WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) FIELDS: MENTORING PATHWAYS DURING THE PH.D.

A Dissertation

by

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ABSTRACT

Women make up a little over half of higher education enrollment in the United States and earn more college and graduate degrees than men earn. However, the gender gap in science education at all academic levels persists. This is especially true in high-end, math-intensive fields such as engineering and statistics. Research suggests that a contributing factor to the departure of women pursing degrees in science, technology, engineering, and mathematics (STEM) is due to a lack of preparation and mentoring. Research surrounding graduate student success focuses on graduate student attrition; why students leave instead of why they stay. Graduate socialization models as well as graduate persistence models suggest that mentoring is a key factor in persistence. While some research exists related to graduate student mentoring, little is known about the factors of mentoring that contribute to graduate student success.

The purpose of this qualitative case study was to examine the role that mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization. Twelve domestic female doctoral students at a Doctoral University – Very high research were interviewed. All women were in at least their third year of their doctoral program and identified as enrolled in a STEM discipline based on National Science Foundation (NSF) definitions. Data were analyzed using the constant comparative method.

Findings suggest that early preparation for doctoral graduate school matters and typically comes in the form of mentorship from faculty at the undergraduate or master's level. Additionally, participants often expressed disconnect between a desired connection

to and support from their graduate faculty advisor compared to their experiences of technical training and academic guidance. For all participants a noted investment in oneself translated to a determination and focus that can be described as grit. In addition, participants indicated that while mentorship came from both male and female faculty, female faculty role models were essential to their ability to see themselves in a successful STEM career post degree. Implications for department and discipline onboarding as well as the support of graduate students are discussed. Additional research focused on graduate student grit and perseverance is recommended.

DEDICATION

Soli Deo Gloria.

To Mom and Dad: Thank you for believing in me, encouraging me in all things, and teaching me that there is no sacrifice too small for the value of one's education.

To my wonderful husband, Cameron: This document is a testament to your strength, your belief in me, and the innumerable sacrifices made to help me fulfill my dream.

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CHAPTER I

INTRODUCTION

In 2016, The World Economic Forum named the 10 biggest global challenges facing humanity and called for action from corporations and people in both the public and private sectors (Hutt, 2016). Food security, inclusive economic growth, world of evolving work/trade, climate change, global finance, digital innovation and the internet, gender parity, international trade and investment, long-term investing, and healthcare were identified by The World Economic Forum as the focused crises of this century. What is striking about this list is that they are interrelated issues of agriculture, job training, financial stability, and the political, social, and economic impacts of a diversified workforce, that all have to unite to change the way the world operates, hopefully making it better. Central to this change is innovation, research, and new approaches to complex problems, such as the persistent problems related to women in STEM fields.

As this chapter will discuss, decades of research have asserted that growing and diversifying the STEM workforce is imperative to tackling 21st century challenges (Del Giudice, 2014; Hutt, 2016; UN Women, 2017). Yet, evidence suggests that the United States continues to falter in the recruitment, training/education, and retention of women and other minorities in Science, Technology, Engineering and Mathematics (STEM) fields (Blickenstaff, 2005; Ceci et al. 2014; Clewell, Darke, & Tartere, 2000; Corbett, & Hill, 2015; De Welde, & Laursen, 2011). Hill, Corbett, and Rose (2010) conducted a study for the American Association of University Women that focused on the reasons there were so few women in STEM. In their study, the researchers found that small changes to

departmental culture can provide integration and retention of female students and faculty. They note that "the foundation for a STEM career is laid early in life, but scientists and engineers are made in colleges and universities" (p. xv). Hill et al. goes on to assert that the implementation of mentoring programs, along with effective work-life policies assisted in the recruitment and retention of female graduate students and junior faculty. Given this information, the purpose of this study was to examine the role that mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization.

Globalization, digital innovation, and climate change, are a few of the factors the UN Women (2017) cited as continuing influences that are changing the world we live in and the people that inhabit it. These factors and many others pose both challenges and opportunities to realizing the need for a more integrated and diversified workforce that can expand research focused on the complex technological challenges present in today's society. The 2019 International Day of Women and Girls in Science used the theme of "inclusive green growth" in line with the United Nations 2030 Agenda for Sustainable Development. It is a particularly relevant topic given the increased focus on new technologies and the way science and engineering are shaping our world. The United Nations 2030 Agenda is a commitment to eradicate poverty and achieve sustainable development by 2030 world-wide, ensuring that no one is left behind (United Nations, 2015). This agenda will require problem solving, improvement, and research to answer the challenge.

Closer to home, the National Science Foundation, the American Association of University Women, and the United States White House have cited the importance of increasing the diversity numbers in STEM as a way to bring the best minds and our

greatest talent to help drive innovation and problem solving of complex problems forward. In 2009, President Barack Obama created the White House Council on Women and Girls by executive order. Through this Council, the President's Educate to Innovate campaign evolved, focusing on the importance of expanding access to STEM education among women and other underrepresented groups (Educate to Innovate, 2009). In expressing why integration of equal proportions of women and minorities is important to STEM and to the innovation of the United States, President Obama stated "Half our team, we're not even putting on the field. We've got to change those numbers" (Corbett & Hill, 2015, p. ix).

The National Science Foundation is advised and guided by a number of committees and directorates that help provide data, analysis, and recommendations on STEM activities across diverse STEM fields, diverse populations of scientists, through educational STEM pathways (pipelines), and funding. The Committee on Equal Opportunities in Science and Engineering (CEOSE, 2003) provides a biennial report that address the advancement, or lack thereof, of women, underrepresented minorities, and persons with disabilities. In the committee's lengthy review of a decennial block of data, from 1994 to 2003, the committee identified a significant gap in recruitment, persistence, and incorporation of all underrepresented populations.

> The global and local challenges of the technological world of today reverberate with a call – a call for the best minds to work together to advance and apply science, technology, engineering, and mathematics (STEM) – enabling us to understand and deal with growing complexity. This call also inspires possibilities, as people with diverse ways of working, thinking, and learning engage in challenging, fulfilling, and exciting work in STEM areas. For the United States, it

> means that continuing technological leadership depends on the healthy development of the science and engineering talent of *all* its citizens. (Committee on Equal Opportunities in Science and Engineering, 2004, p. i)

From the 2004 decennial report, through the 2011-2012 biennial report, The Committee on Equal Opportunities in Science and Engineering identified the key factors needed for a systematic pathway between K-12 education and higher education: an importance for mentorship through academic and workforce programs and institutional transformations. Up until about 2012, the United States government, the National Science Foundation, and the National Institutes of Health reported that key interventions designed to support girls and women should exist along the pre-college and undergraduate connections to STEM education. In the 2013-2014 CEOSE report, the committee noted that significant gains in recruitment and retention of women had been made within the pre-college, undergraduate, and graduate continuum of STEM education. Of note, however, is the lack of growth of both enrollment and completion for women in engineering, mathematics, computer sciences, and physical sciences, also identified as the hard math sciences (CEOSE, 2015).

Much of the literature about women in STEM focuses on the factors that led to departure from the STEM pipeline. Understanding how and why some women persist in their pursuit of STEM education could be a key element in understanding how to enhance and broaden women's pathways into advanced STEM education, research, and careers. As noted by CEOSE's 2011-2012 biennial report, connecting persistence to the key factors of mentorship, institutional and/or departmental transformations – particularly around climate, and other elements not yet fleshed out – could aid universities and the STEM

research communities in fostering diverse environments ability to engage in and solve the global challenges of our time.

Background

Higher education is a complex system designed to account for learning, research, and service of both its faculty and students. For more than 375 years, American institutions of higher education have been creating, evolving, and transforming into unique places of learning. In this section, a brief review of the evolution of doctoral education, the emergence and expansion of STEM education as a field of study, and the role of female diversification within higher-education will be presented. The intent of the background section is to lay the foundation for the importance of continued research around women in STEM and particularly doctoral women in STEM. What follows is a brief discussion on doctoral education in the U.S. followed by a brief summary of Science, Technology, Engineering, and Mathematics (STEM) as a collective field of study. The section goes on to introduce the evolution of women in STEM and explain the persistent concern for enhancing the STEM pipeline for women.

