those things end up taking a backseat.”

Socially, Marissa had a small group of three to four girls that she remained friends with from elementary to high school. In high school, she recalled her friend group making a shift as she knew a lot of individuals from show choir. She spoke on the impact her show choir friends had on her personality as “many of the people from that group were very outgoing and outspoken.” A lot of Marissa’s close friends were girls but she does not remember intentionally making the decision to only be friends with girls. In fact, she recalls that a lot of her interests lied with activities that boys were stereotypically a part of.

“I don’t know if I identified myself as being kind of tomboyish when I was younger but looking back I do. I think of myself as somebody who, you know as I got into upper elementary school, all my friends were girls but I remember playing on playgrounds with
boys in my class and not wanting to wear dresses all of the time and so I think I look back
and think of myself when I was younger as tomboyish.”

Growing up, Marissa went to public schools that were predominantly Caucasian and
African American. However, she recalls her upper level courses in high school being mostly
Caucasian. “School was fun and fine but it wasn’t really ever something I was focused on
intently, as far as academics.” Marissa went on to discuss how she does not recall her parents
ever pushing her or her sister academically. They had expectations for Marissa and her sister to
do well but, “…they really did let us be in charge…” when it came to course selections or
ensuring they completed their school work.

Thinking specifically about her mathematics career, Marissa remembers taking algebra in
eighth grade and completing geometry, algebra 2, trigonometry, and calculus in high school.
Mathematics never caused her any difficulties and she remembers always understanding the
math when she was in class. “Math meant some problem solving but it really became about
calculating when I was younger, even through middle and high school. It didn’t really become
about problem solving again until I got to college.” She did particularly well in her algebra and
calculus courses and found she enjoyed these much more than geometry. However, when asking
her which would have been her favorite class, she did not provide a response.

“I don’t know that I have any strong recollections of moments in mathematics that stand
out to me other than things like being able to take algebra early or taking calculus in high
school. I don’t know that I had experiences where there was a moment in class that really
stood out that was mathematical.”

Despite being unable to recall her mathematics experiences as a child, she was able to
confidently express how much she enjoyed mathematics.
“I think that I have always enjoyed solving problems in math, even as a young kid, I’ve always identified that math was my favorite subject when I was in school. That’s been consistent throughout childhood and into adulthood.” She attributes her positive attitude towards math due to her success with it. “Being good at it, it’s really easy to enjoy something you are good at.” However, in school, a lot of her mathematical memories revolve around the personalities of her math teachers and not the math itself.

“My trig teacher was very quirky and really funny. My calculus teacher was learning calculus while she was teaching it because that was just when calculus was becoming a high school topic. My geometry teacher in high school was very matronly and very motherly but also very stern and strict so that’s what stands out.”

**Undergraduate Experiences**

Loving the western part of North Carolina, Marissa decided to attend a liberal arts, public university in that part of state. Having only applied to two schools, she knew she would love being near the mountains and she wanted to attend a school that was smaller in size as “it seemed more manageable.” She did not know anything about the department she was joining but she was aware of the positive reputation of the school for being a great institution with strong faculty-student relationships. Marissa decided to major in mathematics with a 6-12 teaching certification. Starting college, there was no doubt that she wanted to teach but she did not ever think about teaching options beyond the K-12 grade level. “I wanted the flexibility of being able to teach at the middle or high school which was probably the reason behind the decision of getting a math degree.” Marissa also knew she would not want to teach anything else as she always considered math to be enjoyable and something that she was good at.
For her first two years in college, Marissa lived on campus and served as a resident advisor her second year. Despite being a mathematics major, she still found time to do the things she enjoyed. “I would consider myself an average, maybe slightly above average college student.” Marissa spent a lot of time outdoors with a specific interest in hiking. She participated as a member of the school’s mathematics club. Marissa also worked as a paid tutor in the math lab which she found particularly enjoyable. For her, this position felt a lot like teaching and was providing her experiences that would be valuable further down her career.

Overall, she had a very positive undergraduate experience and does not recall facing any challenges. She was simply concerned about completing her required courses and getting good grades. “As a student, you are always worried about the grade.” However, as she began to shift to upper level mathematics, her motivation to do well began to shift. “I think learning more of that advanced mathematics was something that was very motivating as well and then success.” Marissa went on to discuss how her upper level math classes were challenging. She went from always being successful in a math class to “sometimes or not as always successful.” She discussed how the class content was very different than anything she had seen in her K-12 experience. She quickly began to enjoy challenging subjects like topology and real analysis. “When you take on a challenge like a really hard problem and you really work at it and you have some success with it, that just feels really good.”

Marissa went on to discuss that despite her frustration with difficult content, the faculty were always approachable and willing to help. She felt like the faculty truly wanted to see students succeed. She went on to talk about her cohort and how this group was also very supportive of one another. “I never felt like I was the one person who didn’t understand.” She discussed how she created a close group of four friends that had a large influence on her
undergraduate experience. One member of the group was not a math major but she took some of the same math course. She did not seem to enjoy thinking about math but wanted to be successful. Two members of the group were going into teaching. They did not seem to enjoy the upper level mathematics courses and wanted to just complete them to get their degree. The final member was a non-traditional student who had a lot of impact on Marissa. She was much older and had come back to school to change careers. As Marissa reflected on the dynamics of this group and remembered that one was a single mother, it began to force her to think about how an education is important in order to get a job to support a family. Further, realizing that all of her close friends were female, she could not recall why she chose to seek out help from females more than males. “Probably having a peer group within those courses right, having a cohort, that was probably pivotal for me. Having people to talk to about it.”

Thinking about her department demographics, Marissa explained that it was not very diverse but this was probably because the institution was not very diverse. She had a lot of women classmates, because those pursuing teaching were in her major classes too. However, there were only two or three women faculty members out of about twenty total faculty members. Despite a supportive department, Marissa did not feel that the professors were good at helping to build conceptual learning. She attributes this failure due to their background in mathematics instead of mathematics education. “I think I did and still do see a distinction between mathematics and mathematics education. I ultimately think they have a different focus.” She went on to describe that mathematicians spend more time thinking about mathematics. They do not have to worry about the best ways to communicate the math. Whereas, math educators are interested in student learning of mathematics.”
In her senior year, Marissa finally began to realize that there were teaching options beyond K-12 learning as she formed closer relationships with faculty mentors. One female faculty member who taught several of Marissa’s undergraduate mathematics classes had a significant impact on Marissa. Her presence in the department showed Marissa “that any woman could be a mathematician if she wanted to.” Further, Marissa respected the instructor’s teaching style and ways of explaining mathematics to her students. Marissa used what she had learned to finish up her teaching certification requirements. She interned in a middle school for half of a semester and also had a chance to student teach for six months. With her interest being grades 6-12, she spent three months in the middle school and three months in the high school. Although a great experience, Marissa would quickly learn that these practicum experiences did not fully prepare her to enter the professional world.

**First Professional Experiences**

After completing her undergraduate degree, Marissa accepted a seventh grade math and science teaching position in the same city of her undergraduate institution. Although she enjoyed this position, it posed a lot of challenges. Her first year was very shocking. “There’s a lot you can’t be taught.” She discussed how difficult it was to teach students who were pre-teenagers. She found herself focused not only on how to teach content but also worried about how to manage behavior, something that was particularly challenging for her. The faculty members were very kind and willing to help her but a lot of them did not like their job. “It was really hard to find positive conversations about teaching and about working with kids at my school.” By the end of her first year, Marissa knew she did not want to stay in this position. She returned for a second year but began exploring other professional options.
Graduate Experiences

Deciding to leave the public school system, Marissa began applying to graduate schools during her second year of teaching. She knew she wanted to go to graduate school for pure mathematics but she wanted to stay somewhat local. She applied to three North Carolina schools and ended up selecting a competitive research institution in North Carolina that offered her a teaching assistant position. The program took five years to complete with the first two years concentrating on coursework. Before the start of her third year, she was required to take qualifying exams which she passed on the first try. She then spent her last three years completing coursework with a balance of dissertation research.

The department demographics were racially very diverse. However, in respect to gender, female representation was significantly lower than male representation. In fact, Marissa could only recall interacting with two female faculty members in the entire five years she was at the institution. Despite the lack of female faculty members, Marissa never felt singled out as a female student in the program. She mentioned that half if not more than half of the students were female. Unfortunately, racial diversity was not present in respect to the student population.

Marissa’s graduate experience was much more challenging to face than her undergraduate experience. Her classes were extremely rigorous. “I was probably underprepared in many ways.” Feeling as though she did not have enough knowledge, she often wondered if she could even be successful. “Can I really understand the concepts well? My lack of preparedness prevented me from seeing the big picture.” She continued discussing how she did not have the support of her peers the way she had experienced as an undergraduate. “You’re more worried about making mistakes because you think that’s going to be such a big no or impact the way people are going to think about you.” She noticed that even her peers were not interacting with
one another either. When it came to research, Marissa also faced challenges. “I wasn’t good at asking questions.” Prior to her doctoral experience, Marissa had only a small research project as an undergraduate where she went deeper into a topic but she had never done research the way it was expected at the graduate level.

Despite her challenges, Marissa found ways to stay positive. Her advisor offered a lot of support and was very patient with her as she began conducting research. She also found a lot of joy in her TA position. She began by teaching a recitation course but was given a heavier teaching load than other graduate students once the department saw her teaching performance. She had the chance to teach the calculus sequence, discrete mathematics, and a financial math course which were all large lecture courses. Outside of school, she continued to rely on her family. “I hold my personal relationships really closely and they are really important.” During her second year of graduate school, she married the man she had been dating since her final year as an undergraduate. The two had already been living together for some time so they did not face any difficult transitions. “It was a nice break from the work.” Marissa attributes a lot of her success to the love and support she had from her family. “Any issues I might have had if I didn’t have that, I was able to avoid.”

**Second Professional Experiences**

Upon graduating with her doctoral degree, Marissa accepted a position at a public university in Western North Carolina, different than the undergraduate institution she had attended. Having been in this position for 15 years now, she has served as a tenure track instructor, associate professor, and is now a full professor. “I feel like the department is a good fit for me and I feel like I have a lot to contribute to the department.” With a total of approximately 30 tenure track faculty and approximately 15 non-tenured teaching positions, 40%
of the faculty are female and 20% represent a racial minority group. She went on to discuss how the department is extremely supportive of one another and always willing to share classroom materials. She also notices a strong connection between faculty with a mathematics background and those with a mathematics education background.

Marissa went on to discuss her job responsibilities. About 70% of her role revolves around teaching, 10% revolves around service, and 20% revolves around research and scholarship. On average, she teaches three courses in the fall and two courses in the spring. If she is keeping up with her scholarship responsibilities, she can request a course release in the spring which is why she generally only teaches two courses in the spring. The lighter load allows her to focus on areas of service. Marissa works on math and science partnerships with K-12 teachers along with several different funded projects. She also helps advise actuarial science undergraduate students. Lastly, Marissa serves on different committees to include: Strategic planning; program assessment; and a department personnel committee. “I think during the semester, it’s really hard not to devote time to teaching and still teach well. So, the majority of my interactions on campus are with people who are there for my class. I tend to give teaching all of my attention.” She then uses her summers to focus on digging into research that interests her. Marissa’s research focuses on teacher learning and she finds herself partnering with math educators often on grant work. “I’m really inspired to think about ways of improving my teaching based upon what I tell teachers to do in their K-12 classes.”

One challenge that Marissa has faced in the field of education is thinking about the audience. She discussed that it is important to think about how you craft something in a manner that’s appropriate for the respective age group. “I don’t know if we do a good job of, or if I do a good job in my teaching helping them to see that it is all about problem solving and thinking
about really good problems because I too, am shoving content down their throat so to speak.”

Marissa remembered when she was a student that she found learning big chunks of information challenging. Instead, to be successful, she would do problems and apply it to different scenarios and examples.

“I’ve always been one who has to write. When I’m taking notes or copying something from a book or even now, I think as an adult, when I work through a problem, it’s a lot easier for me to work with a pencil in my hand.”

Marissa explained that this type of method to learning needs to be adopted by students more often. Too many students are trying to memorize information without making connections. She notices some of her upper level mathematics students, such as her calculus students, seeing the mathematics “…as a tool for problem solving where they have problems in the context of their field.” Viewing math as something that is relatable is likely to help students be successful.

“There’s also real learning that may take place [in the classroom] that doesn’t always look the same. In general, if somebody wants to become a better student in mathematics, then they need to think about mathematical problems. If they want to become a better student in their class, then I think they need to be engaged with what’s going on in class and ask questions when they don’t understand. I see a lot of students that don’t do that.”

With respect to student feelings towards math, Marissa acknowledges that there is a wide spectrum of emotions. However, she finds that some students are willing to try and engage in mathematics learning more than others. Some students are motivated to just get through the course because it is a part of their program. Then, there are some students that struggle because it is something new. “There is this weird, I don’t know, I mean a distinction between K-12 math and undergraduate math. There’s a moment where people are exposed to classes that are totally
different than anything they’ve ever seen.” Reflecting on her experiences as a student, “I think I probably had moments in undergrad where I doubted myself and abilities because what I was being asked to do was so very different.” Aware of these challenges, Marissa makes it an active effort to try to be an approachable instructor encouraging her students to think deeper about the mathematics they are learning, ask questions, and to find counterexamples.

Marissa discussed how having children can create a burden as a professional woman. Two years after accepting a job at her institution, she had her daughter and three years later she had her son. “You are pulled in two definite directions there because your husband or partner has needs that are a little more flexible about when you can meet those needs but you don’t have to worry about keeping him alive.” She went on to describe how she felt pulled back to work much sooner than she would have liked after having her children. She even faced a challenge at work regarding merit pay as her work was being compared to the work others had done in the department while she was on maternity leave. Marissa also mentioned how her and her husband must be more intentional about dividing up domestic duties. She considers their situation fortunate because her husband works from home which allows for a lot of flexibility in his schedule.