Doctoral Education

For more than fifty years, scholars have studied the evolution of graduate education, the relationship between faculty and student, the academic rigors of doctoral education in the United States, and an expanse of topics stemming from the core definition of graduate education. In his brief overview of doctoral education in the United States, Walker (2008) stated:

> The last decade has seen a growing climate of change and reform with regard to Ph.D. programs in the USA. This affects the actual portfolio of the units that make

> up graduate program organizations….Naturally, doctoral education in the USA reflects the society in which it is embedded, in the sense that there is considerable independence and diversity in both the organization of graduate programs and the portfolio of the graduate schools that are nominally responsible for [doctoral] education in the nation's research universities. There are few or no official national standards that doctoral programs must meet – no centralized government organization that is responsible for credentialing or Ph.D. program review. (p. 35)

While Walker asserted that there are few national standards, it could be argued that regional accrediting agencies such as the Higher Learning Commission (HLC), the Southern Association of College and Schools Commission on Colleges (SACSCOC), and the WASC Senior College and University Commission (WSCUC) provide the standards and process for accrediting organizations that are consistent with the academic quality, improvement and accountability expectations of broader nationally recognized agencies. "In the United States, accrediting organizations are non-governmental organization that review and evaluate institutions or programs and render judgments about their accreditation status" (Council for Higher Education Accreditation, 2019). The Council for Higher Education Accreditation (CHEA) asserted that accreditation helps assure a neutral, external party has reviewed the quality of the education offered by an institution; is required for students to access federal financial aid; and provides notice to prospective employers that the educational programs meet accepted educational standards.

Additionally, many academic disciplines undergo discipline specific accreditation. These specialized or programmatic accreditations may be completed on units as large as a college or school within a university or as small as a curriculum within a discipline.

According to WASC Senior College and University Commission most specialized or programmatic accrediting agencies review units within an institution of higher education that is accredited by one of the regional accrediting commissions. Specialized accreditation exists in over 100 disciplines, each with their own standards, policies, and review procedures.

Fundamental to understanding doctoral programs in the United States is to recognize that these programs are loosely coupled with their institutions, connecting more centrally to their disciplines, departments, and colleges. The programs focus on the execution of research and creation of new knowledge as it relates to their fields of education. In this environment, the student-advisor relationship is crucial, but faculty reward structures place little to no emphasis on the "quality of graduate mentoring and graduate teaching" (Walker, 2008, p. 41).

The Council of Graduate Schools (CGS) conducted the Ph.D. Completion Project that tracked the ten-year completion rates for students beginning doctoral education. The study found that regardless of public or private status of the institution, and regardless of field of study, completion rates at year ten for doctoral students was 56% (CGS, 2008a, 2008b). It has been long reported that about 50% of students who start a doctoral program leave. Tinto (1993) presented similar data fifteen years before the CGS study, stating that best estimates indicated that upward of 50% of all beginning students fail to complete their doctoral degrees. Additionally, the National Science Foundation (NSF) data (2014, 2016[a]) indicated that degree completion shifts based on a doctoral student's field of study showed higher graduation rates in STEM fields overall: 49% in humanities, 55% in

mathematics and physical sciences, 56% in social sciences, 63% in life sciences, and 64% in engineering.

These numbers indicate a need to further understand doctoral student enrollment and persistence as data suggested that completion rates overall fields remain flat. Additionally, exploring the evolution of growing completion rates in STEM fields could help to enhance broader persistence and completion rates for doctoral students. It is notable that STEM as a broad field of study successfully graduates more than 50% of its doctoral students but further fractionalization of the components of STEM identify lower success rates. Understanding STEM as whole and the more specific categorizations of academic disciplines within STEM is vital to understanding the unique and interwoven elements of the STEM spectrum.

STEM as a Field of Study

Since World War II, the innovation and technological design that came out of this period, created a race, a race to out advance other nations in the competitive edge of research and technology. In the 1950s and 1960s, "the space race inspired a generation of Americans to pursue education and careers in science and technology" (Burke & Baker McNeill, 2011, p. 1). As noted earlier in this chapter, there are both global and national pressures to increase student interest and success in the fields of science, technology, engineering, and mathematics (STEM), as a way to increase the trained workforce in fields of study that provide significant impact to the technological global economy of the twenty-first century. Undoubtedly, with the advancement of technology as a part of everyday life, STEM fields have become a crucial component. In 2009, President Barak Obama's Educate to Innovate campaign touted the importance of collaborative research across

public and private sector research communities. Foundational to the campaign was a desire to inspire another generation of Americans to pursue education and careers in science and technology. This would include increasing the number of women that major in STEM fields.

Women in STEM

The United States, through the work of major research universities, federal agencies, and corporations, has built a scientific infrastructure unprecedented anywhere else in the world (Goulden, Mason, & Frasch, 2011). Internationally, men and women seek educational opportunities at American universities due to the prestige of programs and access to research and resources. Yet, for more than 40 years, the United States government, federal agencies, and scholars have advocated for parity in admission and graduation of domestic women and minorities (Burke & Baker McNeill, 2011; CEOSE, 2015; Tinto, 1993; Walker, 2008).

In part, the push for increased parity is due to workforce supply and demand. As technology and other STEM advancements become commonplace pieces of everyday life, the need for more people to fill jobs related to these technologies increase. According to data released from the United States Department of Commerce (2017), STEM jobs in the United States grew 14.0% from 2008 to 2015 compared to the 1.7% growth of non-STEM jobs in the same time period. “Women filled 47 percent of all U.S. jobs in 2015 but hold only 24 percent of STEM jobs. Likewise, women constituted slightly more than half of college educated workers but made up only 25 percent of college educated STEM workers” (United States Department of Commerce [USDC], 2017). According to the U.S. Bureau of Labor Statistics, in 2015, nearly 8.6 million jobs were STEM related (Fayer,

Lacey, & Watson, 2017). From the same report, between 2014 and 2024 mathematical science occupations are projected to have job growth at 28.2% compared to all occupations projected job market growth of 6.5%. With such escalating needs, integration, retention, and graduation of a larger STEM population is necessary to keep up with the workforce demand.

Beyond the growth of the job market and economy surrounding STEM related careers, others argued that the importance in diversifying STEM fields should focus on cultivating talent, and promoting the full inclusion of excellence across the social spectrum (CEOSE, 2004; Gibbs, 2014; Goulden, Mason, & Frasch, 2011). According to 2016 data from the Survey of Earned Doctorates, the total number of doctoral degrees awarded from American colleges and universities in 2016 was 54,904 (NSF, 2018). From the same data set, 25,278 doctorates were awarded to female students and 18,175 of those were United States citizens and permanent residents. These numbers indicated that approximately 46% of doctoral degrees conferred in 2016 were awarded to women, but domestic female doctoral students only make up 33% of conferred Ph.Ds.

Between 2006 and 2016, NSF data shows a 23% growth (2006: 14,762; 2016: 18,175) in graduation of female doctoral students and an 81% graduation growth rate of domestic female doctoral students (NSF, 2018). The NSF data indicated significant gains for women in STEM fields compared to non-STEM – with total growth in STEM estimated at 42% from 2006 to 2016 compared to non-STEM growth rate of 11%. While the gains reported from the NSF and the U.S. Department of Commerce are promising, the data also indicated that women still lag behind their male counterparts in degree completion, especially in mathematically dense fields, such as engineering, computer

science, mathematics, and statistics, while the rise of jobs and research surrounding mathematical science is quickly expanding.

Statement of the Problem

As national data indicated, while doctoral completion rates of female domestic students is on the rise, there is still a gap between those that begin graduate programs in STEM and those who successfully complete their degrees. Since World War II and the detonation of the first atomic bomb, politicians have placed an emphasis on science and innovation as a way to place the United States as a world leader driving jobs, industry, and human advancement.

> Science, Technology, Engineering, Mathematics. Those four words contain the key to the United States holding its position as the innovation and technology leader of the world, given that 80 percent of the fastest growing occupations in the U.S. depend upon a mastery of mathematics and scientific knowledge and skills. (Ganapathy et al., 2014, p. 7).

According to the United States Department of Education (2009), "STEM disciplines provide the foundation for future…advancements in commercialization and innovation and support existing businesses and enterprises that rely on mathematics, science, technology, and engineering expertise" (p. 2).

Women make up a little over half of higher education enrollment in the United States and make up half the national workforce. Women earn more college and graduate degrees than men. "Yet the gender gap in science persists, to a greater degree than in other professions, particularly in high-end, math-intensive fields such as computer science and

engineering" (Del Giudice, 2014, p. 1). Fundamentally, something must be done to keep domestic women engaged in STEM education and focused on STEM career aspirations.

Purpose of the Study

The purpose of this study was to examine the role that mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization. "Researchers suggest that the shortage of women pursing degrees in science is due to a lack of preparation and mentoring" (United States Government Accountability Office, 2004, p. 19). While the research on women's preparation in STEM education is widely examined across all levels of education, studies on the role of the mentoring relationship for female students is disjointed. The literature consistently indicated that women seek out more personal relationships that provide feedback and role modeling (Belenky, Clinchy, Goldberger & Tarule, 1997). More importantly, the vast majority of research on women in STEM at all levels of the STEM pipeline focused on the reasons for women's departure from the pursuit of STEM as a field of study, and frequently cited lack of connection, support, and mentorship as a factor. Limited data has been documented about those who persist and what factors lead to their success.