“My role as a mom and a wife and a family member and a friend, those things typically come first for me.” However, Marissa does feel like her role as a female faculty member has contributed to her department and the mathematical community as a whole. “I think I’m lucky and maybe naïve to what it’s like for some women in STEM fields because I’ve been so fortunate.” Thinking about all of the issues women can face in the STEM workplace, Marissa acknowledged that she has been placed in very encouraging environments. She acknowledged that she believes her gender may affect how students perceive and interact with her. She recalled
hearing students talk about her approachability compared to some of her male counterparts and although some of that could be attributed to personality, Marissa believes gender also plays a role. “I think it’s good that we have efforts to increase the quantity of females in STEM. I would be really interested in a time where whether you are male or female doesn’t matter.”

**Personal Reflection**

Thinking about her personality, Marissa described herself as always being quiet and laid back. Although she does not consider herself to have a “type A personality”, she said, “I do think I’ve always been driven to be successful in doing something that I felt good about and being able to financially support myself and take care of myself.” She went on to discuss how her mother raised her to be extremely independent. Her mother taught her that she did not need to rely on a man to take care of her. This created a very self-driven nature within and helped her to succeed in something that she loves. She defined being successful as “fulfilling requirements and continuing to get better.” She even remembers these attributes existing in her at a young age. She remembers being competitive in high school saying, “I wanted to get good grades and make straight A’s.” Looking at where she is at today, Marissa expressed that she does believe she is a successful mathematics professor. However, she went into further detail stating that she does not feel like she is a mathematics educator nor would she label herself as a successful mathematician. “I still sort of take on a dual role of knowing about a lot of mathematics education research but not really being at the forefront of what’s going on.” She continued saying, “I don’t think I’ve contributed a large sized chunk of knowledge to the field. I think in my mind that’s what a successful mathematician would be.”
Marissa expressed the value of her family on her success. She feels like when parents push their children early on, the child is willing to push themselves later in their life. Having support from home, made her educational experiences less challenging.

“I sort of feel like culturally, we are moving towards encouraging more women to be a part of STEM fields and I guess, I was probably a part of that effort in ways but my family was never one that thought that was anything weird or different so I don’t really look back and see me being distinguished because I’m female and like mathematics, but again, I just think that’s a part of my family and who I grew up with and it wasn’t anything unique or different for me to be interested in math.”

Being able to form relationships with instructors and having friends from her cohort in college also impacted her ability to stay motivated. Further, finding colleagues to collaborate with quickly and having those collaborations be maintained over time has contributed to her success. “Being approachable as an instructor, being a good colleague, being reliable, and a person that can contribute to professional work and research, hopefully those are things that are true [about me].”
Chapter 5: Analysis

The purpose of this chapter is to discuss the themes found across the five participant’s narratives. I have identified the key ideas and compare the similarities as well as the differences among the narratives through a feminist perspective. With this perspective, this study aims to expose gender inequalities that have been socially constructed, disrupt the traditional status-quo, and evoke recognition and discussions regarding the need for social change (Acker, 1987; Hesse-Biber, 2007). Further, this study aims to better understand the intersectionality of demographic characteristics such as race, social class, and age, that all play a role in identifying development (Mellstrom, 2014). Utilizing this lens helped the researcher to look at the gender inequities that each of the participants faced and considers ways in which females encounter obstacles in different areas of their life including their home, social, school, and professional environments. The use of a feminist lens when analyzing data helped direct the researcher’s attention to the social construction of gender and the role gender plays in how one is treated within the mathematics community. Further, through this lens, the researcher could analyze the effect one’s gender has on their perception of their own abilities. Analyzing data from this study through a feminist theoretical lens positively affects the mathematics community and demolishes the negative gender stereotypes that women cannot be successful at or pursue mathematics (Brabeck & Brabeck, 2013). Analyzing through a narrative approach is helpful for the emergence of common experiences among groups of individuals and determining how one makes sense of their social experiences with mathematics (Langer-Osuna & Esmonde, 2017). The key themes identified address the following research questions:

1) What experiences or personal attributes do female mathematicians attribute their success to?
2) What are female mathematicians’ perceptions of mathematics and mathematics abilities and what role do these perceptions play in their success?

3) How do participants view themselves as mathematicians?

The researcher found themes revolving around the positive effects of supportive parents, having approachable instructors, having a strong sense of perseverance and appreciation for challenges, and for being involved in extracurricular activities. This chapter aims to provide an in-depth analysis of each of these themes in addition to other common experiences each of the participants shared. Thus, in addition to the identified themes, the following sections are organized based on similar experiences and the impacts of one’s family, teachers, classroom environments, personal traits, social interactions, and personal views on mathematics.

**Role of Family**

Each of the five participants discussed the role that their families, husbands, and children have had on their educational and professional careers. The two themes revolving around the role of family that emerged from the participants follows in the next two sections.

**Supportive Parents.** From a feminist perspective, previous research has shown that parents tend to stereotypically push their daughters towards nurturing activities in which she must provide assistance to others (Luscher & Pillemer, 1998). Literature states that parents must provide positive encouragement so females can develop a positive mindset about pursuing their education and being successful beyond the stereotypical gender roles imposed on women by society (Froschl & Sprung, 2016). Each of the five participants spent much time discussing the impact that their families had on their lives. Each participant discussed having a close relationship with their parents and siblings and how this impacted them growing up. Although the educational background and the cultural influence of their families differed, each participant
felt well supported by their families. Participants commented on the ways that their families motivated them, financially supported their education, served as role models, and even emotionally supported them in times of difficulty.

Tara discussed that her parents motivated her and her brother throughout their lives in respect to their education. Tara’s mom attempted to make learning fun by turning educational opportunities into games supporting the ideas that current research hold towards the impact of informal education impacting female interest in mathematics (Shapiro & Sax, 2011). Tara recalled the impact of her mom supporting a career day at her elementary school. Tara expressed feelings of “pride” stating, “I remember being so proud that my mom could come to school and share her career with my class and give that perspective to my classmates and it also gave my class perspective on me. I’m really proud of her.” Later in one of her interviews, she stated, “I don’t know how my confidence was built but I really think it was a lot of micro-impacts.” She further explained that her mom’s influence and example was one of the micro-impacts that continued to motivate her throughout her education. Tara’s comments about various impacts support the literature that discusses females being influenced by various external factors when considering STEM fields (Gunderson, Ramirez, Levine & Beilock, 2012).

Like other participants, Cindy expressed having a close relationship with her parents. Cindy saw how important education was to her parents as her mom worked to support Cindy’s father to obtain his graduate degree. During summers, her father would require her to read at least one classical novel and encourage her to further explore the family library for other texts that would interest her. When it came time for Cindy to go to college, they played an active role in helping her choose which schools to apply to. “He [her father] was very keen of the idea of sending me to a women’s college because he had read the research and how successful students
coming out of those schools were relative to peers at co-ed schools.” To offer financial support, her family took out a second mortgage which paid for the entirety of Cindy’s undergraduate degree.

Coming from a long line of doctors, Sara’s family valued the importance of a degree and encouraged her to pursue her interests. “There was never any question that I would go to undergrad.” Initially, Sara pursued a pre-medical degree assuming she was expected to maintain the family’s professional legacy. To her surprise, when she expressed a desire to switch to a mathematics major, her family did not react negatively. Throughout her path to obtaining her degrees at different levels, she knew she could always go to her parents when she felt frustrated and faced obstacles. They would often help reinforce the idea that, “...you get to a point where you’re like well, I’m too far in to quit now.” In a later interview, Sara went on to discuss the importance of receiving emotional support from parents and the role this plays on a child’s success. She discussed that parents can have a large role on what subjects a child pursues. Similarly, literature also acknowledges that parents can often direct their children’s interests towards particular subjects (Schwarts & Hanson, 1993). She went on to describe the parental influence on the adoption of a growth mindset as well as the ability to appreciate education. This mindset results in continued persistence and optimistic attitudes towards challenging subjects and increased confidence to overcome negative stereotypes (Froschl & Sprung, 2016).

Linda shared stories about the practical aspects of education that she learned from not only her parents but even her grandparents. Despite their lack of formal education, Linda saw from their example that education could be applied to real world scenarios and that knowledge is useful. Unlike the other participants, Linda’s family never encouraged her to pursue a college education and could not financially support her. However, her family made every effort to
emotionally support Linda and motivate her to reach her goals. In addition, seeing the financial struggles that her family faced growing up, Linda knew she wanted her story to be different.

Reflecting on the impact of her family, Marissa described them as kind, supportive, and encouraging. Valuing the importance of quality time with her family, Marissa was influenced by the professional roles of many of her family members. With both her parents in education careers revolving around science and mathematics, Marissa developed a love for mathematics and teaching at a young age. She went on to discuss that she feels much of her success is due to the support she had from her family. “Any issues I might have had if I didn’t have that, I was able to avoid.” When thinking about her students, Marissa discussed the noticeable positive impact that a supportive family has on a child versus a child who does not have a supportive family. When parents play an active role in their child’s education and motivate them early on, Marissa believes that the child is more likely to motivate themselves towards success later on in their life.

The narratives of each participant showed that parents and family played an integral role in the lives of the female mathematicians. Many of the participant’s stories counter argued the claims made within the literature review section of this paper. None of the participants ever felt that their parents directed their interests towards non-mathematics related activities. In addition, none of the participants voiced concerns of ever feeling like their parents did not have confidence in their mathematical abilities. However, aligning with the feminist theoretical framework for this study, the participant’s stories about their families did support the idea that underrepresentation issues of females in mathematics requires the action of more than just classroom teachers (Hyde, Lindberg, Linn, Ellis, & Williams, 2008).

**Impact of Family on Professional Goals.** A common theme from three of the five participants that evolved was the impact of having a husband and children while in a professional
academia position or while pursuing a mathematics degree. These three participants discussed that having children does in fact create an additional difficulty for women to overcome within a university mathematics department. To honor and respect the request of some of the participants who made sensitive comments, their pseudonym identities are not disclosed.

One participant discussed that she believes marriage can run the risk of being a “career killer”.

“I think that to be successful in math requires being selfish in a lot of ways and society better tolerates selfishness from husbands than it does from wives. I think that’s changing. I know a lot of people that got married in graduate school and the guy has a research career and the woman is teaching.”

This participant went on to discuss that there are domestic duties that cannot be ignored in a home and that women generally end up being the individual to take on these responsibilities. She also discussed the notion of children and how this can also be burdensome. “Children are incredibly time consuming. That’s an enormous load to put on yourself.” Her views about the burdens related to having a family align with the literature and are often questioned by leading feminist theorists. Feminists focused on issues of gender inequality and challenge concepts such as, “Why is a woman automatically considered the caregiver of children in the family?” (Donovan, 2012).

The second participant married her husband while she was completing her Ph.D. For her, this was an opportunity to share her time with somebody and to take time away from all the work that came along with school. However, she did discuss that having children can create a different type of obstacle with respect to one’s professional advancement. Having two children, she found herself needing to take maternity leave and being away from her work for an extended period of
time. She also mentioned how her and her husband must be more intentional about dividing up domestic duties. Compared to a lot of other women, she knows she and her husband are fortunate because he has the flexibility of working from home and thus, she has not felt too restricted in her career. However, she discussed how the responsibility of children can be difficult for families that do not have that sort of flexibility.

While in her profession, the third participant also had two children. Like the two participants described above, she discussed the challenges that having children can pose on a female mathematician. “I had my daughter and two weeks later, I had her in a carrier teaching a class. I never asked permission for those things. I just did it.” She discussed that as a professional woman, she had to learn to push the status quo. Many professionals will assume that having a child means you want to stop the tenure clock, but this was not a wish that she had. Like many feminist theorists, she was attentive to the power and gender inequities she was noticing within academia when it came to receiving tenure (Riley, 1999). Further, she discussed that professional women are often the individuals who are impacted most by having a family.

“The brunt of family life, the brunt of department service, all fall on women. Because of that, I think that those things that do happen in family life do happen in times that are pivotal to women in their careers. We have these processes of promotion and tenure that are very rigid. They don’t really allow for there to be a problem in your family, whether it’s having children or it’s your parents or those sorts of things but I think that falls heavily on women.”

Role of Teachers and the Classroom Environment

As discussed in the literature review section of this paper, mathematics teachers and educators play a significant role in creating a classroom environment that fosters positive
mathematics identity (Froschl & Sprung, 2016). The perceptions of one’s own mathematical abilities, the way educators conceptualize the meaning of mathematics and how one introduces the learning of mathematics all play in a role in the motivational development of a student (Gunderson et al., 2012; Wigfield & Wagner, 2005). Further, through a feminist lens, one can begin to evaluate how students are treated based on gender differences. Society is organized by gender that sets preferences for gender specific types of work and access to resources. Thus, if similar separations between gender exist in the classroom, one can conclude that an environment of gender inequality has been established. Each of the five participants discussed the impact of teachers and educators at each stage of their educational career. In addition, each participant reflected on the positive and negative encounters they had within the mathematics classroom and how these impacted their perception of being a female interested in mathematics.

**Early Mathematics Memories.** One interesting similarity between all five of the participants was their inability to recall early mathematical experiences that were positive. Tara was the only participant who could recall a positive early encounter. She remembered playing a game in her first-grade mathematics class where she would practice her pattern recognition skills. Being able to answer questions quickly and compete with her classmates, Tara found a lot of joy in this classroom activity.

Like Tara, Linda’s earliest memory in the mathematics classroom occurred while she was in elementary school. However, Linda’s memories do not bring back feelings of joy or excitement for learning. She recalled her third-grade mathematics classroom when the teacher paddled students who had not properly learned their multiplication tables that day. It was in this experience that Linda began to question the teaching practices she had seen displayed in her class that day and considered how she would have handled the situation differently.
Sara’s earliest memory is learning in her middle grades mathematics class. Unfortunately, her memories revolve around the struggles she faced when learning new mathematical concepts. She continually felt like she had to work significantly harder to learn mathematical material than her peers.

Both Cindy and Marissa’s earliest memories are within their high school mathematics classes. Cindy struggled to remember the classes she took or the types of activities she would engage in during her mathematics classes. Similarly, Marissa stated,

“I don’t know that I have any strong recollections of moments in mathematics that stand out to me other than things like being able to take algebra early or taking calculus in high school. I don’t know that I had experiences where there was a moment in class that really stood out that was mathematical.”

However, both participants were able to think back to specific instructors with whom they had positive encounters. Cindy discussed appreciation for a male mathematics teacher’s way of teaching concepts to his students. She also mentioned a female mathematics teacher who was willing to allow Cindy to design her own assignments to meet the level of mathematical rigor that Cindy desired. Marissa discussed the plethora of personalities she encountered from her mathematics teacher’s in high school and how these stood out more “than the math itself”.

**College Classroom Experiences.** Each of the five participants had their individual experiences within the college classroom with some similar themes across all five narratives. Literature discusses that the mathematics classroom can have a strong impact on helping a student develop positive academic identity in mathematics (Langer-Osuna, 2017). With both positive and negative experiences, each participant’s narrative supported the idea that a classroom environment that reinforces and confirms positive behaviors will develop a
willingness in students to engage in similar activities in the future (Urdan & Schoenfelder, 2006). Marissa stated in one of her interviews, “Being good at it, it’s really easy to enjoy something you are good at.” Similarly, Tara stated, “Once I figured out that I was good at it [math], it became my favorite subject.” Those with a strong, positive math identity believe that not only can they do mathematics but that they have a place in the math community and the math classroom (Froschl & Sprung, 2016).

**Approachability of the Instructor.** The sense that the instructor was approachable was a common theme that was seen across all five narratives. When female students feel their mathematical abilities are being compared in respect to other students in the class, negative attitudes can exist and a desire to participate in classroom activities can diminish (Nguyen & Ryan, 2008). Thus, current literature stresses the importance of support figures providing positive encouragement so that female students can develop a positive mindset about their mathematics capabilities (Froschl & Sprung, 2016). Many of the participants discussed feeling comfortable going to instructors for help when they felt the professors were willing to help and not judging their mathematical abilities. This supports the ideas of Social Identity Theory which states that it is human nature to desire to maintain a positive personal and social identity (Schmader, 2002).

Sara spoke very highly of her undergraduate professors explaining that they created a warm and welcoming environment. For most of her undergraduate and graduate career, Sara struggled with comprehending the upper level mathematics she was learning. She felt the instructors at her institution were very approachable and willing to help her better comprehend the material. Further, she felt the professors truly desired to see her succeed. Sara went on to discuss how she discovered having approachable instructors who possessed a lot of energy in the
classroom was critical for her success. Even when picking a research advisor in graduate school, she considered which professors would be approachable and that “wouldn’t’ make her feel super dumb all the time.” As a professional now in academia, she makes an active effort to be conscientious of the way she responds to her students and the language she uses in her class such as the phrases, “this is easy”, to ensure her students feel comfortable approaching her about questions and concerns.

Tara spoke highly of her college mathematics classroom experiences. Like her experiences growing up, she always felt like she could participate in class discussions and engage in mathematical dialogue. She discussed how she often took on leadership roles when working within groups for projects and assignments. For this reason, Tara felt that her instructors liked her and appreciated her participation in class. Thinking about her undergraduate career, Tara discussed that although she had a positive relationship with her professors, nobody in particular had a strong impact on her academic career. It was not until her first Ph.D. experience that Tara could begin recalling challenges in the mathematics classroom. She remembered the difficulty of some of her first statistics Ph.D. courses and the frustration she would feel as she struggled with the material. For the first time in her academic career, Tara would need to go to her professors to ask for academic assistance. She always felt that her instructors were approachable and willing to help.

Like Tara, Cindy and Marissa both had a very similar experience in their undergraduate careers. Both women expressed feelings of comfort when going to their professors because they knew their professors desired to see them succeed. Cindy expressed that she even felt that she was well regarded by the faculty members due her strong academic performance in her classes. Marissa went on to discuss how as a mathematician in academia, she makes an active effort to
try to be an approachable instructor. She understands that by encouraging her students to seek her for advice and help when needed, they are much more likely to be successful in her class. Marissa believes that her gender as a female plays a role in making her seem more approachable.

During conversations with Linda, she first expressed feelings of approachability in respect to her Ph.D. level instructors. Having a relationship already with her instructors since she had completed her Master’s degree under their instruction, a positive rapport had already been established. Like Cindy however, she was unable to make any personal or mentorship connections.

**Feelings of Isolation.** From a narrative perspective, researchers try to better understand one’s identity development through the stories they tell and how one makes sense of their experiences in relation to their mathematical self. These stories shed light on how an individual positions themselves within a community of practice as well as explains how they feel others within the community view them (Langer- Osuna & Esmonde, 2017). In addition, from a feminist theoretical perspective, gender inequality issues are seen as the root for understanding how and why women feel restricted or underprivileged (Riley, 1999). Utilizing this perspective along with a feminist theoretical lens, four of the five participants expressed feelings of isolation at some point in their collegiate or professional career which raises some concerns about the issues female students are facing in the field of mathematics.

Throughout her mathematical education, Sara always struggled with the mathematics she was learning while it seemed like everyone around her “just got it”. During graduate school, Sara expressed that she had a very difficult time fitting in because she did not see herself as mathematical as those around her. Although these thoughts did not stop Sara from continuing in the field of mathematics, literature states that these sorts of thoughts generally affect one’s
motivation in a negative direction and cause a disinterest for pursuing anything related to mathematics (Christy & Fox, 2014). “Of course, I wouldn’t identify with anyone. These people were so far out of my league with their fancy pants, R1 institution doing incredible math research. There’s no way I could identify with that.” Sara never felt as “naturally smart” as those around her. Even at professional conferences, Sara has always felt out of place. She stated her and her friend always feel like “stupid little girls together” when attending professional conferences. Feminists stress the negative impact of such thoughts as social comparisons come naturally and can have a large impact on a students’ sense of self-efficacy, motivation, and engagement (Ryan & Patrick, 2001).

When Tara was asked to leave the Ph.D. program, clear signs of frustration and isolation were noted. In one of her interviews, Tara stated,

“I feel like I just got dumped. I had poured my heart and soul into this program for one and a half years and then they are like nope, you missed it by half a point. Goodbye. That was really hurtful. Thinking back, it still is really hurtful. I’m happy with where I ended up but it’s just the way they did it that was so hurtful.”

In this moment, Tara did not know what she wanted to do moving forward. She recalled that this experience was true for several female students in the department.

“None of the females from my cohort earned a Ph.D. in statistics. Not one. Some people failed the exam like me, some left after they got their masters to get married, while others left because they were offered jobs paying good salaries with just a master’s degree.”

At another point in her undergraduate years, Tara considered switching to a computer science degree. However, noticing that there were no women in the program and that she would be isolated as the only female in the program, she decided to not pursue the major. Professionally,
Tara later discussed her first experience as a community college instructor occurred right after she made a move from the north to the south. For Tara, she faced a “culture shock” as she had to learn the way southern culture operated. She often felt confused and did not understand why people in the south interpreted her actions differently than her intentions. These feelings created a sense of isolation.

Cindy first had feelings of isolation when she was in high school. Doing extremely well in her mathematics classes, she was looking for more rigor and growth. “I got to about my sophomore year and I just had this feeling that I had gotten everything out of it that I was going to get.” Unfortunately, her experience was not different in college. She recalled being frustrated on multiple accounts because the professors would stop the lectures from moving forward until everyone caught up and understood the material.

“The class would grind to a halt. My feeling was that it wasn’t fair. I understand that you want to help people that are struggling but it wasn’t fair to the students that were not having those difficulties because all of a sudden they couldn’t get out of the course what they could of.”

While pursuing her Ph.D., Cindy felt truly isolated because nobody in her family had attended graduate school. Cindy did not have anybody to turn to for help or advice on how to navigate the Ph.D. academic world. Instead, she often felt like she was figuring things out as she went. Cindy went on to discuss that even now as a professional, she sometimes feels isolated because of the lack of women mathematicians. The “farther I went up the ladder,” the fewer women she said that she saw within the field. “It’s the accumulation after years and years that you or I begin to ask, What’s the message here? What is the community saying to me?’ More importantly what are my peers hearing? What are my colleagues hearing?”
Like Cindy, Linda found herself frustrated in her K-12 mathematics classes as everything came very easy to her. She recalled always finishing up her work quickly and being required to complete assignments that her teachers would create to keep her busy while the other students finished the original work. When going off to college, Linda felt extremely alone and isolated having no idea how to navigate the college world. As a first-generation college student, her family could not assist her with anything. For this reason, she even lost out on a lot of opportunities to receive financial aid. Going to graduate school, Linda continued to feel isolated as she was forced to adapt to the culture of living in a big city. “It was emotionally and mentally draining.” Linda discussed how even being at a large research institution, she did not understand concepts such as “faculty office hours” nor the first-name basis, student-mentor relationship.

**Feeling underprepared.** Each of the five participants expressed feeling extremely underprepared academically when going to graduate school. Sara, Tara, Marissa, and Linda all felt unprepared to be engaged in research. None of them had any research experience at their previous institutions and thus, struggled even when trying to find a research advisor. Even after completing a thesis, Tara still did not feel prepared to complete a dissertation at her next institution. Both Tara and Cindy discussed feeling frustrated when it came to writing a research paper. Sara and Marissa discussed it challenging to devise research questions in their respective areas to further explore. Linda relied on her social group to help her better understand what a research project should look like and how to conduct research.

When entering graduate school, Cindy felt that she had not had a strong and diverse background in various mathematics disciplines. It was at this point that she felt her undergraduate institution had not given her a strong idea of what it meant to do math. Instead, her school had been preparing students who were going into teaching rather than going to
graduate school for mathematics. Tara expressed similar concerns when she entered her doctoral program. Feeling extremely underprepared in her mathematics classes and missing needed prerequisite knowledge, she began to doubt her previous institution decisions. On several accounts, Marissa wondered if she could even be successful because she felt so underprepared in graduate school. “Can I really understand the concepts well? My lack of preparedness prevented me from seeing the big picture.” Linda expressed similar feelings noticing that the content she was experiencing in graduate school was nowhere near as rigorous as the content of graduate school. Like Cindy, Linda felt her institution had presented material in a way to prepare future educators and had focused on making connections rather than diving into deep, mathematical content.

Role of Self

Gender gaps in mathematics performance have become much smaller over time but gaps in self-concept and aspiration remain large (Dasgupta & stout, 2014). The “leaky pipeline” metaphor serves to give a visual of the processes women in mathematics studies face while going through their educational experiences and onto a career (Blickenstaff, 2005). Due to gender inequality issues in the mathematics classroom, women are more likely to leak out than their male counterparts (Gasser & Shaffer, 2014). Thus, it is critical that researcher better understand how one self-identifies and what role an individual feels their gender plays in their day to day activities. Daily, students are challenged with tasks in the mathematics classroom that influence their beliefs regarding their mathematical abilities (Wigfield & Wagner, 2005). This was also true for each of the five women in this study. However, each participant possessed positive control over their achievement and positive self-efficacy which are factors needed to tackle tasks that do not necessarily come easy to them (Wigfield & Wagner, 2005).
efficacy also plays a role in determining the way students react to confusing material (Lent, Brown, & Larkin, 1986). The five participants showed that despite challenging material or facing obstacles, they were able to endure and trust in their ability to succeed.

Sara discussed the idea of mathematical anxiety stating,

“There was a lot I had to overcome in terms of imposter syndrome and anxiety about math and being the dumbest one there and all that’s in grad school that I had to learn about, internalize, grow from and take that into my teaching.”

Despite not feeling like she was the strongest mathematical student, Sara always put forth her best effort to succeed in her mathematics classes. Facing imposter syndrome again as an instructor, she can recall the time when she used to be scared to teach her students because she thought “people would see right through me and realize I knew nothing.” However, she was able to overcome her fears and realize that it was acceptable to make mistakes. She often uses her experiences to help her students better understand that it is ok to try something and to make mistakes. The key is to learn from those mistakes. “If it [math] was easy, it would be boring.”

In her professional experience, Linda has also seen the impacts of anxiety on students within the mathematics classroom. Mathematics anxiety can begin impacting students as early as the first grade and Linda’s statements claim that students carry this anxiety even in their college courses (Ashcraft, 2002). She discussed how students are often impacted by previous events that cause them to shut down their learning for all future mathematics courses. Experiences with traditional, large, lecture math classrooms that focus on timed tests or asking questions on the spot can increase feelings of math anxiety (Curtain-Phillips, 2017). Linda believes that if people can become more confident in their math abilities, the mathematics field will likely retain more students. “People can do math and they just never know it.”
Growing up, Tara felt extremely confident in her mathematical abilities. She was able to quickly identify her skills with pattern recognition compared to her peers in first grade. “There was never anybody that could tell me that I was not good at math.” She enjoyed learning and thinking deeply about the mathematics she was learning. She knew her instructors always enjoyed having her in class but after having one instructor who made her feel that he did not think she was smart upset her. “Math is so much a part of me that when a math teacher didn’t like me, then I really took it personally.” Her frustrations continued in doctoral school when she faced material that was new and complex to her. She found herself acting much more hesitant to participate in her classes than she had before. When she did ask questions in class, her peers would be shocked that she did not know various concepts. “I would feel like a complete idiot.” Due to her self-driven nature, she was able to overcome these feelings but she later mentioned that she notices similar feelings amongst her students. She has seen a lot of students who do not possess a strong mathematical identity as she did. “You just got to keep telling people they can do it and eventually they will believe it.” She went on to say that anybody can do math if they just try.