In order to understand the impact that mentoring has on female domestic STEM doctoral students' abilities to persist in their academic pursuits, the following questions provided the foundation for this study.

1. What are the experiences of female domestic STEM doctoral students in mentoring relationships?
2. What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?

3. Do gender difference between mentor and mentee in mentoring relationships have a different effect on the experiences of domestic STEM doctoral students compared to homogeneous gender mentoring relationships?

This study focused on the role that mentoring played as a component of socialization in aiding female domestic STEM doctoral students to persist in their academic programs.

Conceptual Frameworks of Socialization and Mentoring

Graduate student success has been measured by a number of factors including graduation rates, time to degree, graduate student retention, educational attainment, academic achievement, and student advancement. One of these factors, graduate student retention, is linked to factors that can determine whether a student does or does not persist in their academic program. Much of the research around persistence of graduate students focuses on graduate student attrition; why students leave instead of why students stay. As stated earlier in this chapter, it is estimated that approximately 50% of all students that enroll in doctoral programs fail to complete their degrees (CGS, 2008a; NSF, 2012; NSF 2014; Tinto, 1993). Tinto (1993) stated that a theory on graduate student persistence should be "shaped by the personal and intellectual interactions that occur within and between students and faculty and the various communities that make up the academic and social systems of the institution" (p. 231).

Based on these localized communities and interactions that take place within the campus environment for graduate students, Tinto asserted that "doctoral persistence is more likely to reflect the specific character of student-faculty interactions than is undergraduate persistence" (p. 232). The quality of the Ph.D. experience for graduate students is a complex system woven into a major assumption that doctoral students pursue

their degrees in preparation to enter the professoriate. Because of this assumption, the faculty-graduate student relationship and subsequent engagement become central to student success. Austin (2002) indicated that the road to tenure is

> … characterized by stress, pressure, and uncertainty. Institutional leaders who hire new Ph.D. graduates for faculty positions, analysts of higher education, and potential faculty members, including graduate students, raise questions about the appropriateness of graduate program preparation for the changing workplace contexts that the next generation of faculty will face. (p. 64)

While many graduate students may not intend to pursue faculty positions, research indicated that many leave their educational pursuits due to a lack of connection between their field of study and career aspirations (Baird, 1969; Golde, 1998; Nyquist et al., 1999). Austin (2002; 2009), Golde (1998), and Gardner (2010a) assert that key to a graduate student developing and maintaining a connection to their academic discipline involves intentional and active integration of the graduate student through the process of socialization.

Graduate Student Socialization

In addition to graduate student attrition due to the mismatch between a graduate student's discipline and department, research indicated that graduate student socialization can play an integral role in student persistence. Austin (2002) found that while varying departments, disciplines, and institutions utilized different mechanisms to integrate graduate students into their academic communities, all graduate students reported their socialization process included observing, listening, and interacting with faculty. Additionally, Austin asserted that the lack of intentionality, structure, and guided reflection

that should accompany engagements with faculty created a lack of "systematic professional development opportunities" (p.104) needed for successful integration into the academy.

In addition to the lack of systematic professional development, Austin's research asserted that the minimal feedback and mentoring from faculty coupled with few opportunities for guided reflection created a vacuum devoid of intentional training, role modeling, and guidance. Austin asserted that key to improving graduate school is more attention to regular mentoring, advising, and feedback. The emphasis on the mentoring as a component of socialization and its inherent believe that quality mentoring will grow the number of graduate students that persist plays a key role in the basis for this study.

Gardner (2010a) asserted that the "socialization process, by definition, is inherently social" (p. 69). By nature of integrating into an organization or group of people, a graduate student must interact with members of the organization. In order to persist a graduate student must construct relationships that are beneficial, that they garner information and guidance from, and that directs successful incorporation into the organization. Clark and Corcoran (1986) cited "calls for detailed examination of the process of sponsorship in science to uncover significant differences in the training of women" (p. 25). The authors stated that sponsorship, role modeling, and mentorship were concepts that were essential to the evolution of the academy, especially a diversified academy. Gardner (2010a) echoed this conclusion with findings that specified support from others as a key factor in graduate student completion of doctoral degrees and outlined the importance of positive faculty-graduate student matches. In Gardner's study students from departments with high completion rates indicated that support from constituencies within their department were

instrumental to academic success. Faculty members were identified as a key constituency for many students. Even for graduate students from departments identified with low completion rates (engineering and mathematics), faculty were described as critical for support.

Austin's body of research (Austin, 2002, 2009; Austin, et al., 2009; Austin & McDaniels, 2006) around graduate student socialization was used to understand the pipeline into faculty careers, Golde's (Golde, 1998, 2000, 2005, 2010; Golde, et al., 2006; Golde & Dore, 2001) use of graduate socialization created a framework for evaluating the attrition and influence of disciplinary culture on graduate education, and Gardner's (Gardner, 2005, 2008a, 2008b, 2009a, 2009b, 2010a, 2010b; Gardner & Barnes, 2007; Lott, Gardner, & Powers, 2009) research built of Golde's work to further understand the graduate socialization process and provided a three phase model to explain doctoral student development. Research focused a variety of aspects related to graduate student socialization has consistently indicated that a fundamental element of the socialization process lies in the mentorship of a graduate student by a faculty member within the discipline. In addition to the researchers noted above, Baird (1969) and Tinto (1993) examined the complex experiences of graduate students and indicated that thoughtful engagement within the academic discipline by the graduate student and faculty was an essential element of success. That is, mentoring during graduate school matters.

Mentoring

Mentorship, then, becomes an important role to graduate education and graduate student persistence. If the faculty-graduate student relationship is central to graduate student persistence and research on attrition directs researchers back to the lack of

connection and sense of belonging in a student's field of study, a positive, productive mentor relationship and established community support are essential to graduate student success. Redmond (1990) defined mentoring as "the act of providing wise and friendly counsel" (p. 188). Additionally, mentoring has been defined as "the action of advising or training another person, especially a less experienced colleague" (Mentoring, 2019).

There are two types of mentoring relationships identified in the mentoring literature: formal and informal mentoring (Ragins & Cotton, 1999). The distinction between the two types focuses on how the relationship initiated, the arrangement of the relationship, and the focus or outcomes of the relationship. Informal mentoring describes a voluntary relationship that evolves from mutual respect and a close intimate relationship. In contrast, the formal mentoring relationship is structured, often assigned by a third party, and goals have typically been pre-determined before the mentoring relationship begins.

Regardless of the type of mentoring relationship individuals are engaged in, Kram (1983) identified two key functions of the mentoring relationship: career development and psychosocial. The career development function provides the basis for integration into a community or organization through the sponsorship, coaching, and professional development of the protégé. The psychosocial function focuses on personal development of the protégé that enhances their sense of competence, effectiveness in the professional role, and development of a clear identity within the professional community. In addition to the personal development of the psychosocial function, the mentor functions as a role model and friend.

Developing an understanding of the varying experiences and outcomes associated with the mentoring of graduate students may assist in providing insight into what aspects

of mentoring are valuable to the graduate student socialization process. As noted by the research on graduate socialization, more intentional engagement by a faculty member in the role of mentor can positively contribute to graduate student persistence (Austin, 2002; Austin et al., 2009; Corbett, & Hill, 2015; Gardner, 2008; Golde, 1998). Providing information that outlines the key components of graduate student mentorship may assist faculty in thoughtful, intentional engagement of the faculty-graduate student relationship.

Methodology

This study was conducted using a qualitative methodology. Qualitative research according to Creswell (2003), can involve a number of research approaches: narratives, phenomenologies, ethnographies, grounded theory, and case studies. Based on the research questions outlined in this study, with the purpose of this study to examine the role that mentoring plays in the persistence of female domestic STEM doctoral students through the lens of socialization, a case study approach was selected as the qualitative methodology.

Case studies have become a commonly used method to conduct qualitative research (Creswell, 2003; Merriam, 1998; Stake, 2000). A case study, as described by Schwandt (2001), is a methodological strategy where a case is central to the research. Merriam (1998) indicated that the case can be a seen as a single entity or better described as a unit around which there are boundaries. A case study method was selected for this study because the focus on STEM graduate education provides a clear and concise boundary to the case, creating a clear conceptual understanding of what was studied inside the boundaries of the case.

The research site selected was a large, public research institution located in the Southern the United States. The site selection for the case study research was chosen

because the institution boasts a robust STEM program awarding doctoral degrees in 78 STEM programs. While qualitative research does not seek generalizability (Creswell, 2003), insuring that there would be a large enough pool of perspective participants to draw from was important. Thus, the site selection.

Limitations

By design, research has limitations, regardless of the methodology selected by the researcher to conduct the study. The data for this study on domestic female doctoral students in STEM was collected at one institution. By design, a single-institution case study does not allow for findings that are easily generalized to other institutions. Still, the findings from this study can be transferred to future research that employs similar research questions (Lincoln & Guba, 1985).

In addition to the single-institution case study, the participants represent only a fraction of the doctoral degree granting STEM disciplines represented at the institution. Of the 78 programs offered, only ten programs are represented in the participant make up. The time needed to identify and interview one or more participants from each program was not feasible. Using the constant comparative method, the researcher identified a point of saturation to guide the number of women interviewed (Creswell, 2007).

Further, participants were purposefully selected for this study based on a pre-established set of criteria (Merriam, 2009). The set of criteria excluded the use of international students which in many STEM fields make up a majority of currently enrolled female doctoral students. This criteria was established to enhance the understanding of the influences present in the current graduate environment that aid in

patching a leaky pipeline in the United States for women in STEM at the graduate level and into the faculty ranks.

In addition to the research limitations associated with this study, as noted above, it is important to note that this study was conducted for the fulfillment of my doctoral dissertation study, a time in which I, too, was a doctoral student. Peshkin (1988) specified the value in all researchers developing an awareness of their own subjectivity and the "possible impact on their work" (p. 20). While trustworthiness of the data was ensured through member checking and peer debriefing (Lincoln & Guba, 1985; Merriam, 1998), my own assumptions and understandings about the doctoral experience nevertheless existed at the time of the study. Furthermore, I had spent 15 plus years of professional work supporting doctoral students outside of the academic setting within my professional role. The extensive time communicating and supporting graduate students provided both context and expectations about what the graduate experience was. As Peshkin noted, part of the process of conducting quality research, a researcher should enhance their awareness of their own subjectivity through a formal, systematic monitoring of oneself. Peshkin (1988) noted that this "monitoring is a necessary exercise, a workout, a tuning up of my subjectivity to get it into shape ... to keep the line of my subjectivity open and straight … a warning to myself so that I may avoid the trap of perceiving just that which my own untamed sentiments have sought out and served up as data" (p. 20). I, too seek to acknowledge my subjectivity and share it outwardly to self-monitor and tame that which I may have believed to perceive.

Significance of the Study

This study was designed to understand the connections that female domestic doctoral students make with their research advisor and/or other mentors. Additionally, the study explored the potential relationships these women created with other faculty, administrators, or individuals that promoted an environment for resilience and success. Finally, the study was designed to partially aide in the understanding of the role gender differences of mentors and mentees play within the faculty-graduate student relationship, and may play in the persistence and success of these doctoral students.

As noted in the literature review, research on the engagement of both women and minorities in STEM predominately focuses on attrition and the reasons for women's departure from academic pursuits (Blickenstaff, 2005; Golde 1998, Golde 2005; Tinto, 1993). This study contributes to the body of knowledge on doctoral student persistence and the support systems that lead to persistence. The data and thick description provided through the semi-structured interviews allows for a deep understanding of each women's doctoral academic journey, providing guideposts or points of interface that may be used in future research to further the understanding of how academic resilience is built and capitalized on within the path to the Ph.D.

Additionally, from a practitioner's lens, the research provides information on the experiences of these women that have aided in their persistence. By understanding how mentoring has influenced female domestic doctoral students, the study findings are effective in influencing approaches to training and supporting faculty advisors. There may be ways for academic departments to expand the experiences of participants described in

Chapter IV into training or intervention programs that can be applied more broadly to support other women pursing doctoral education.

In adding to the knowledge base of doctoral student persistence, this study provides information that could afford institutions of higher education an increased understanding of the female experience with an increasing scrutinization of higher education around the rising costs of education, time to degree completion, and the mounting student loan debt. Graduate education must also be prepared to provide solutions and answer these concerns. Seeking ways to increase and enhance persistence from doctoral students is good for universities both economically and reputationally. There is a growing body of research around supporting women in the pipeline as junior faculty to tenure (Goulden, Mason, & Frasch, 2011). As universities, colleges, and departments work to influence cultural and climate change to support women faculty, understanding doctoral graduate experiences can provide a foundation for lived experiences that may impact commitment and engagement.

Definition of Terms

Attrition identifies the decrease in the size of a cohort. This can be the incoming cohort of a specific program, the admission cohort of a graduate school, etc. Attrition is the diminution in numbers of students resulting from lower student retention (Hagedorn, 2005).

Mentorship is a process for the informal transmission of knowledge, social capital, and psychosocial support perceived by the recipient as relevant to work, career, or professional development; mentoring entails informal communication, usually face-to-face and during a sustained period of time, between a person who is perceived to have greater

relevant knowledge, wisdom, or experience (the mentor) and a person who is perceived to have less (the protégé).

Persistence is the act of continuing towards an education goal. It may include continual enrollment by semester until attainment is achieved. Hagedorn (2005) indicated that the words persistence and retention are often used interchangeably. Hagedorn asserted that persistence is a student measure. The National Center for Education Statistics uses retention as a way to measure institutional success of factors that contribute to student completion. Persistence then is the student measure used to access factors created or internalized by the student towards their educational degree.

Graduate Student Socialization is defined by Campbell and Tierney (2015, p. 1) as "the process through which individuals gain the knowledge, skills, and values necessary for successful entry into a professional career requiring an advanced level of specialized knowledge and skills."

STEM refers to the physical, biological, and agricultural sciences; computer and information sciences; engineering and engineering technologies; and mathematics.

Organization of the Study

This dissertation is organized into five chapters. Chapter I provided an introduction, background and overview of the problem. The chapter also briefly discussed the theoretical framework and provided the purpose of the study. A review of relevant literature is covered in Chapter II including: the history of doctoral education in the United States, the inclusion of women as students in doctoral programs, the evolution of STEM as a collective field of study, and the role or persistence in understanding female domestic doctoral students' success. Additionally, Chapter II provides information related to

socialization and mentoring theory that is used to support the persistence framework of this research. In Chapter III, the methods for collecting and analyzing the interview data are described. Chapter IV documents the results of the study and the analysis of the data. Finally, Chapter V provides a summary of the study's significant findings, a discussion of the conclusions of the research questions, and recommendations for practice and future research.

CHAPTER II

REVIEW OF LITERATURE

This chapter provides a review of the literature framing this research study. There is a growing breadth of literature that seeks to understand how to recruit and retain women in science, technology, engineering, and mathematics (STEM) fields. Through the exploration of literature in this chapter, the reader should gain an understanding of the evolution of graduate education in the United States, particularly related to research, the role and expansion of access for women in graduate education, the increased emphasis on STEM education in the United States, and the educational pipeline as it relates to women in STEM. These five key areas of literature set the stage for understanding why the persistence of women through the STEM pipeline and, in particular, at the doctoral level is important to answering the question: What role does mentoring play in the persistence of female domestic STEM doctoral students through the lens of socialization? To better understand where graduate education is heading, one must first understand where it has come from. To establish a foundation for this chapter, I begin with a brief overview of the evolution of graduate education in the United States. Next, the chapter will cover women in higher education, followed by an exploration of STEM education and women's engagement within STEM fields of study. The chapter then discusses the conceptual frameworks of graduate student socialization, specifically the characteristic of mentoring. Finally, an overview of mentoring and its role within graduate student socialization theory is covered.

History of Graduate Education

Up until the mid-nineteenth century, higher education in the United States could be defined as a classical education focused on the Latin and Greek curriculum that was brought to the United States from the teaching models of Oxford and Cambridge universities in England (Geiger, 2002). The primary focus of undergraduate education heading into the nineteenth century was to train men to become ministers. As more small institutions were founded, growth of the undergraduate degree evolved to include a more liberal education with training for some lawyers and doctors (Perkin, 1997). During this period in American higher education, all schools were small, boosting a small faculty, and the undergraduate curriculum, grounded on this liberal arts model, drilled students in geometry, ancient history, logic, ethics, rhetoric, and ancient languages.

Around the mid-nineteenth century, scholars began to travel to Germany to study for one to three years in order to obtain a Doctor of Philosophy (Ph.D.) (Storr, 1969). In the 1860s and 1870s, Yale and Harvard awarded a small number of Ph.D.s (Geiger, 2002). The first graduate school in the United States was established at Johns Hopkins University in 1876. Johns Hopkins framed its curriculum around the German education model of research and thereby became the underpinning of the modern American research university (Clark, 2006). Daniel Coit Gilman, the first president of Johns Hopkins University, lead the institution in an academic framework of blending teaching and research. Gilman and Johns Hopkins became known for their focus on the support of faculty research, where Gilman is cited as saying “the best teachers are usually those who are free, competent and willing to make original researches in the library and laboratory” (Johns Hopkins University, 2019).