Marissa expressed similar concerns when she was in graduate school. “You’re more worried about making mistakes because you think that’s going to be such a big no or impact the way people are going to think about you.” For Marissa, this fear prevented her from collaborating with her peers and instead, she found herself relying on instructors for help. Marissa notices similar feelings among her students. Knowing that everyone is not going to possess a strong mathematical identity, she tries to help her students understand the importance of relating the mathematics they are learning to real world scenarios and examples. Seeing math as something that is relatable is much more likely to result in success. Literature also supports
the idea that students continually enter the mathematics classroom and see no purpose in their learning of the material (Kitchen, 2016). Thus, by implementing mathematical instruction that focuses on conceptual understanding, reasoning, problem solving, and making connections with real-world applications, students will likely gain interest in the learning of mathematics (Sherman, Richardson, & Yard, 2014). With the same argument, Cindy stated that the mathematics community needs to introduce industry opportunities and stop assuming all mathematics students will go into academia. “We don’t make it easy for people to say, ‘I’d like to consider options outside of academia’.”

**Competitive Nature.** Four of five participants described their tendency to compete with siblings and peers. This counter argues the current literature that states teachers believe their male students possess stronger competitive characteristics than girls (Carpenter, Fennema, Peterson, & Chiang, 1989). From a feminist perspective, these findings support the idea that one’s gender should not be an automatic depiction of how a woman should act or be seen in society (Butler, 1988).

Growing up, both Sara and Tara played sports. Both women expressed being super competitive and their competitiveness motivating them to get through their schooling. Sara stated that this competitive nature encouraged her “to give everything my all, all the time.” Tara found her competitive nature to also come out in respect to competing with her brother. Tara discussed how they competed with one another in just about everything. Like Sara, Tara believes that her competitive nature started as something innocent but continued to grow and play a significant role in her schooling.

Cindy also discussed being competitive with her brother growing up. Frustrated, she discussed how her brother always seemed to be better at everything than her. She quickly learned
that there was no point in competing with her brother or anybody else. Instead, she began to focus on competing with herself. “I am enormously competitive with myself in the sense that I want to be better than I am. I want to beat myself.”

Marissa recalled being competitive in high school. She remembers being concerned about obtaining good grades and always trying to make straight A’s. Like Cindy, she discussed the idea of reaching her personal best. This self-driven nature is what she believes has contributed to her success in a field that she loves.

**Perseverance and Facing Challenges.** One of the most significant themes that was present throughout the lives of all five participants was the characteristic of perseverance. Each of the five participants faced their own sets of challenges to get where they are at today but each of the participants was able to overcome those obstacles. Agreeing with scholars working under a feminist lens, the participants of this study proved that challenges go beyond gender alone but that they also involve the intersectionality of other important demographic characteristics such as race, social class, and age (Mellstron, 2014). Literature discusses that the additional fear of failure forces girls to become unmotivated and uninterested in learning mathematics (Spencer, Steele & Quinn, 1999). For the women in this study, their determination to succeed and not fail propelled them even more into the learning of mathematics. A study conducted by Park, Cook, and Greenwald (2001) showed that the first year of college often serves as a turning point within one’s STEM identity and by the second year of college, many women fail to persist in STEM-related majors due to a negative academic identity. For these women, they faced quite the opposite. Four of the participants made the decision to actually pursue mathematics after their first year of college and all five participants continued within mathematics despite the difficult encounters they faced.
As early as she can remember, Sara always struggled within the mathematics classroom. Sara can easily recall having to work harder than her peers to ensure her success. She laughed as she shared, “This is probably why I did better than everyone else because I studied more.”

Looking back, she attributes her success to her work and study ethic. She can remember being in courses that she would not be doing as well as she wanted to and how she would continue pushing herself to do better and bring up her grade. Sara’s experiences were the same in her graduate career. “I got through it. I worked hard and I got good grades. I liked working hard at math. I liked trying to understand these weird and abstract topics. I thought it was fun.” Her perseverance and willingness to dive deeper for understanding helped change her perspective of mathematics in a positive way.

For Tara, her competitive nature combined with her desire to be the best helped her to develop the trait of perseverance. Tara’s ability to persevere was able to shine through during her Ph.D. experience. For the first time in her life, Tara felt as if she was not the best mathematics student in the classroom. She looked at the challenges she was facing and found a way to bargain with her peers in order to be more successful. Doing well in her probability class, she would help her classmates with probability homework and they would help her with statistics homework. Tara’s perseverance also shined through when she was asked to leave the Ph.D. program. Tara was completely crushed when she failed her exam by only half a point but she did not allow it to defeat her. She taught for one year but also took random classes at various schools to continue learning mathematics and non-math related topics. A year later, she decided she would go back to Ph.D. school and attempt a doctoral degree in mathematics education. “Look at me, I struggled but overcame it and look where I’m at now.” Tara discussed how she appreciates the challenges that she faces even within her profession. She discussed teaching new classes and
how although it can be challenging, it is one of the greatest forms of professional development. “The love of learning, finding it fun, competition, and confidence all made me successful.”

Mathematics always came easy to Cindy. She never faced any challenges in the mathematics classroom. In the summer after her junior year after undergrad, Cindy took time to play with some of the mathematics she had learned in her courses from the spring. Facing the challenge of trying to better understand the mathematics she was working with, Cindy ended up proving mathematical theorems. From this moment, she began to appreciate the challenges of mathematics. However, Cindy’s first test of perseverance came while she was working to obtain her Ph.D. Doing extremely poorly in her first-year Ph.D. courses, Cindy took her qualifying exams and failed. Despite this emotional experience and setback, Cindy refused to give up. She knew that her love for mathematics was too strong to quit. She continued to work diligently in her classes during her second year and significantly brought up her grades. She went to a second institution to pursue her Ph.D. degree and had a much more positive experience. Reflecting on her love for mathematics to this day, she discussed how mathematical research in particular can be very challenging but also the best form of professional development.

“One of the things I love about math is that it is so difficult. I am more interested in the problems I’m not sure I can solve than the one’s I know how to solve. Those are boring. I like the challenge of I’m not sure I can do this.”

For Marissa, the true test of perseverance came in undergrad. She had always performed well in her K-12 mathematics classes but as soon as she entered upper level math courses, the material was extremely challenging. However, she found a way to enjoy challenging subjects such as topology and real analysis. She discussed how she would feel so satisfied and proud when she would work on a challenging problem but overcome and solve it. In her profession, she
finds it challenging to think about the audience she is speaking to and crafting her lectures to the needs of the group. However, she finds herself inspired and motivated to think of new and creative ways of improving her teaching.

From the moment she was a young girl, Linda showed signs of perseverance and determination. Coming from a low socioeconomic status, there were several moments where Linda had to “take care of things that were probably better fixed by adults.” Linda was always determined to change the financial cycle within her family which motivated her to face challenges head first. “So I think I had a drive to just get stuff done that came from the practicality from being on the farm and it was never defined by schooling.” When peers or faculty would make jokes about “hillbillies, rednecks, and country bumpkins,” this would motivate Linda to prove people wrong and work harder. Even when she went to graduate school and faced struggles learning the culture of academia, Linda did not allow it to stop her from being successful.

“I’ve always been kind of defiant in that way. So it’s almost like well, if you think I can’t do this just because I’m a whatever, redneck, woman, whatever it may be, then it just makes me more determined to do it. To prove to somebody you know, we can do these things.” She continued, “From an early age, I think my mom recognized how head strong I was in absolutely everything and she knew that whatever I wanted to do, I was just going to do it. I don’t know that I would say she was the strongest impact on that actually because I don’t think she ever directly…Once she realized that I was going to be different, she never really tried to herd me in one direction or another.”
Same Gender Role Models

Research has shown that role models can be inspirational, enhance self-evaluations and motivation, and possibly guide academic and career aspirations (Schwartz & Hanson, 1993). Specifically, same-gender relationships can be powerful in creating a sense of belonging as noticeable similarities become much more obvious (Lockwood, 2006). All five women discussed the concept of having a role model and the impact it can have on one’s professional outlook. Rather unconventionally, four of the five participants discussed having a same gender role model but rather than being a positive thing, expressed that the individual showed each of them what not to do or what not to become.

Sara discussed that she was strongly impacted by various professor mentors who encouraged her to pursue more opportunities to work with mathematics in graduate school. However, Sara did not discuss the impact between male versus female mentors. In fact, she discussed that as she encountered more female mathematicians that supported the “mathy woman” stereotype, the more it propelled her to be something different.

Like Sara, Tara could not recall having any impactful female mentors throughout her educational career. Tara did discuss that she believes seeing her mom go back to school to obtain an accounting degree definitely impacted her in a positive way and in a sense, her mom became a role model. However, in respect to female mathematician mentors, she feels like many instructors inspired her as to what not to do in the classroom. She now uses these experiences to guide her pedagogical methods.

When discussing the idea of mentors, Cindy admitted that she did not understand the need for having a mentor in her life when obtaining her degrees. Looking back, she wishes she had taken more time to forge relationships with more faculty members. “I think for a long time it
was hard for me to admit not knowing and being unsure. I thought it would look weak.” Cindy feels like she learned a lot from those who did not help her and uses this experience to make an active effort to be more helpful towards her students.

In her undergraduate career, Linda was able to find various female role models that had a positive impact on her experiences. In particular, she recalled going to a special event for females in mathematics during her senior year of undergrad. Here, she shadowed a woman that helped Linda see for the first time, that she could do what she loved while still being involved in mathematics. This experience inspired Linda to go to graduate school. However, Linda discussed that the impact of female role models was very different in graduate school. “I can’t say that I ever found somebody that could serve as a mentor to me at a point when I needed that.” In fact, one female mathematician came from a similar socioeconomic background but put in a lot of effort to hide her background. For Linda, this became an example of what she did not want to become.

**Positive Social Interactions**

Each of the five participants discussed the importance of having friendships while in their college career. Social group association, both within and outside of the classroom, can heavily impact one’s performance (Oyserman, 2009). Each of the five participants made several positive social connections with individuals that occurred outside of their mathematics community.

For Sara, she did not find herself having a very strong social experience in undergrad. She had joined a social sorority but as she began to mature throughout college, she began to fall away from this group. She never really felt like she had a close group of friends while in undergrad. However, in graduate school, joining the ultimate frisbee team gave her a chance to make a group of friends that she felt she connected with. She also met her now husband in
graduate school along with her best friend. She also connected with four other individuals in her mathematics department which helped her to avoid feelings of isolation and have friends to collaborate with.

Tara was able to make two close friends while an undergraduate that she continues to be friends with today. Neither was a math major but they shared some classes together and all cared about doing well in their academics. Tara went on to discuss that having a social network was very helpful in graduate school. “…I loved the fact that I had people I could ask my questions of that weren’t my faculty members and get help with all of that. I was probably still top fifteen percent, maybe twenty percent, but I really liked having the collaborative ability with my classmates.”

Cindy discussed that most of the challenges she faced as an undergraduate revolved around social issues. She was extremely shy and did not have many friends. Thinking about the individuals she did associate with, she explained that they were not mathematicians but instead in the humanities. “I never had a sense of community or my people or my tribe. It’s hard to say which is cause and which is effect.” If she was facing any challenges in her courses, she always relied on her faculty for help. Cindy’s shyness continued as a professional but eventually she was able to overcome this personality trait. She discussed how her shyness was a negative trait for her to have as it prevented her from making positive networking connections. “It’s one thing to be reserved by choice or stepping back so you can listen to people and observe. It’s another thing to be just so rigidly locked with fear that you can’t function or perform. That’s not good.” She discussed how today, she feels that by being a mathematician, one “sort of puts up their flag and says they want to join a tribe.” However, she continued discussing that although she often feels she belongs, she also has feelings of being an outcast as the only woman.
“Being able to find your tribe. At various times I’ve considered leaving academia and
going into industry…it’s just undeniable that this is the life and type of work I am ideally
suited for. My colleagues…these are my people. This is my tribe. But I don’t always feel
it’s my community because of the underrepresentation of women.”

Marissa had a very positive experience socially while in undergrad. Her mathematics
cohort was extremely tight knit and supportive of one another. Four women in particular from
her cohort had a large, positive influence on her experience. “Probably having a peer group
within those courses right, having a cohort, that was probably pivotal for me. Having people to
talk to about it.” Unfortunately, she did not have the same experience in graduate school. Afraid
to seem like they did not belong in graduate school, Marissa discussed how her peers did not
collaborate outside of class or interact with one another. Luckily, Marissa and her now husband
were living together and married one another during her second year of graduate school. “This
was a nice break from the work.”

Like Marissa, Linda also had a very positive social experience in undergrad. Her cohort
was a very close group and would often hang out with one another outside of class. She recalled
it feeling a lot like high school. In graduate school, she met her now husband on the very first
day of school. Linda recalled the importance of meeting him and how he was able to help her
with a lot of the cultural norms of academia in graduate school. “We went out that first week
together and if I had not met him, I really think I would have packed up and went back to
Mississippi within the first month.” She was able to easily make more friends as he would
introduce her to the people he knew.

“I didn’t know it at the time but I had found my tribe basically. This group of people who
were so interested in learning absolutely everything there was to know, who loved
meeting other people and finding out more about what they did. That spark, that’s actually what kept me in graduate school.”