Graduate education and research became tantamount in the American model of higher education, working hand-in-hand to provide opportunity for *Wissenschaft,* "an approach to learning, a method of scholarship aimed at active intellect, sound judgment, and moral feeling" (Perkin, 1997, p. 17). Neither graduate education nor research were viable prospects on their own and were very dependent on outside support for their success. In the 1920s, the role of charitable foundations and, in a few limited cases, corporations became the catalyst for the growth of graduate education and research. Primary credit is given to the Rockefeller Foundation for its substantial contributions to research in a breadth of areas. In addition to funding research, the Rockefeller Foundation, along with the National Research Council, also received acknowledgement for providing higher education with the creation of the postdoctoral position (Geiger, 2002). Established in 1919, these fellowships were limited to mathematics, physics, and chemistry, but bolstered

> American higher education at one of its weakest points – the transition from graduate study to faculty status. The new Ph.D.s, instead of being relegated in the usual manner of extensive introductory instruction, were able to extend mastery of their field at the most advanced centers for research in the country. (Geiger, 2002, p. 280)

By the latter part of the 1920s and early 1930s, the beginnings of an established formulation of graduate study had emerged. The rationalization of graduate education into formal departments and positions with standards, along with greater financial support for graduate students, the existence of the post-doctoral fellowship, and the formulization of faculty career structures synergized to provide advanced education in the United States.

The next eighty years would provide small incremental adjustments to the model; however, much of what is apparent today in graduate education was founded by the end of the Great Depression. Still, the model is murky and complex, recognizing that central to the production of research and graduate degrees is that of the undergraduate education.

Historical Overview of Mentoring

The word "mentor" was first used in Greek mythology during Homer's epic, *The Odyssey* (Aldisert, 2001; Chao, 1997; Choa, Walz, & Gardner, 1992). Odysseus appointed a guardian to the family to take care of the household and family affairs prior to departing on his voyage. This guardian's name was Mentor. Over the ten years that Odysseus was gone, Mentor acted as a teacher, advisor, friend, and protector to Telemachus, the son of Odysseus. From this origin, the term mentor has emerged to "describe the efforts, and hold as a model, the ideal role Mentor was reported to play in the development of his protégé, Telemachus" (Rosser, 2004).

During the Middle Ages, similar relationships were documented in research surrounding craft guilds. Young boys were apprenticed to a master, someone of high standing and excellent skills within a trade (Murray, 2001). Although archaeologists and anthropologists can trace mentoring relationships throughout history beginning in the Stone Age (Rosser, 2004), no mention of mentoring is found in social science literature until the late 1970s (Wanberg, Welsh, & Hezlett, 2003). Rosser (2004) identified that the works of researchers on mentorship in the late 1970s set the stage for what Bozeman and Feeney (2007) would indicate as an influx of articles published on mentoring from the late 1970s to the early 2000s. In their recent accounting of research articles, more than 500 articles were published in management and education literature from 1987 to 1997.

What is Mentoring?

Professional and popular literature assert that the role of mentoring is the cure to a thousand ills, the answer to organizational and professional development, and the key to career advancement, just to name a few (Mertz, 2004). Because mentoring is seen as the answer to so many organizational, professional, and personal challenges, defining mentoring is complicated. “Definitions of mentoring come in all sizes, foci, and levels of inclusiveness” (Mertz, 2004, p. 541).

Many popular definitions of mentoring focus on the process of having a developmental relationship with two people (Rosser, 2004). The one-on-one interpersonal relationship serves as a distinguishing element from other forms of learning and development. Gibbons (2000) defined mentoring as “a protected relationship in which learning and experimentation can occur, potential skills can be developed, and in which results can be measured in terms of competence gained rather than curricular territory covered” (p. 18). A key aspect of mentoring is the focus on the “learning and development needs of the protégé at a professional and a personal level” (Rosser, 2004, p. 29). While mentoring is seen as beneficial to personal development, much of the current literature examines mentoring relationships through work or educational contexts with a key focus on professional development (Noe, Greenberger, & Wang, 2002; Wanberg et al., 2003).

With an emphasis on work and professional settings framing the current research on mentoring, primarily definitions of mentoring focus on the career advancement or professional development of a protégé from an individual in a position of authority within the professional context (Choa et al., 1992; Gaskill, 1991; Ragins & Cotton, 1991). Traditionally, mentoring has been defined as “an intense interpersonal exchange between a

senior experienced colleague (mentor) and a less experienced junior colleague (protégé) in which the mentor provides support, direction, and feedback regarding career plans and personal development" (Russell & Adams, 1997, p. 12).

Using Russell and Adams' definition of mentoring, connecting the faculty-graduate student relationship as a part of the mentoring process is almost effortless. The mentor defined in the literature as the senior experienced colleague in a higher education setting is known as the faculty advisor. The protégé described as the less experienced junior colleague is definition assigned to the graduate student. Together the faculty advisor and the graduate student engage in a relationship that should provide support, direction, and feedback from the faculty advisor to the graduate student for the purpose of developing the graduate student into a sound researcher, a professional faculty colleague, and to assist the graduate student in the completion of the graduate degree program.

Hunt and Michael (1983) defined a mentor as "an individual with advanced experience and knowledge committed to providing support and increasing the upward mobility of a junior organization member, or protégé (p. 475). Key to all definitions of mentoring; "mentors use their greater knowledge, experience, professional connections, and status to help develop their protégé, not to simply pull the protégé up the organization on the mentor's coattails" (Bass, 1990, p. 90). Wanberg, Welsh, and Hezlett (2003) indicated that regardless of the mentoring definition a study subscribes to, mentoring is believed to be the "most intense and powerful one-on-one developmental relationship, entailing the most influence, identification, and emotional involvement" (p. 5). While it is generally agreed that mentoring is powerful, mentoring is also considered to be one of the most complex relationships (Levinson et al., 1978).

Women in Higher Education

Throughout the evolution of the American graduate education system, women were widely not present in higher education. Prior to the American Civil War few colleges admitted women. Mount Holyoke Female Seminary was founded in 1837 for the teaching of religious doctrine to women. Oberlin Collegiate Institute opened in 1833 and by 1837 became the first coeducational college. While a handful of colleges for women emerged, female enrollment in higher education did not advance at a steady pace until after the Civil War (Graham, 1978). Graham indicated that in 1870, enrollment at women's colleges accounted for approximately 6,500 women and those enrolled at co-educational colleges was approximately 2,600 women. Combined, these enrollment numbers accounted for approximately 21% of higher education's enrollment. By 1930, women's enrollment had grown to 44% of the total higher educational enrollment, with 83% of all women enrolled working towards degrees at co-educational institutions (Graham, 1978; Rossiter, 1982).

The increasing growth of women in higher education has been attributed to a number of societal factors and public policy enactments that created a framework for access to education. According to Tardy (2017), in the 1940s approximately 26.9% of females ages 18-19 were enrolled in higher education in the United States. Just 50 years later, in 1990, this enrollment number jumped to 59.9%. This substantial change happened in only 50 years, partially due to important developments during the 20th century that spurred a change in the female role within society. It is a common held belief that The Nineteenth Amendment granting women the right to vote (ratified on August 18, 1920), the Fair Labor Standards Act of 1938 which mandated that women receive the same minimum wage as their male counterparts, and Title IX of the Education Amendments Act

of 1972 created a more positive environment for women and their pursuit of a postsecondary education (Tardy, 2017). These societal shifts created a "uniform standard by which all women would be judged" (Graham, 1978). As access and enrollment for women increased at the undergraduate level, so did enrollment at the graduate level.

Women in Graduate Education

Women who sought to advance advance their education through either professional degrees or through the pursuit of doctorates were an infinitesimal percentage of the academic population for much of the twentieth century according to Graham (1978). In her article on the history of women in American higher education, Graham, indicated that before 1890, less than 150 doctoral degrees were conferred. From that 150 conferred degrees, approximately seven were awarded to women. Helen Magill White was the first American woman to earn a Ph. D. in Greek from Boston University in 1877. After these sparse early degrees, women's completion of doctoral programs steadily climbed and by 1976, 23% of doctoral degrees awarded were conferred to women. Some 30 plus years after Graham's last data set reported on doctoral degrees awarded to women, the Council of Graduate Schools Completion Study (CoGS, 2008a) showed that gender was still a significant predictor of doctoral degree completion. The CoGS data revealed that in 1996-97 and 1997-98, of the 9,396 doctoral students who were monitored for degree completion, 63% of conferred doctoral degrees were earned by men and only about 37% were earned by women. Linking the two data sets together, the data indicates that in the 20 plus years between set one (provided by Graham) and set two (provided by CoGS), women's completion of doctoral degrees grew approximately 15%.

Sixteen years since the COGS data was collected, women have reversed those graduation rates surpassing male attainment. The most recent data provided by the National Center for Education Statistics (NCES) indicated that in 2016, cumulatively across all fields of study, females out earned doctoral degrees compared to their male counterparts (National Science Foundation, 2018a). The 2016 degrees conferred data shows women earning 51.8% of doctoral degrees (across all degree fields) and their male counterparts earning 48.2% of doctoral degrees (NSF, 2018a). When considering all non-STEM fields of study, "58% of doctorates were awarded to women in 2016, a share that has changed little since 2007" (NSF, 2018a, p. 2).

Looking at the breadth of expansion of female enrollment in higher education, not only enrollment numbers in completion rates have grown, so have the fields of studies women pursued advanced degrees in. While women have earned professional degrees (dental, medical, and veterinarian) and doctoral degrees since the late 1800s, these women were few and far between. After World War II, the alignment of educational advancement and professionalism collided to create a plateau focused on more liberal arts education for women. Advancements in education, sociology, history, and languages were the first fields to see growth in women's enrollment (Tardy, 2017). In a 30 year comparison conducted by the National Science Foundation (2008) the percentage of female doctorate recipients, by broad field of study showed that in 1978 education doctoral degrees were nearly 25% of degrees awarded, followed by life sciences (approximately 17%) and humanities at 14%. Thirty years later, life sciences doctoral degrees awarded grew to 23%, while education doctoral degrees had fallen to 14% and humanities to 9%. Women's movement into more

mathematically based science and engineering fields has created an effort to better understand how and why women's educational aspirations and attainment have shifted.

STEM as a Field of Study

There has been a historical evolution to the use and understanding of what the acronym STEM stands for. While the term itself was coined in the 1980s by Dr. Rita Colwell, the director of the National Science Foundation (NSF) at the time, the concepts that feed into STEM education began with the formation of the NSF in 1950. According to the NSF website, the independent federal agency was created by the United States Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" (National Science Foundation, 2019). NSF has two major components that make up the direction and leadership of the organization: the director and NSF staff that oversee the programs and administration of NSF and the 24-member National Science Board that establishes the policies and direction of the organization's work.

The NSF supports research to maintain our nation's interests and advancement in global science and industry. Millions of dollars are awarded annually to support proposals from schools for STEM education as a component of the NSF programmatic platform (NSF, 2018b). STEM is used as a descriptor or designation that creates criteria for research and educational programmatic grant proposals funded by the NSF. A primary area of funding is for research focused on preparing students for study and work within the fields of science, technology, engineering, and mathematics (STEM). Beyond study and research in STEM fields, the educational programs are designed to foster inquiry, logical reasoning, and collaboration skills (NSF, 2019).

Evolution of STEM

The American society places a great emphasis on the role science, technology, engineering, and mathematics is incorporated into every aspect of the American experience. Broadly speaking, STEM is used to define success, in education, career attainment, knowledge advancement, and innovation. According to the U.S. Department of Education (2019) "in an ever-changing, increasingly complex world, it's more important than ever that our nation's youth are prepared to bring knowledge and skill to solve problems, make sense of information, and know how to gather and evaluate evidence to make decisions. The importance placed on STEM and its role in the advancement and evolutional of the American culture has created a significant amount of data collection, tracking, and evaluation to determine the success, weakness, and growth of STEM in America. The significance of STEM as both an education platform and a career path are grounded in America's global political environment post World War II. How did the United States get here as a society?

In 1957, the American public turned its eyes to the Soviet Union and the launch of the first satellite, Sputnik. In response to this technical achievement, the United States Congress passed the National Defense Education Act (NDEA) in 1958. The NDEA was established as a way for the United States to compete globally in the sciences, and committed one billion dollars over four years to support what we now know as STEM education (Jolly, 2009). Nationally, a tremendous emphasis on America's role globally in creating and innovating through math, science, and engineering has prompted the United States government to pour billions of dollars annually into research, education, and technological advancements through the National Science Foundation, the Department of

Education, and the National Aeronautics and Space Administration (NASA), to name a few, with one key emphasis that America generate a world class STEM workforce.

In 2009, United States President, Barack Obama set a priority for increasing the number of students and teachers engaged in and well versed in the STEM fields. The White House's "Educate to Innovate" campaign placed an emphasis on elevating American students to the top of science and math achievement globally (Educate to Innovate, 2010). In the initial launch of the "Educate to Innovate" campaign, President Obama stated that "reaffirming and strengthening America's role as the world's engine of scientific discovery and technological innovation is essential to meeting the challenges of this century" (Educate to Innovate, 2009). Obama identified three overarching priorities as goals of the campaign: increasing STEM literacy, improving the quality of math and science teaching, and expanding STEM education and career opportunities to underrepresented groups, including women and minorities. In the twentieth and now the twenty-first centuries, there exists an interconnection between the federal government, education, and industry that holds paramount to its core policy that education in science, technology, engineering, and math is key to global competition and financial prosperity.

"The global landscape of [science and engineering] research, education, and business activities has undergone dramatic shifts since the turn of the twenty-first century, as regions, countries, and economies around the globe continue to invest in science and technology" (National Science Board Commission, 2018, p. O3). Countries, including the United States' place a focus on STEM as a return on investment for national gross domestic product (GDP). At the core, governments place an emphasis on and an investment in the education of individuals that can compete in the global market and

knowledge commodity of STEM. This effort is essential to the earning power of the country and the global positioning within the world market. To be competitive on all fronts related to STEM advancement, inclusion and integration of a wide range of individuals is necessary for diverse thought. However, STEM as a field of study, industry, and innovation lags in the incorporation of women and minorities (NSBC, 2018).

Women in STEM

Increasing diversity in STEM fields provides for more voices to be heard. A review of research conducted by Anna Powers (2018) indicated that having a diverse workforce plays an important function in industry, where companies see upwards of a 19% higher revenue stream when investing in a diversified workforce. The inclusion of a broad range of voices and thought allows for increased innovation and competitiveness, helps to address concerns of social equity, and helps to address industry concerns that there are too few qualified individuals in the STEM workforce (Committee on Maximizing the Potential of Women in Academic Science and Engineering National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; Educate to Innovate, 2009; Edzie, 2014).

Yet, there continues to be disparity amongst women and minorities in their engagement in STEM fields on both the educational and career fronts. “In the 32 years since Title IX was enacted, women’s roles in American life have changed greatly and women have made significant gains in many fields. Despite these gains, much attention has focused on the limited participation of women in mathematics, engineering, and science” (United States Government Accountability Office [GAO], 2004, p. 1).

There have been sustained increases in women's participation in the sciences over the last three decades, especially in life science fields such as biology and botany (USGAO, 2004; Committee on Maximizing…, 2007). According to the USGAO (2004), the growth of women studying science has grown, with more growth at the undergraduate level than the graduate level. Additionally, the proportion of female faculty in STEM has increased since the early 1970s, however, "women still lag behind their male counterparts in terms of salary and rank" (USGAO, 2004, p. 14). Again, faculty increases are seen most significantly in the life sciences, as opposed to math, engineering, and computer sciences.

The data on women's enrollment is STEM fields begs the question of why women continue to select out of these fields of study (Gaston-Gayles & Ampaw, 2014; Lott, Gardner, & Powers, 2009; Sax, 1994). Research studies indicate that there are a number of factors that can impact women's choice to pursue STEM education, including exposure, support, and self-efficacy (Tran, Herrera, & Gasiewski, 2011). The Committee on Maximizing the Potential of Women in Academic Science and Engineering (2007) stated that as the committee's deliberations progressed in working to answer the questions put before them by the National Academies, "it became increasingly clear that various cultural stereotypes and commonly held but unproven beliefs play major, frequently unacknowledged roles in the perception and treatment of women and their work in the scientific and engineering community" (p. 23). The committee identified 11 beliefs that perpetuate the reduced participation of women in STEM. In connection to this study on female STEM doctoral students, the following beliefs are of interest: women are not as competitive as men and women do not want jobs in academe; women faculty are less productive than men; and the system as currently configured has worked well in producing

great science so why change it. Within the 275 page report, the committee created a call to action, indicating that solutions need to be created to insure female persistence throughout the STEM pipeline is achieved.