**Beliefs, Attitudes, and Views of Mathematics**

A person’s beliefs and attitudes towards the learning of mathematics plays a significant role in one’s increased interest to learn math and in turn pursue further mathematics learning and careers (Schoenfeld, 1989). Outside of the themes categorized above, the narratives of the five participants showed other types of similar themes that were not discussed in the literature. The emerging themes are described in the next three sections.

**Type of Institution.** All five participants shared some similarities in the types of colleges they chose to attend for undergrad. Sara, Marissa, and Linda chose to attend liberal arts colleges. Sara, Cindy, and Linda attended private institutions. Cindy’s school was a women’s college and Tara was the only individual to attend a research institution. All five participants discussed that their reasons for choosing the colleges they attended had nothing to do with the reputation of the departments. Instead, for Sara, Tara, Marissa, and Linda, they selected their schools primarily based on the location. Upon applying to several different women’s colleges, Cindy made her decision with her father’s input and based her decision on the opportunity to attend classes at several different satellite locations.

All five participants attended public research institutions for graduate school. Sara, Cindy, and Marissa each went through five- year Ph.D. programs. Tara and Linda earned their masters and Ph.D. degrees separately and not within the same program. See table 1.
Table 1: An overview of the types of schools each of the participants attended.

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>PUBLIC OR PRIVATE (Undergraduate)</th>
<th>TYPE OF SCHOOL (Undergraduate)</th>
<th>REASON FOR DECISION (Undergraduate)</th>
<th>AP CALC IN HS</th>
<th>PUBLIC OR PRIVATE (Graduate)</th>
<th>TYPE OF SCHOOL (Graduate)</th>
<th>TYPE OF DEGREE</th>
<th>TA, RA, or Neither?</th>
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<td>5 YEAR PH.D.</td>
<td>TA</td>
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<td>LOCATION</td>
<td>NO</td>
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<td>RESEARCH</td>
<td>MASTERS + PH.D.</td>
<td>Neither</td>
</tr>
<tr>
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<td>FATHER’S INFLUENCE</td>
<td>NO</td>
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<td>RESEARCH</td>
<td>5 YEAR PH.D.</td>
<td>Neither</td>
</tr>
<tr>
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<td>RESEARCH</td>
<td>LOCATION</td>
<td>YES</td>
<td>PUBLIC</td>
<td>RESEARCH</td>
<td>MASTERS + PH.D.</td>
<td>TA</td>
</tr>
<tr>
<td>MARISSA</td>
<td>PUBLIC</td>
<td>LIBERAL ARTS</td>
<td>LOCATION</td>
<td>YES</td>
<td>PUBLIC</td>
<td>RESEARCH</td>
<td>5 YEAR PH.D.</td>
<td>TA</td>
</tr>
</tbody>
</table>

The five participants also share some similarities in the types of colleges where they are employed. Sara, Cindy, and Tara work at private institutions while Linda and Marissa work at public institutions. Sara, Marissa, and Linda are at liberal arts schools while Tara is at a liberal arts school for women only. Cindy works at a respected research school. The decision to work at their current institutions was based on location for Sara, Tara, and Marissa. Cindy’s decision was based on the opportunity to collaborate and work with faculty that she highly respects within her field. See table 2.
**Table 2: An overview of the types of schools each of the participants works at.**

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
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<th>TYPE OF SCHOOL</th>
<th>SPECIAL NOTES</th>
<th>REASON FOR DECISION</th>
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<td>R1</td>
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<td>WOMEN'S COLLEGE</td>
<td>LOCATION</td>
</tr>
<tr>
<td>MARISSA</td>
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<td></td>
<td>LOCATION</td>
</tr>
</tbody>
</table>

**Professional Goals.** One interesting theme that emerged from all five participants was that each went to college without an idea about how they would utilize their degree or what profession they would end up in. Further, the notion of working within academia was never something any of the five participants considered as a professional goal until their senior year of undergraduate or later. Working underneath a feminist lens, one must question if these participants were not afforded the same opportunities or encouragement to pursue mathematics because of their gender. Further, this raises a concern about how the five participants were learning mathematics and how relatable they each saw it to their lives. Beyond the math topics taught in schools, mathematics is typically perceived by females as not relatable to one’s daily concerns and routines (Young-Loveridge et al., 2005). The five participants support the ideas that students continually enter the mathematics classroom and see no purpose or end goal in their learning of the material (Kitchen, 2016).
Upon attending college, Sara had the intentions of pursuing a pre-medical neuroscience degree. Unfortunately, finding that her classes were not interesting her, Sara decided to switch majors. Debating between mathematics and chemistry, she only chose mathematics to avoid taking 8am chemistry labs. For all her undergraduate career, Sara did not know how she was going to use her degree. She decided to go to graduate school assuming that she could “just figure it out” there. It was at this time that Sara finally decided she wanted to pursue academia. Working as a teacher assistant (TA) while pursuing her degree, Sara found a love for teaching and this ignited a desire to become a college professor. Today, Sara holds teaching to a high priority among her other professional responsibilities. She enjoys the opportunity to help her students understand the mathematics they are learning and not just memorizing it all.

Going to college, Tara knew she wanted to major in mathematics, but she had no idea what area of mathematics she wanted to concentrate on. “I read down the list of different choices and I was like, ‘Actuarial Science, well that one looks interesting’. I literally just rolled with it.” Needing to buy herself time to pass her Actuarial exam, Tara decided to complete her masters degree in math. Again, Tara found herself in a space where she was trying to “figure out what I wanted to do.” After completing internship and shadowing experiences, Tara began to find she did not like this area of mathematics although she had obtained her undergraduate degree. At this point, Tara began to consider academia. She also worked as a teacher assistant (TA) but taught both pure mathematics courses and mathematics courses for preservice teachers. This experience positively impacted her views on academia and she went on to obtain a masters mathematics degree with a concentration in education and a Ph.D. in mathematics education. Tara also considers her teaching to be her main professional focus as well as developing special topic courses to take a closer look at statistical concepts.
Marissa was always interested in pursuing education. In fact, she went to college and declared a math major with a 6-12 teaching certification. However, Marissa’s view on teaching only existed within the grade span of K-12. She had never considered academia on a collegiate level until her senior year of undergrad. A female faculty mentor in particular, helped Marissa see that “any woman could be a mathematician if she wanted to” and that there were opportunities for female faculty at the collegiate level. While pursuing her Ph.D., Marissa served as a teaching assistant (TA) and quickly developed an even stronger passion for teaching at the college level.

Linda went to college as a history major but began to add on other courses due to the recommendations of faculty. One professor in particular saw her mathematical abilities and encouraged her to add a mathematics minor, a mathematics major, and later a teacher education minor. Despite her degrees, Linda had no idea how she planned to utilize her degrees. She considered some sort of data analysis position but was not sure this is what she wanted to do. “I really didn’t know what else you could do with a math degree. It had not crossed my mind at all at that point to go into academia. I had no idea that people could do research in math education or teaching.” Upon deciding to go to graduate school for a masters in mathematics, Linda was still unsure of exactly how she would use her degree. However, after facing situations where the faculty around her were not assisting her in the ways she needed, Linda began to think about academia during her masters degree. “I think he [math advisor] really thought I was just complaining about it rather than actually trying to have a discussion about what to do. He wasn’t very responsive.” Frustrated with her experience, she decided to change her program area and focus on a masters degree in math education instead. Today, Linda is very passionate about the work she does for preservice mathematics teachers and the research development she has made.
towards equity issues in the mathematics classroom. Further, Linda appreciates the opportunities she has to work with her students and the chance to positively affect their views on mathematics.

Choosing a major was not an easy task for Cindy either. She was interested in a plethora of areas and could not quite decide exactly what she wanted to do as a career. Cindy ended up declaring a mathematics major only because she had to declare a major in order to study abroad. Cindy stated, “I declared a math major because it was easy and I didn’t have to write essays.” It was not until her senior year that Cindy first began thinking about academia after her summer experience where she was able to prove advanced mathematical theorems. Almost immediately, she decided to apply to graduate school as she could not believe “that people get paid to do this stuff.” Cindy’s motivation for pursuing academia was to be involved with the research of mathematics which she regards as an important aspect of the work she does today.

**Involvement and Interests.** Each of the five participants described their interests and involvements throughout their collegiate and professional careers with several similarities emerging between the narratives. These similar themes are described in the following three sections.

*Extracurricular activities in college.* Four of the five women were involved in some type of activity or program outside of the mathematics classroom in college. While in undergrad, Sara participated in Greek life and joined a social sorority. During her first year of undergrad, Tara lived on campus and was a part of a living learning community focused on academic and study skills. Marissa worked a Resident Advisor of a residence hall community while in undergrad. She also found herself spending a lot of time outdoors with a specific interest in hiking. Later in college, Marissa became involved with the school’s mathematics club as well as serving as a
paid tutor in the mathematics lab. Linda worked within a work study position in the mathematics department at her undergraduate institution.

Sara, Tara, and Marissa all worked as a TA initially teaching recitation courses. With each individual excelling in this teaching position, each was given a heavier load teaching higher level courses. Tara was also given the opportunity to instruct preservice teachers. While in graduate school for her masters and Ph.D., Linda held jobs that were not associated with any types of graduate student funding. While working on her Ph.D., Linda held a second job in a graduate position to work with a rural math education program. In graduate school, Sara was the only person who involved herself in a non-math related activity by joining the ultimate Frisbee team where she would grow her social network.

Cindy was the only participant that did not discuss being involved in any sort of extracurricular activities throughout her collegiate experiences. She possessed extremely opposite views of the other four participants who were involved at their institutions.

“It takes too much time to get a Ph.D. in math. They [students] are working 60 hours a week at a minimum in math if they are going to be successful. It’s just enormously difficult and it takes a lot of time to master.” She continued saying, “When you’re a graduate student in math that’s all you’re doing. That is your whole world. People…interesting people who have hobbies don’t get Ph.D.’s. You are in that world and spending all that time in the math department.”

Cindy continued to express very strong opinions towards people who are involved with outside activities. Ironically enough, she mentioned being involved in sports as Sara was during graduate school saying,
“If it’s important to you to play ultimate frisbee regularly because you want to be on the team and you want to do some volunteer work, I just, it’s not my experience that those people go into academia at a tier 1 academic research school.”

**Mathematics outside of school.** Beyond the mathematics classroom and school-related activities, four of the five women were involved in mathematics outside of school. Tara could recall doing mathematics in a game-like format at home with her mom as a child. She also discussed an opportunity to participate in two summer math camps that left positive lasting impressions on her mathematical development. Cindy recalled doing mathematics outside of school while having a bad day in college. She found it soothing and comforting to work out algebraic type problems. As an elementary mathematics specialist, Marissa’s mom would do mathematics problems and discuss mathematical topics while at home with her. Lastly, Linda recalled having several encounters with mathematical concepts with life on the farm. She constantly attempted to make connections from material she was learning in class to what she was seeing on the farm.

**Similar interests.** A common theme among four of the five participants was a love for being outside when they were a child. Sara, Tara, Marissa, and Linda all discussed going outside and categorized themselves as “tomboys” growing up. Further, Sara, Marissa, and Linda made it a point to express that they loved animals.

A second common interest that emerged from three of the five participants was a love for reading as a child. Cindy, Marissa, and Linda all discussed how they loved to read and how their love for reading grew organically. Each remembered having books and reading material around the house and their other family members also reading quite often.
Views on Being a Successful Mathematician

In order to help address the research questions at hand, each participant was asked questions revolving around their beliefs about themselves being successful and about being a successful mathematician. Each of the five participants shared common themes in their responses to the two separate concepts.

I Am Successful. All five participants expressed that they feel they have been successful in their careers. Sara stated, “It would be hard to argue that I haven’t been successful with it.” Thinking about her personal definition of success, she described feelings of joy towards the teaching and doing of mathematics. Further, she believes she has put her best efforts in and out of the classroom positively impacting her students with positive teaching practices and engaging in active research. Likewise, when Tara and Marissa were asked if they regarded themselves as successful, both ladies did not hesitate to quickly answer, “yes”. Tara did not offer much explanation but Marissa described being successful as “fulfilling requirements and continuing to get better.” Cindy also considers herself successful as she has done much work that she is proud of and contributed to her field of study. Linda described herself as successful attributing her success to many of her character traits and never allowing any obstacles to defeat her.

“Success in respect to somebody in their career, is to feel happy and to feel fulfilled. Things are better off when they left them or when they found it. I definitely am happy. I definitely find a lot of fulfillment in what I do and I think for the most part all the projects and things I’ve done, things are better off when we finish a project than they were before we started.”

I Am Not a Mathematician. Tara was the only participant that confidently considered herself a mathematician and even took the description further to call herself a successful
statistician. Each of the other participants offered an explanation to describe having qualities of a mathematician but claimed they were not true mathematicians. When asked if she would consider herself a mathematician, Sara responded, “Yes, but more of a teacher mathematician. Like, I think of a heavy researcher but I’m definitely a teacher.” Sara discussed a clear divide between math educators who focus on teaching whereas mathematicians focus on mathematics research. Linda shared similar views initially identifying her role as a mathematics educator and not of a mathematician.

“I don’t know why. I guess because I don’t have that doctorate in mathematics that it’s one of those things that separates me from my colleagues upstairs. If I called myself a mathematician, I would be assuming to take on something that’s probably a part of their identity and wrapped up in some definition that I don’t have.”

Further discussing the world of academia and mathematics, she later tweaked her response asking if the applied form of mathematics could be included in the definition of a mathematician. “Most people don’t think of math education as an applied mathematics but if you will grant me that, then yes, I am a mathematician.”