> This needless waste of the nation's scientific talent must end. In addition to considerations of equity that govern employment in other sectors of the nation's workforce, the United States now faces stiffening science and engineering competition from other nations. We urgently need to make full use of all of our talent to maintain our nation's leadership. Affording women scientists and engineers the academic career opportunities merited by their educational and professional achievements must be given a high priority by our nation. (Committee on Maximizing…, 2007, p. xii)

The STEM Pipeline

As noted in the previous section, women are an underrepresented population in STEM education, both as students and faculty. Female students are less likely to study STEM and are less likely to perform well on math and science achievement tests, as compared to their male counterparts (Clewell, Darke, & Tartre, 2000). Female STEM professionals earn less than their male colleagues, are less likely to hold positions of prestige, and are underrepresented in STEM fields. While research data provided by the National Science Foundation and the National Academies indicated that women have gained footing over the last 30 years in STEM, female faculty members are vastly underrepresented in key STEM fields, such as, engineering, technology, and mathematics (Clewell et al., 2000; Hill, Corbett, & St. Rose, 2010).

The National Science Foundation created the Program for Women and Girls (PWG) in 1993 as an effort to remedy the disparity between men and women's interest, enrollment, and workforce engagement in STEM areas (Clewell et al., 2000). Consistently, governmental agencies such as the National Science Foundation and the United States Department of Commerce, site the importance of STEM careers as crucial to America's innovative capacity and global effectiveness. The U.S. Department of Commerce (2011) reports that data collected from its American Community Survey indicated that women fill close to half of all jobs in the U.S. economy, however, women hold less than 25% of all STEM related positions (p. 1).

Research on the attrition of women in STEM fields and their declining level of engagement throughout key points in STEM education provide several areas of concern which include: the disproportionate high number of females who lose interest in science during middle school and high school, low enrollment numbers of women in undergraduate STEM majors, the decline of women in STEM even from those women who engaged in advanced high school science and math courses; and the loss of women from undergraduate STEM majors, who choose not to enroll in graduate STEM programs (Hill et al., 2010). While some women do progress beyond high school and undergraduate STEM education there is continued research on the reasons for departure of women who do enroll in graduate STEM degree programs, given so few completing their degrees. In addition to the study and tracking of women's educational careers in STEM fields and too often their departure, current STEM research also examines the causes for a slow rate of women's advancement in academic and industry STEM careers. Combined, this area of research creates the foundation of the STEM pipeline for women. "The STEM pipeline

starts in elementary school and extends through the professoriate and the rest of the [STEM] workforce" (Inside Higher Ed, 2015, p. 3). Understanding the pipeline helps to better understand the complex nature of acquiring equity in STEM education.

To understand the problems associated with women and STEM at the university level, it is important to look at the pipeline issue. The following sections will identify key issues that impact women's progress through the STEM pipeline and ultimately hinder persistence through STEM graduate programs. Exploring the dynamics of the high school, baccalaureate, and the graduate STEM pipeline sheds light on critical components of women's engagement in STEM education.

High School STEM Engagement

Elementary and secondary schools are the first stages in the long ongoing culture process that filters women out of science and math. "Exposure to mathematics throughout high school has been called a 'critical filter' in the process" (Reskin, Koretz, & Francis, 1996). Past research has suggested that males and females have the capacity to compete at the same level in math and science (Committee on Maximizing…, 2007), yet, research data indicates that while female students are capable of competing in advanced courses in math and science, during their high school years, females begin to experience decreasing levels of confidence.

> Recent research reports that women are not adequately prepared in K-12 or undergraduate school and so they lose interest in the sciences. According to several studies, in grade 12, high school girls took fewer courses in science, scored slightly lower on standardized science exams, were more likely to have negative attitudes toward science, and were less likely to declare

science as a college major, as compared with high school boys. (USGAO, 2004, p. 19)

Advocates of pre-collegiate STEM programs indicated that providing female high school students exposure and structured support while enrolled in advanced math and science courses help to strengthen the number of women who will enroll in and persist through the undergraduate STEM degree program (Edzie, 2014).

Baccalaureate Pipeline

In this section, the literature presented will highlight female students' decisions to leave or persist through collegiate baccalaureate STEM degree programs. Siebens and Ryan (2012) reported the 2009 United States Census data showed that more than half of college graduates were female (54.7%). However, females earned less than 15% of the bachelor degrees in STEM programs compared to their male peers who made up 87% of completed STEM bachelor degrees. In 2000, the United States Department of Education reported that since 1998 the number of females enrolling in higher education has exceeded their male counterparts (Huang, Taddese, & Walter, 2000). Yet, despite this increase in enrollment and graduation rates of female undergraduate students, male enrollment and graduation rates in STEM programs continued to surpass female students.

"Women are underrepresented among STEM bachelor's degree recipients primarily because they are less likely than men to major in STEM" (Reskin et al., 1996, p. 57). According to Hill, Corbett et al. (2010), 29% of male freshmen planned to enroll in STEM majors while only 15% of their female peers indicated a desire to major in STEM. For women who do enroll and persist in a STEM discipline at the undergraduate level, many STEM based industries recruit heavily from this population. The 2009 United States

Census data indicated that while women make up 48% of the U.S. workforce, women comprise just 24% of STEM workers (U.S. Census Bureau, 2011). Companies are seeking to increase their share of female diversity, and women find that their earnings are higher in STEM careers than in other areas of employment, choosing to leave education at this critical juncture between undergraduate and graduate education

For women who enroll in undergraduate STEM programs but leave without completing a STEM degree, the number one leading factor to attrition is through switching majors to non-STEM fields (Chen, 2013). "Results further indicated that low- and high-performing STEM entrants may exit STEM fields in different ways. The probability of exiting STEM fields by dropping out of college was higher for low-performing students (i.e., those with an overall college GPA of less than 2.5) than for high-performing students (i.e., those with an overall college GPA of 3.5 or higher), while the probability of leaving STEM fields by switching majors was higher for students in the high-performing group than for their peers in the low-performing group" (p. vi).

Graduate STEM Enrollment

As with the rest of the STEM pipeline and as the focus of this dissertation, female enrollment in STEM graduate education continues to decline compared to their male counterparts. Some graduate schools and researchers are concerned with the recruitment of students, especially minority students, including women, into graduate education (Council of Graduate Schools & Educational Testing Service, 2010). "There are a limited number of programs that attempt to identify talented undergraduate students, especially those from underrepresented groups, and prepare them for entry into graduate education" (p. 29).

The national decline in the number of students entering STEM fields significantly affects many influential companies and government agencies (Edzie, 2014). According to Duderstadt and Womack (2003), the number one strategic resource in the world is that of knowledge itself. This resource comes in the form of educated people and their ideas. "In this context, the focus of global competition is no longer only on manufacturing and trade but also on the production of knowledge and the development and recruitment of the 'best and brightest' from around the world" (National Academy of Science, National Academy of Engineering, & Institute of Medicine, 2007, p. 162).

Given the fact that fewer women enroll in graduate STEM programs and data shows a decline in the persistence of STEM doctoral students, closing the gender gap at the doctoral level in both the enrollment and degree completion of women is difficult. According to National Academy of Science, National Academy of Engineering, and Institute of Medicine's 2007 study on the STEM education, "an abiding interest in a field and the encouragement of a mentor often contribute to the "positive side" of a student's decision to pursue graduate education" (p. 168), and provides a stronger indicator of persistence (Golde, 2005).

As noted at the beginning of this chapter and within this section, the key focus of this study is on the role mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization. Golde's (2005) research indicated that a positive connection and relationship with a mentor were key factors in a graduate student's enrollment in a doctoral program and their ability to persist to completion. However, according to research conducted by De Welde and Laursen (2011), female graduate

students expressed immediate barriers to success in their STEM graduate disciplines, and over time the barriers became increasingly evident to the participants.

De Welde and Laursen identified four barriers that were prominent in the participants' narratives and impeded completion of STEM doctoral study. These barriers focused on the formal culture of STEM fields that "positioned women as outsiders, including both overt sexism and more subtle forms of exclusion from the "old boys' club," (p. 577). The other two barriers were identified as institutional structures of the academy. These institutional structures were described as difficult to navigate and included "the lack of role models or mentors and conflicts between the traditional timeline of academic careers and women's child-bearing years" (p. 577).

Given De Welde and Laursen's findings, further research to understand these barriers and opportunities to minimize or remove them could assist in efforts to grow the graduate STEM pipeline for women. According to Betz's (1994) research on career counseling for women in STEM, the researcher noted that women entering STEM graduate programs were as well prepared academically as their male counterparts. Betz asserted that based on the leveled academic preparation for both women in men, research into the institutional climate and the lack of social support might help explain the departure of women from graduate STEM programs.