Although Cindy is heavily engaged in mathematical research, she still does not consider herself to be a mathematician.

“I’m not what you would call a true mathematician. These are the people that eat, breathe, sleep mathematics. Who probably even read history of mathematics and read popular books about mathematics and they are just brilliant. I have always envied them because I’m really just more dilettantish. I don’t have that breadth or depth of interest. At the same time, while I have envied them that, I have not gone so far as to feeling
inadequate about it. To some sense because there’s no point. That’s just not who I am. That’s not how I was built like that.”

When thinking about her role, Marissa struggled to identify herself stating that she was neither a mathematician nor a mathematics educator. However, she does believe she is a successful mathematics professor. “I still sort of take on a dual role of knowing about a lot of math education research but not really being at the forefront of what’s going on.” She continued saying, “I don’t think I’ve contributed a large sized chunk of knowledge to the field. I think in my mind that’s what a successful mathematician would be.”
Chapter 6: Conclusions, Limitations, and Implications

The purpose of this chapter is to provide the reader with a final overview of this dissertation study along with the rationale and the guiding research questions for the study. The conclusion aims to provide a brief summary of the study’s findings categorized by the leading research question. This summary is followed by the limitations of the study. Lastly, I provide implications for future research where I pose possible questions for future research studies and courses of actions.

Rationale

Aware that being a female in the mathematics field makes me a minority, I have a personal interest in better understanding what experiences and attributes make female individuals successful. Recognizing the intersectionality of several personal attributes such as my race, status as a first-generation college graduate, and economic class, I am interested in observing the similarities between myself and other females in mathematics. Committed to the field of education, one of my primary objectives has been on providing equitable opportunities for all students in the mathematics classroom. Further, as a feminist researcher, I aim to push the status-quo and belief that female students cannot be successful in the mathematics classroom and within mathematics fields. Thus, this study was created to better understand the views, beliefs, and attitudes of those females currently in the mathematics field of work.

The purpose of this study was to understand what factors contribute to female success in mathematics while operating under a feminist theoretical framework. Unlike traditional and frequently used frameworks that place greater value on the man’s perspective, using a feminist theoretical lens acknowledges women’s perspectives and ways of knowing (Belenky et al., 1997). I worked under the theoretical assumption that gender is an organizing principle of
society that creates gender differences that particularly oppresses the female community. The

guiding research questions for this study were as follows:

1) What experiences or personal attributes do female mathematicians attribute their success to?

2) What are female mathematicians’ perceptions of mathematics and mathematics abilities and what role do these perceptions play in their success?

3) How do participants view themselves as mathematicians?

**Summary of Findings for Research Question One**

The first research question of my study is as follows:

1) What experiences or personal attributes do female mathematicians attribute their success to?

Upon analysis of the data gathered, I identified common themes regarding experiences and attributes among all five participants. Experiences participants discussed that contributed to their success as female mathematicians included: positive classroom environments, engaging in mathematics outside the classroom, overcoming challenges. Personal attributes participants described as supporting their success include their competitive nature, perseverance, and their personal views on what role their gender plays in their success.

**Experiences.** Each of the participants of this study had unique experiences inside and outside of the classroom that they attribute their success to. These experiences and their individual impacts are discussed in the following three sections.

**Positive Classroom Environments.** With more years spent in the mathematics classroom, students obtain the ability to judge their own competency and value in the subject area (Eccles, 1983). Each of the participants discussed how creating a classroom environment that reinforces and confirms positive behaviors will develop a willingness in students to engage in similar
activities in the future (Urdan & Schoenfelder, 2006). One interesting similarity between all five of the participants was their inability to recall early mathematical experiences that were positive. From a feminist perspective, this speaks volumes to the inequalities imposed on these participants since an early age. The lack of memorable early learning experiences leads directly to how these participants began to define mathematics for themselves and how they began to position themselves in a male-dominated field. However, when thinking about collegiate memories, each participant remembered at least one experience that propelled them towards their professional goals. Being in courses where participants could recall collaborating with peers and having approachable instructors that they could interact with, helped when facing challenges with the mathematics.

*Engaging in mathematics outside of school.* This study showed the significance of students having experiences outside of the mathematics classroom to positively shape their attitudes towards mathematics. This can be particularly helpful to female students who are not always afforded these opportunities in classrooms that intentionally make efforts towards tearing down gender constructs in mathematics. Evidence of this finding is seen from four of the five participants in this study who had formal and informal experiences with mathematics outside of school. While in graduate school, three participants, Sara, Tara, and Marissa, worked as teacher assistants (TA) teaching recitation sections for mathematics courses. Each participant discussed the positive impact this experience had on their development as a successful professor. Although not a TA, Linda had a similar experience working as a mathematics professor while completing her graduate degree. She was also given a position to work with a rural education program for preservice teachers which impacted the research interests she has today. Although not in a formal
position, Cindy engaged in much research with the professors in her department which laid the foundation for her continue to pursue her interests as a professional.

Personal experiences that the participants described as being impactful were being involved in mathematics clubs, attending mathematics conferences, and seeing the applications of mathematics used in the real world. Tara and Marissa discussed the positive impacts of being involved in a math club and Tara went on to also mention the impact two summer camps had on her success. Linda discussed the significant impact of an experience she had visiting an institution for an event revolving around females in mathematics. Through this experience, she could relate to other female mathematicians and finally understood that pursuing mathematics did not mean she had to sacrifice her interests. Sara and Cindy each described experiences at professional conferences and feeling as though they were out of place. While Sara felt not as mathematically grounded as those around her, Cindy noticed the lack of females in the field of mathematics. Both women used these experiences to propel them forward as they have continued in their career. More informally, Tara spoke of the memories she has with learning mathematics in a game-like format with her mother. These experiences growing up helped Tara develop a positive attitude toward learning. Marissa discussed memories of helping her mother prepare materials for various mathematics workshops and her mom doing different mathematics problems with her. Linda recalled seeing various applications of mathematics being used in her home life. She enjoyed the opportunities to make personal connections between what she was learning at school to what she was learning at home. These experiences helped Linda learn to make connections to material as she advanced in her mathematics career. Cindy recalled memories of doing mathematics and listening to classical music to relax and unwind while in
undergrad. Finding mathematics both soothing and comforting to her, helped develop a positive mindset towards mathematics which played a role in her perceptions during challenging times.

*Overcoming obstacles.* Each of the five participants attributed challenging experiences to their success. Although each participant had a different experience, they all discussed the important lessons they learned when pushing through obstacles and challenges that came their way. For both Tara and Cindy, being told they were not cut out for a Ph.D. in mathematics program, was both devastating and heartbreaking to hear. However, rather than choosing to accept the perception of others, each individual used this experience to push them academically and still obtained Ph.D. degrees. Sara found her mathematics classes to be conceptually difficult to grasp but allowed these experiences to teach her the quality of perseverance. Sara went on to discuss that individuals who end up being successful in mathematics are those that do not give up. This trait continues to be an asset to her even today as she continues to advance in her career. Similarly, Marissa described always being confident in her math abilities until her graduate experience. Facing classes that were much more rigorous and learning content that was unfamiliar to her, Marissa found herself frustrated. However, these experiences taught her the importance of remaining positive and relying on others for support. While trying to adjust to an urban lifestyle, Linda experienced several challenges in her graduate experience. Living in a large city, using public transportation, and being away from her family for the first time were only a few of the challenges she faced. For the first time, Linda was having difficulty with mathematics content and with navigating the resources available to her on a university campus. She also felt set apart from the female mathematicians at her graduate school in respect to the way she looked and dressed. However, she held onto her differences and used her unique perceptions to contribute in her classes and to the mathematics community. Today, she is able to
use her experiences to motivate other students from rural areas and inspire students to take advantage of opportunities even when they may not feel the most comfortable. Overcoming challenges appeared to be a strong factor for all the participants. Although unintentional, each of the participants made statements regarding their competitive nature to prove to individuals that they can overcome obstacles even when the odds are against them. Being willing to challenge the gender constructions made by society must be a trait one has in order to be successful as a female in mathematics.

**Personal Attributes.** Each of the participants discussed their personal traits and qualities that they believe have played a role in their success as a female mathematician. These attributes are discussed in the following sections.

**Competitive nature.** Four of the five participants discussed much of their success being attributed to their natural, competitive nature. The desire to either outperform somebody or outperform themselves motivated them each to excel in their academics and professional careers. One’s identity can be described as not only how one regards themselves but also “how an individual is recognized and looked upon by others (Grootenboer & Zevenbergen, 2008, p. 243)”. Several of the participants mentioned how they were even more motivated when they received attention for seeming like one of the smartest or highest achieving students in the class. These social comparisons can come naturally and for these participants, had a positive effect on their sense of self-efficacy, motivation, and engagement (Ryan & Patrick, 2001).

**Perseverance.** As mentioned in the previous section, all five participants exemplified characteristics related to perseverance when facing challenges. Although each participant’s experiences were unique, each faced their own sets of challenges to get where they are today. With a strong sense of positive self-efficacy, each participant was willing to put in effort to
overcome challenging situations and persist in the face of obstacles (Lent, Lopen, & Bieschke, 1991). Further, several participants expressed being able to embrace the difficult moments and view it as an opportunity to prove to themselves that they can overcome challenges. For each of the participants, their challenges did not stop at graduate school. Their challenges as a female mathematician continue today but with a strong sense of perseverance, these women continue to be successful in the field of mathematics and contribute to the mathematics community and classroom.

*Role of Gender.* Feminist researchers argue that there are many injustices imposed on females that are socially constructed. Further, there is a need for women’s lives and achievements to be honored and documented. As I gathered the stories of each participant, I was able to see from the outside the effects of gender on each participant. Interestingly, all five participants discussed that they did not allow their gender to play a role in their own perceptions of their abilities to succeed. Despite what the community says about females in mathematics, each participant knew that with strong work ethic and dedication, she would be able to be successful in her field of study. Even when participants were faced with gender discrimination, it was not an experience that defeated any of the participants. Each of the participants knows their personal attributes of hard work, dedication, and passion for mathematics and interacting with students has been the leading contributors to their success. Although these statements and findings align with their narratives, to state that their gender did not ever play a role would be an injustice to feminist research. It is clear that these participants do not fully recognize that their gender put them at a disadvantage compared to their male counterparts. However, several participants continually pointed to feelings of isolation as there was a lack of females around them. One participant even allowed this to deter her from pursing an additional STEM major.
Others continue to notice the lack of women as they continue to climb the “ladder of success” yet they do not feel their gender plays a role in their lives in respect to mathematics. This should raise concerns among the feminist research community and shows that we must make stronger efforts to raise awareness between what should be socially acceptable and unacceptable.

**Role of Parents, Teachers, Classroom Environment and Other Support Figures.** Beyond experiences and personal attributes were the importance of parents, teachers, and other support figures. Participants also went on to discuss the impact of the classroom environment on their success.

**Parents and Support Figures.** Parents and other support figures can provide positive encouragement so that females develop a positive mindset and see themselves as capable figures to successfully do mathematics (Froschl & Sprung, 2016). Each of the participants discussed the importance of having supportive parents who encourage their children to pursue subjects they are interested in. Several of the participants discussed that even as an educator they observed that there is a noticeable difference between students who have parents that motivate them versus those that do not. Each participant also discussed the role of teachers and the classroom environment.

Although each participant attributed their success to the factors of parents and teachers, their reasoning was different than what current literature states. Each of the participants narratives refuted the current literature in respect to parents and teachers having more confidence in the math abilities of males (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Further, no participant discussed feeling like an adult ever imposed ideas of being unable to do mathematics because of their gender going against ideas made in the literature (Schwartz & Hanson, 1993). Only one participant discussed her family encouraging her to pursue a stereotypically feminine
professional role but all participants did take notice of the large increase in female representation in the education aspects of their program areas. This awareness supports the ideas in current literature that state society has a tendency to motivate females towards academic and professional choices that it views as stereotypically feminine that include care taking roles such as nurse or elementary teacher (Schwartz & Hanson, 1993).

Several of the participants discussed the positive impact that having a social network can have on one’s experiences. Those with a strong, positive math identity believe that not only can they do mathematics but that they have a place in the math community and math classroom (Froschl & Sprung, 2016). Whether needing a break from school or needing to talk to somebody who could relate to the challenges of pursuing a mathematics degree, each participant found comfort in a friend at some point in their educational and professional career. Several participants even attributed their network of friends as motivation to continue through school. The participants of this study showed that through their social groups, both within and outside of the classroom, their performance was impacted due to the linked societal social expectations and norms (Oyserman, 2009). Participants discussed that having friends that cared about their academics as well as friends who were willing to overcome challenges in their education, positively impacted the participants own views on endurance. However, despite being able to find a social network, several participants also discussed the feeling of isolation at some point in their educational or professional career. With little women present in their mathematics departments, several participants discussed being unable to find their “tribe”. This notion supports the argument of many feminists who agree that gendered oppression is structured into society and often institutionalized through the way we speak and the gendered attitudes we
possess (Weedon, 1999). Thus, without other female representation, several of the participants faced an experience of gender inequality in their educational or professional career.

Similar to the literature, these findings support the idea that parents, teachers, friends and the classroom environment all play a role in influencing students to pursue mathematics (Eccles, Jacobs & Harold, 1990; Tiedemann, 2000; Langer-Osuna, 2017). Women are also heavily influenced by their perceptions of their own abilities. Further, these narratives support the idea that girls, influenced by negative gender stereotypes, are more likely to believe that they cannot be successful in mathematics (James, 2009). To help address the underrepresentation issues of females in STEM, some argue that differences are a result of socialization to mathematics while others believe in gender differences in terms of cognitive and innate abilities (Schwartz & Hanson, 1993). The participants of this study proved that their cognitive abilities were strong and their mathematical performance in the classroom was positive. However, the stories of each participant did support the understandings of leading feminist theorists that explain gender as a social construction of identities that go beyond biological differences. These social constructions influence how men and women’s behaviors are shaped in and outside of the mathematics classroom (Nagel, 2003).

**Summary of Findings for Research Question Two**

The second research question of my study is as follows:

1) What are female mathematicians’ perceptions of mathematics and mathematics abilities and what role do these perceptions play in their success?

**Perceptions of Mathematics.** Thinking about what mathematics meant to each participant, several described mathematics as a “puzzle.” For this reason, each participant tackled mathematics with a mindset that it was not going to be easy but with dedication and
perseverance, it was something they could be successful at. Each participant discussed the need for possessing strong, positive self-efficacy as individuals doing mathematics will face difficult tasks. Several participants made statements such as, “If it [math] was easy, it would be boring.” Each of the participants discussed how this type of mindset is important for students to possess as they go through their academic career in respect to mathematics. Participants discussed the ideas of math anxiety and how students bring negative, previous experiences with them to the mathematics classroom. Supporting the literature, negative misconceptions of mathematics has created strong anxieties towards the subject area (Bekdemir, 2012; Beilock, Gunderson, Ramirez & Levine, 2010). As individuals who have confidence in their math abilities and now working in academia, the participants do not hesitate to interact with students and work to positively shape a students’ math abilities as they know it can be a subject that frightens and induces anxiety (Grootenboer & Zevenbergen, 2008).

Several of the participants discussed their perception that mathematics, particularly in respect to academia, does not always lend itself well to an individual who desires to advance in their career while also growing a family at home. The feminist framework accepts the belief that for many families, gender stereotypes and inequalities still exist within the household and feminists question such concepts as, “Why is the woman automatically considered the caregiver of children in the family?” (Donovan, 2012). Feminist theorists who argue issues of gender inequality are generally not seeking any type of special privileges for women but instead simply want to see that everyone receive equal consideration without gender discrimination (Bartels, Carnes, Kaatz & Kolehmainen, 2015; Prentice & Carranza, 2002). Families must try to find ways to divide up domestic duties more evenly between the two spouses. Each of the participants discussed that having a spouse and children creates an issue of finding work-life balance.
Further, not belonging to a mathematics department that creates a supportive culture by increasing resources to help reduce work related stress that tends to spill over into non-work related roles can also have negative effects on women in academia (Premeaux, Adkins, & Mossholder, 2007). Like many feminist theorists, several of the participants are attentive to the power and gender inequities within academia when it comes to receiving tenure (Riley, 1999). Needing to take time away from work after pregnancy can also impact obtainment of tenure which adds on additional stress. One participant in particular discussed having to file paperwork with her institution just to verify that she did not want her role as a mother to stop the tenure clock.

Upon collecting the narratives of each participant and being attentive to body language, it appeared that participants did not feel as comfortable talking about raising a family in respect to their careers. Many feminists describe the patriarchy system as one where it is a man’s job to lead and a woman’s role to follow (Ruiz, 2005). This is also true in the household where the woman typically takes on the role of caregiver. This was evident when participants discussed their roles as mothers. As a feminist researcher, I felt that several participants were hesitant or felt embarrassed to discuss the heavy duties of motherhood. It seemed as if any negative statements regarding the vast amount of responsibilities of being a mother were stated carefully as to protect their reputation as a woman. One participant even requested that her statements towards being a wife and mother not be included in the study. This clearly raises concerns of gender equality as women feel they must carry this weight of caregiver with joy at all times. Participants seem to believe that identifying it as a burden in any way appears to reflect negatively on one’s characters.
Several participants perceive mathematics as an important skill that transfers to other aspects of life. Sara even went on to discuss the transferrable skills that are developed through mathematics such as problem solving skills, critical thinking skills, strong communication skills, and learning to pay attention to detail. She makes it an effort to help her students recognize these skills and teaches students how to sell their strengths from the mathematics classroom in order to make themselves more marketable for professional opportunities. Despite her teachers and instructors not making real-world connections to mathematics, Linda was able to naturally do this as she saw mathematics being used on the farm. Quickly, she began to see that although one could accomplish tasks in life without mathematics, using mathematical skills and concepts could help one be more efficient and reach optimal solutions.

When thinking about their perceptions of mathematics, each participant used various adjectives. Cindy describe the subject of mathematics as one that is beautiful and that brings her peace and tranquility. Sara took time to reflect as she expressed mathematics was something that evokes a lot of emotion out of her. Unable to categorize her thoughts and express herself clearly, she then proceeded to say, “It’s like trying to say what does earth mean to you?” For Marissa, mathematics is a subject that requires deep thought about unanswered questions. Tara had similar views when she discussed mathematical research. For Tara, using mathematics is a way to tell a story as she analyzes data in her research. Linda described mathematics and the work she does within mathematics as something she is able to emotionally connect with. It is an avenue that she can use to evoke change.

**Role Perceptions Played in Their Success.** All five participants expressed that they feel they have been successful in their careers. Each participant discussed that making a difference, contributing to their mathematical community, and doing something they love are all reasons
they identify themselves as being successful. Further, participants discussed that the opportunity to impact and motivate students to conceptually learn mathematics and see it as a subject relatable to their everyday lives is something to be proud of. Accepting the notion that mathematics is something necessary for life, each participant has used this perception to continue to learn and grow within mathematics. Further, as individuals in academia, participants are able to introduce mathematics in real-world contexts to help students become passionate about the subject. Marissa discussed that she finds mathematics relatable and when making connections, students are much more likely to be successful. Linda recalled making personal connections from her high school precalculus course to what she was seeing on the farm and attributes much of her success to these connections.

One’s perceptions of mathematics along with their desire to pursue mathematics work shows a strong positive correlation and cannot be considered as mutually exclusive (Black et al., 2010). To understand one’s mathematical identity, studying their commitment and engagement to mathematics can help give insight as to how valued it is (Froschl & Sprung, 2016). Based on the narratives of each participant, there was no question that each individual was committed to the field of mathematics. Perceiving mathematics as a challenging subject and knowing the obstacles they had overcome, all five participants made comments to the effect of, “How could I not call myself successful?” Thus, by stating that they all felt successful within mathematics proved that each has a strong, positive mathematical identity. It is unclear if the participants, like society, only attribute their mathematical success as women to hard work and efforts rather than to talent and ability (Piatek-Jimanez, 2008). However, the narratives do show that overcoming obstacles does play a role in one’s perception of their mathematical abilities.
Summary of Findings for Research Question Three

The third research question of my study is as follows:

3) How do participants view themselves as mathematicians?

With each participant being selected based on their qualifications described in the methods section of this paper, the researcher was surprised to hear that four of the five participants did not confidently identify themselves as mathematicians. Although each participant had their own reasons for not identifying themselves as a mathematician, the main idea of their arguments was their lack of intense, mathematical research. Participants who held their teaching to higher importance seemed to not believe that was a quality of a true mathematician. Further, participants explained clear divides in their perceptions of mathematicians versus mathematics educators stating that the goals and focus of each professional differs.

For Tara, she did not hesitate to quickly address her views as being a mathematician. Considering all the hard work and effort that she put in to obtaining her degrees, she knows she is a statistician. However, as an individual who obtained a Ph.D. in mathematics education, she understands that others may view her differently due to the title of her degree. For this reason, despite her personal views, she feels that she has a lot to prove to colleagues who only know her credentials. Tara expressed frustration when speaking about people in the field who do not have the same level of respect for individuals with a mathematics education degree versus pure mathematics degree.

For the other participants, their statements on being a mathematician varied but some expressed similar views with Tara regarding the perceptions others have of those who hold a Ph.D. in a pure mathematics field versus those who hold a Ph.D. in a mathematics education
field. Cindy, despite feeling like a mathematician, did not want to define herself as a “true mathematician” which she described as somebody who allows mathematics to consume their interests. She went on to discuss how mathematicians are brilliant and extremely diligent to contribute to the mathematical community. Other participants supported this idea of mathematicians needing to contribute innovative, mathematical research to the mathematics community. Participants discussed that if a person claims to be a mathematician, they must be on the forefront of relevant concerns within the mathematics community.

Unrelated to their gender, a social comparison of job responsibilities and an evident view of the hierarchy of responsibilities, each participant compared themselves socially to others in their field which proved to have a negative impact on their beliefs and identification as a mathematician (Wigfield & Wagner, 2005). A common deterring factor for pursuing mathematics is the idea that it is difficult, lacking emotion, theoretical in nature, not relevant, and more relatable to those with masculine interests (Ernest, 2006). Although all of these characteristics were not mentioned, several of the participants did discuss that they identify with being a mathematics educator as it is relevant to the practical implementation of teaching others how to do mathematics. The field of mathematics education is perceived to provide appropriate mathematical knowledge, understanding, and skills to a classroom of diverse students (Bass, 1997). Thinking about the ideas of mathematics, Linda even described herself as a mathematician only if she could define mathematician by someone engaging in applied mathematics.

Participants went on to discuss how as a mathematics professor, their understanding of mathematics must go beyond being able to understand for themselves and instead communicate mathematical ideas at a level of understanding for students. Participants feel these are not the
concerns of a mathematician whose main concern is to conduct mathematical research and explain their findings to expert colleagues who already possess mathematical understanding.

As Becher and Trowler (2001) noted, “being a member of a disciplinary community involves a sense of identity,” (p. 47). Identity is defined as, “…an overall sense of who one is. It is a broader construct than other self-system components, inclusive of self-concept and self-esteem (Wigfield & Wagner, 2005). The way a person identifies themselves and how one feels they are recognized and looked upon by others will shape a person’s identity (Grootenboer, Smith, & Lowrie, 2006). Further, the beliefs, attitudes, and emotions in conjunction with their motivation and approach to learn math makes up their mathematical identity (Froschl & Sprung, 2016). From the findings of this study, it is evident that participants do not fully identify with the community they practice within. Further, several participants discussed the need to defend their academic background as their degrees, particularly mathematics education degrees, may not always be respected by others in the mathematics field. These life experiences impact individuals and cause their identity to constantly change in terms of their past, current, and future state (Oyserman, 2009).

Limitations of the Study

Despite the thorough design of the study, strong use of qualitative methods, and analysis that considers trustworthiness and credibility, there are still limitations. These limitations are described in the following three sections.

Length of time. This study was conducted as part of the completion of a doctoral program, time limitations were a factor. The use of a longitudinal study would allow the researcher to have a much stronger and more coherent understanding of the participants’ experiences. A longitudinal study would also provide the researcher an opportunity to see how
the participants continued to be affected by experiences and how these would impact their perceptions even as an established, working STEM professional. Changes can be easily evaluated in a longitudinal study as cause and effect relationships can be discovered (Cohen, Manion, & Morrison, 2017).

**Manual approaches.** All analysis approaches for this study were done manually. There was no sound reason for this decision other than the researcher preferred to write out all the data. Being a narrative study, the researcher felt more connected to the stories when writing them out manually. The use of manual methods also allowed the researcher to devise a method with post-it notes that made organizing the data easier. In addition, writing out information helped the researcher to internalize themes and develop codes. However, the researcher also acknowledges that the coding process could have been impacted if some form of coding technology had been used such as NVIVO or Atlas.ti. It is possible that with such deep and rich interviews, the researcher failed to identify all codes and similarities between participants.

**Sample size.** The analysis provided is only a representation of five females in the field of mathematics and should be generalized on a larger scale with caution. The researcher acknowledges that each of the participants’ stories are subjective, personal, and emotional. Thus, it is possible that the addition of more participants would have offered more diverse experiences and findings. Although 80 female mathematicians in the state were contacted, it is a possibility that individuals may have been overlooked if they did not appear on the college’s website. Further, the lack of response from most of the female mathematicians contacted also raises some concerns. It is possible that individuals chose to not respond to the email due to their lack of interest in the study. It is also possible that individuals felt an emotional connection to the study and did not want to discuss topics related to gender discrimination or inequality. The researcher
also acknowledges that due to the nature of email communication, it is very likely that individuals deleted the recruitment email before reading it simply due to a lack of interest or time to be involved in an additional obligation.

**Familiarity with the participants.** Prior to this study, participants and the researcher did not know have any previous encounters. For this reason, it is possible that the stories participants revealed were censored. Participants are much more likely to be open in an interview where they feel comfortable and have spent time with the interviewer. Being able to get to know another and their work as well as develop a closer relationship can result in participants revealing additional information about their experiences (Sanjari et al., 2014).

**Retelling stories.** As a study with a narrative research design, the researcher made conclusions based on data collected through communication in a variety of forms. These varying stories were then connected and experiences were weaved together among the participants. The researcher’s aim has been to connect and weave together experiences and events among various participants to expose any similar themes (Woodiwiss, Smith, & Lockwood, 2017). Thus, it is possible that the researcher has pieced together stories and in doing so, may have left out or emphasized particular aspects.

**Censored stories.** Once all narratives had been written, the researcher shared them with all the participants asking that each look over their respective narrative. Each participant was asked to ensure that the researcher had interpreted their stories correctly and that no information was included that the participant did not want to share. Participants were given the opportunity to delete, alter, and change anything that had been written regarding their personal narrative. The researcher acknowledges that participants altered their narratives to reflect themselves in a positive light. Several participants deleted direct quotes that did not represent positive situations
and experiences. This serves as a limitation to the study as original quotes offered insight on new findings for female professional experiences in collegiate mathematics but could not be included out of respect to the participants of the study.

**Implications for Future Research**

As outlined within the literature review section of this paper, literature discusses the role of parents, teachers, classroom environment, as well as the role of personal perceptions of one’s abilities as all important factors on one’s mathematical success. Although each of these participants discussed similar characteristics, several of the findings of this study refuted current literature that discusses exactly how these factors and characteristics either motivate or discourage females from pursuing STEM fields, particularly mathematics. With factors in both formal and informal educational settings playing a role in female interests and decisions to engage in mathematics, we must continue to investigate the knowledge we have gained through a feminist lens to positively transform their lives and ride of gender inequalities in mathematics. For this reason, the researcher encourages the research community to spend more time engaging in mathematical research revolving around the issues of females pursuing STEM in order to offer relevant literature to the research community. Further, by conducting new research, fresh perspectives related to the issues females are currently facing today will help to better address the issue.

**Implications for Parents.** The researcher proposes that new research is conducted regarding the impact of a supportive family on a female pursuing mathematics. This study refuted current literature which states that parents tend to incorporate gender-related stereotypes in the home (Eccles, Jacobs & Harold, 1990). Further, this study refuted the idea that parents often direct their daughters’ interest toward non-math related activities (Schwartz & Hanson,
Each of the participants discussed that having a supportive family played an integral role in their success. Further, several of the participants discussed that due to their supportive family, they were encouraged to participate in math related activities outside of the classroom. Evidence of these findings can be seen from one participant in particular who discussed doing mathematics with her mother in a game-like format while another participant discussed seeing real-world applications of mathematics in her home life. Some of the participants discussed being supported by their families to attend special workshops, conferences, and classes that allowed for growth related to mathematical knowledge outside of the classroom. This poses an important question for future research:

1. What types of mathematical activities outside of the classroom have an impact on the persistence and success of a female student pursuing a mathematics degree? What role do these activities play in students’ persistence?

2. In what ways can parents positively contribute to the development of their child’s interest in and knowledge of mathematics?

Implications for Institutions and Mathematics Departments. Prior to conducting this study, the researcher had not considered the uniqueness of the types of schools that the participants attended. Instead, the researcher anticipated findings only related to where the participants work. However, this study showed similarities in the types of institutions each participant attended. Three participants went to liberal arts universities for undergrad, one went to a woman’s college, and one went to a research university. All five participants went to public, research institutions for graduate school. Four of the participants that discussed a love for teaching currently work at a liberal arts institution while the participant that discussed a love for research chose a job at a R1 research institution. This brings about some interesting connections
when looking at what each participant enjoys as a professional. There are parallel similarities between the individuals that went to small, liberal arts schools and those that highly regard their teaching as the most important aspect of their job. There are also noticeable connections to those who love teaching to those who held a teacher assistant position in graduate school. The majority of the decisions for selecting a school at all levels were based on location. Further, all five of the participants discussed that none of their decisions for the schools they attended were based on the reputation of the department. In fact, all participants expressed having little or no knowledge about the department prior to entering their respective program. Through a feminist lens, the researcher assumes that the lack of knowledge regarding mathematics departments is related to the lack of resources and opportunities provided to female students to investigate STEM fields and degrees prior to going to college. With gendered oppression attitudes and behaviors pushing women towards non-STEM related majors and careers, females do not take the time to research and consider being a part of these departments. These findings raise some interesting questions for future research:

1. When making a choice about an university students will attend, what factors or characteristics do they consider? Do these factors or characteristics vary depending upon the degree objective of the student?

2. What influential marketing efforts and strategies can institutions implement to increase the number of female student applicants to the mathematics department?

Several of the participants discussed going to college without the intentions of majoring in a mathematics related field. Although mathematics was a subject they always enjoyed, several of the participants discussed not having an understanding of how a mathematics degree could be utilized as a professional. These findings support current literature that discuss mathematics
being viewed as something not relatable for female students (Linn & Hyde, 2009). Becoming complacent solving word problems revolving mainly around measurement, sports and science, female mathematics students are further encouraged to believe that math is not relatable (McClure, 2000). Thus, female students are continually entering the mathematics classroom and see no purpose in their learning of the material (Kitchen, 2016). In addition to not knowing how to use a mathematics degree, participants recalled having little memory of mathematics growing up because even then, mathematics was not made relatable to one’s daily concerns and routines (Young-Loveridge et al., 2005). These findings pose possible research questions for future studies:

1. In what ways can mathematics departments effectively expose students to professional opportunities within mathematics?

2. What impact does bringing practitioners in a mathematics or related field from the community serve to addressing issues revolving around how to use a mathematics degree?

3. What perceptions do female mathematicians have towards the job opportunities available to them and what role does their gender play in these opportunities?

4. What efforts can departments and teachers in the mathematics classroom do to help students feel that math is a relatable subject?

In the undergraduate and graduate experiences, participants expressed that their departmental culture made them feel like academia was the only option for individuals obtaining a mathematics degree if they wanted to be considered successful within the field. Some participants even noted significant gender differences among their mathematics classes designed for pre-educators versus their mathematics classes for non-educators. From a feminist
perspective, this only supports the idea that gender organizes society in a way that sets preferences for gender specific types of work and appropriate social roles. In addition to these concerns, each participant expressed feelings of being underprepared for their doctoral program because their previous programs were preparing them for academia. Several participants felt that their courses had not been rigorous enough for a student going to get a doctoral degree in mathematics and that understanding how to conduct research was not an expectation of graduate from programs prior to the Ph.D. level. Several participants discussed the transferrable skills that mathematics offers and that more students would likely pursue mathematics if they knew academia was not the only option. Further, participants expressed distaste for feeling like the mathematics community looks down upon those who do not pursue academia and conduct research. This raises concerns for mathematics departments in how they interact with their students and how they prepare their students for the workforce. These findings raise some research questions for future research studies:

1. In what ways can mathematics departments better support students who do not plan to pursue academia?

2. What resources and experiences inside and outside of the mathematics classroom, can mathematics departments provide to better support students entering the nonacademic workforce?

3. What characteristics and requirements should an undergraduate and graduate program have in order to prepare students for a doctoral program? Are there specific courses concentrating on certain topics that should be offered that would better prepare students for doctoral programs?
Female student interest and desire to pursue STEM courses at the college level, particularly in mathematics, as well as the retention of females in STEM-related careers remains to be significantly lower than their male counterparts (NSF, 2011). As a researcher adopting a feminist researcher’s perspective, it is believed that scientific research is deeply gender-biased. Therefore, this study has made the experiences of women the central focal point in this study (Crawford & Marecek, 1989). With a qualitative methods design, extensive interviews, personal photos, and artifacts were all used to further examine the impact of personal experiences and perceived qualities in one’s desire to pursue mathematics. All data has been analyzed through a feminist theoretical lens with the understanding that women are at a disadvantage and are often denied opportunities that are given to their male counterparts (Rosser, 2007). This study brought light to gender differences in society and raised questions regarding the best ways to move forward in the fight for women’s liberation in the field of mathematics. Further, this study has explored the perceptions of female mathematics faculty members and the skills and abilities they perceive as integral for developing into a successful female mathematician. It is the hope of the researcher that this study has contributed to the mathematics community in a positive way by identifying ways to encourage female persistence in mathematics.
REFERENCES


Maranto, C. L., & Griffin, A. E. (2011). The antecedents of a ‘chilly climate’ for women faculty in higher education. *Human relations, 64*(2), 139-159


Prentice, D. A., & Carranza, E. (2002). What women and men should be, shouldn't be, are allowed to be, and don't have to be: The contents of prescriptive gender stereotypes. *Psychology of women quarterly, 26*(4), 269-281.


APPENDICES
PROPOSAL APPENDIX A: RECRUITMENT LETTER

Hello,

My name is Angelina Knies and I am a current Ph.D student at North Carolina State University. I am writing to request your participation in a study. The purpose of this study is to better understand what experiences or personal attributes female mathematicians attribute their success to.

If you agree to participate as one of the instructors for this study, I will ask for you to meet with me for three separate one-hour interviews and ask that you bring personal photos that you feel document your experience towards becoming a mathematician. The interviews will be audio-recorded and notes will be taken while you are speaking. I will not obtain any copies of the photos you bring to the interview. All data collected will be kept confidential. No reference will be made in oral or written reports which could link you to the study. Your participation in this study will not affect your employment status in any manner.

I greatly appreciate your assistance in making this research study possible. If you have any questions related to the study, please feel free to contact me via email at ayknies@Ncsu.edu.

Sincerely,

Angelina Knies
PROPOSAL APPENDIX B: INTERVIEW PROTOCOL
Adapted from Flowers & Hancock, 2003

Date:
Location:
Interviewee Pseudonym:
Time Interview Began: Time Interview Ended:

Introductory Protocol:

To facilitate my note-taking, I would like to audio-record our conversation today. For your information, only the researcher and advising chair at North Carolina State University will have access to the tapes. After the tapes are transcribed, they will be destroyed. A pseudonym will be used on the transcription and your real identity will not be tied to it. I would like to ask that you sign a form devised to meet the human subject requirements. Essentially, this documents states that: 1) all information will be held confidential, 2) your participation is voluntary and you may stop at any time if you feel uncomfortable and 3) your understanding that I do not intend to inflict any physical, mental or emotional harm. Thank you for agreeing to participate.

This interview is planned to last no longer than one hour. During this time, I will ask you several questions. Please feel free to expand on the questions as much as you would like. Rich, detailed information would be very helpful for me. If time begins to run short, I will leave the remaining questions for our second scheduled interview.

Greeting:
Thank you for volunteering to participate in this research study. You have been selected to speak with me today because you have been identified as a female mathematics instructor who has a great deal to share about teaching, learning and being a successful female mathematician. This research project focuses on females in mathematics and what experiences and personal attributes one attributes their success to. Further, this study hopes to understand what perceptions female mathematics have about mathematics and their mathematical abilities and what role these perceptions play in their success.

Initial Interview Questions:
(Getting to Know the Participants Background)
1) How long have you been in your present position? How long have you been at this institution? Why did you choose to accept a position at this institution?

2) What is the focus of your research?

3) What classes do you typically teach?

(Learning the Participants Personal Story)
4) Think back to when you were a child. What were your interests and hobbies?
5) What factors do you feel influenced your interests or hobbies that you chose to be a part of?

6) How did your interests evolve over time? What do you feel impacted those changes as you got older?

7) What were your perceptions of math growing up? How do these perceptions compare to the one’s you possess now?

8) What are your perceptions regarding your mathematical abilities? How have these changed over time?

9) If you had to tell somebody what math means to you, what would you say? How do you think your description would have looked ten years ago?

10) Think back from the beginning of your career until now. What do you think has been the most and least influential factors in your life that have propelled your interest and desire to pursue mathematics?

11) Do you have any photos that you would like to share and describe? Do you have any other comments you would like to make or topics that you would like to discuss?

FINAL REFLECTION COMMENTS:

Second Interview Questions:
(Perceptions of Their Role)
1) Briefly describe your role in the classroom as it relates to student learning. How would you describe yourself as a teacher of mathematics?

2) Briefly describe your role as a researcher of mathematics. How would you describe your work in this role?

3) Briefly describe your role as a member of your department. How would you describe your role as a faculty member in this department?

(Understanding the Impact of Outside Influences)
4) Have you had any role models that have guided you through your career to becoming a mathematics professional? Please describe.
5) In detail, explain any struggles or difficulties you faced as a child, while in college or while trying to obtain the position you are in now.

(Understanding the Impact of Gender on Personal Perceptions)
6) Do you feel that you represent a minority population in mathematics? Explain why or why not.

7) How do you feel your gender has impacted the experiences you have had since a young child to your present age?

8) How do you feel your gender has impacted your professional experiences?

9) In what ways were you recognized for being a female pursuing mathematics?

10) What are your current views on females in mathematics? Please explain in detail.

(Understanding What Defines Success)
11) How would you define a strong, successful mathematics student?

12) What characteristics do you believe influence a female student to persist in mathematics courses, majors and fields?

13) In what ways do you help motivate students to persist in mathematics or STEM in general? Does this look differently for female versus male students?

14) What qualities do you look for in a student that help you identify them as somebody that could have success in mathematics?

15) Do you feel that gender plays a role in female student persistence in STEM? Explain why or why not.

16) Do you feel that having a role model of the same race and gender is important in mathematics? Why or why not?

17) What impact do you think parents or other family members have on students’ success in class?

18) Do you have any photos that you would like to share and describe? Do you have any other comments you would like to make or topics that you would like to discuss?

FINAL REFLECTION COMMENTS:
Third Interview Questions:

1) Describe the very first encounter you had with math in your life (that you can remember). What were you learning? Who was with you? What environment were you in? What emotions were you facing?

2) Describe how this statement makes you feel and whether you agree or disagree with the statement: “I make excellent grades on math tests”.

3) Describe what you feel motivated you to do well in school. What helped you perform well in your math classes?

4) Describe how this statement makes you feel and whether you agree or disagree with the statement: “I have always been successful with mathematics. It is a subject that comes easy to me.”

5) Describe what you feel motivated you to pursue a career in mathematics. Were there any particular experiences or interactions that inspired you?

6) Describe how you feel others perceive your math abilities. Think about this from the context of your colleagues, your previous instructors, your family, and your friends.

7) Describe in detail your feelings towards the statement, “Math is not something that comes naturally to me.”

8) Describe in detail what you believe your students feel regarding the subject of math?

9) Describe the quality that you feel you possess(ed) that allows you to be a successful mathematician.

10) Describe any challenges you have faced towards becoming a successful mathematician. Why do you think you were faced with these challenges? How did you overcome them?

11) Do you have any photos that you would like to share and describe? Do you have any other comments you would like to make or topics that you would like to discuss?

FINAL REFLECTION COMMENTS:
PROPOSAL APPENDIX C: VISUAL DISPLAY OF INTERVIEW ANALYSIS

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