Female STEM Faculty Pipeline

While the engagement of women in STEM at the faculty level is not the focus of this study, this literature review would be incomplete without addressing some of the key findings related to the lack of engagement of women as faculty and the often culminating departure of female STEM professors from the academy. The literature on women and the

STEM pipeline is clear there are leaks all along the pathway. It can be argued that the transition of women from graduate school to faculty positions is key to addressing leaks across the pipeline. Bostwick and Weinberg's (2018) research showed that women are far more likely to complete their STEM doctoral program when there are other women in their cohorts and program.

Unlike the STEM pipeline leaks at other points, women who do persist through the STEM graduate pipeline, "the transition from graduate programs to assistant professorships shows more pipeline leakage in the fields in which women are already very prevalent (psychology, life sciences, and social sciences)" (Ceci et al., 2014, p. 75). Data from the 2016 National Science Foundation (2016a) enrollment status indicated women comprised only 25% - 44% of tenure-track assistant professors in math-intensive STEM fields such as engineering, mathematics, computer science, and the physical sciences. Additionally, women occupied 7% to 16% of full professor positions in the United States. Ceci et al. (2014) found women held "66% of tenure-track assistant professorships in psychology, 45% in social sciences, and 38% in life sciences. For full professorships, the figures were 35%, 23%, and 24% respectively" (p. 77).

The disparity between the numbers of female STEM faculty and the leak in non-math intensive STEM fields is attributed to disciplinary cultures, long standing academic believes about female scientists, and a myriad of causes related to a lack of female role models, lack of mentors, and a perceived bias in the hiring and promotion of women (Clark & Corcoran, 1986; Xu, 2008). Wasserman (1998) indicated women who are able to persist in STEM fields have a "survival mechanism – the ability to withstand persistent negative cultural and social attitudes regarding scientific careers for women… [They] must be

willing to be nonconformists and able to tolerate 'outsider' status to survive in a traditionally male scientific culture" (p. 7). Ceci et al. (2014) emphasized the seeming paradox of short supply and higher success for math-intensive STEM fields. "The fields in which women are in the shortest supply are the very fields in which they appear to have the most success (p. 125).

What is consistently noted in the literature on women in STEM at both the graduate and faculty junctures is the key connection to other women, female role models, and mentoring. Understanding that mentorship plays a positive role in persistence for women within the STEM pipeline provides an opportunity to capitalize on the mentor - protégé experience for universities and departments. Additionally, the role female faculty play in the creation of social support in the form of mentoring has been cited as vital to graduate student persistence (Betz, 1994; Ehrhart & Sandier, 1987).

Conceptual Frameworks of Socialization and Mentoring

There are many factors that contribute to a student's persistence and successful completion of an academic course of study. A key theory used in understanding the graduate student's immersion into their chosen field of study is the application of socialization theory, particularly around issues related to mentoring. Socialization is defined "as the process by which a person learns to function within a particular society or group by internalizing its values and norms" (Socialization, 2009). The collective of activities and experiences that combine to create socialization are transferred to the individual through organizational and disciplinary culture (Becher, 1981; 1989; 1999). Tierney (1997) defined organizational culture as "the sum of activities – symbolic and instrumental – that exists in the organization and create shared meaning" (p. 3). In other

words, through the organization's normed behaviors, rituals, and activities new members learn how to communicate, interact, and engage in the environment and with its members; the learned experiences and the members integration into the organization is the process of socialization.

However, socialization of doctoral students (and faculty) can differ based on their disciplinary culture. Becher examined numerous disciplines and fields of study within colleges and universities to understand the cultures within each academic discipline (Becher, 1999). He found that while there were collective common characteristics across the academy and between disciplines, the general process of specialization within a discipline created interesting variation in the field's structure and small pockets of research areas within the discipline. Becher asserted these highly specific and often quite small communities together constituted a discipline but also stated the constant evolution of the research created within the discipline tended to fragment the community into small and smaller units of the specialization, or disciplinary cultures (Becher, 1981; 1999).

It is important to understand the culture that exists within disciplines, as the disciplinary culture creates a shared understanding for the members of the discipline which affects the manner in which individuals are socialized into their fields. According to Becher's (1981) research on the development of a definition of disciplinary culture, the author outlined the role language, discipline taboos (referred to as tribal taboos), epistemological frameworks, and the shared views about the nature of the academic enterprise created to provide commonality within a discipline. For example, social scientists can have positivist, constructivist, or postmodern paradigms to their research; each being valued differently by individuals in other disciplines. Thus, many social

scientists see value in all three paradigms whereas hard scientists value epistemological paradigms grounded in post-positivist approaches to research. Such differences play a role in how graduate students are socialized into the academy.

Becher also indicted that contrasts within disciplines vary over time and place. This finding affirms the understanding that just as the graduate student is socialized into the department and discipline, the graduate student is also changing and influencing culture at the same time. Becher described this process as a "constantly changing kaleidoscope of smaller components" (Becher, 1990, p. 333).

Graduate Student Socialization

Several scholars have discussed the socialization process of graduate students (Antony, 2002; Austin 2002; Baird, 1993; Ellis, 2001; Gardner, 2008b). Graduate student socialization is the process by which new graduate students integrate into their respective departments and disciplines as members of the academic community (Golde, 1998). Golde further explained that "the socialization of graduate students is an unusual double socialization. New students are simultaneously directly socialized into the roles of graduate students and are given preparatory socialization into graduate student life and the future career common to most doctoral students" (pg. 56). According to Tierney and Bensimon (1996) socialization is a two-way process where individuals both influence the organization and are influenced by it. Becher (1990) emphasized the evolution of the organizational culture as members redefined the specializations within each discipline. Graduate student socialization is an active process in which new students begin to learn and extrapolate meaning from the department and discipline cultures while also influencing the organization with ideas, experiences, and values. Through this process,

organizations are learning and changing with the addition of new membership; departments and disciplines are learning and changing with the addition of new graduate students, new faculty, and evolving research specializations.

Generally, the graduate student socialization process consists of several phases or stages depending on the model and author reviewed. Primarily, the stages focus on the developmental nature of the socialization process within each stage. Stages are centered on the anticipation of entering graduate school and the expected experience. Typically, one or more stages focus on the progression through the degree program; usually, the final stage focuses on the culmination and the departure from the program (Antony, 2002, Baird, 1993, Gardner, 2010).

Golde (1998) asserted that graduate students' transition through four tasks within graduate socialization and into graduate student life. The *first task* "is that of intellectual mastery…the second task is learning about the realities of life as a graduate student…the third task is learning about the profession for which one is preparing…[and] the fourth task is integrating oneself into the department" (Golde, 1998, p. 56). To complete the first task, graduate students engage in coursework and begin to work in an intellectual setting such as a lab or other intellectual environment. The primary question associated with intellectual mastery is "Can I do this?" (p. 56).

In the *second task*, graduate students begin to question their value in the pursuit of graduate learning. During this phase, students develop an understanding of the realities of graduate student life. Understanding the struggles and expectations, Golde (1998) indicated that graduate students ask "Do I want to be a graduate student?" (p. 56). They

question the worth and value of the experience compared to the time, cost, pressure, and expectations.

While in graduate school, graduate students begin to explore and learn about the profession of interest; this is the *third task* of the socialization process. Throughout the third task, students are questioning their ability and desire to do the work that is "Do they desire to be faculty?" Golde (1998) stated that the key question graduate students ask is: "Do I want to do this work?" (p. 56). Golde explained that the second and third tasks are tied together and as a graduate student engages in the work of these socialization pieces they determine if graduate school is right for them, if they can see their future in academe.

In the *fourth and final task* of the graduate socialization process, graduate students integrate themselves into the department. While engaged in this task, graduate students are assessing departmental fit and collegial community. Golde (1998) indicated that the critical component of this task is confirming the relationship with other faculty, staff, and peers is a good fit. At this task, the key question graduate students ask is "Do I belong here?" (p. 56).

Mentoring, Socialization, and Attrition

As noted earlier in this chapter, much of the literature concerning doctoral student education is focused on reasons students leave their academic programs without completing their degrees, known as attrition. Research indicates that there are a number of reasons why graduate students leave their academic programs before completing their degrees. The main categories related to doctoral student attrition that have been noted throughout the literature includes: graduate student attrition due to financial reasons, primarily limited funding or lack of funding (Bowen & Rudenstine, 1992; Nettles &

Millett, 2006), graduate student attrition related to gender differences (Herzig, 2004b; Maher, Ford, & Thompson, 2004), graduate student attrition related to racial differences (Ellis, 2001, Herzig, 2004a), graduate student attrition as it relates to the discipline (Golde, 2005, Nettles & Millett, 2006), graduate student attrition related to the socialization experience (Austin 2002; Gardner, 2008; Gardner, 2010; Golde, 1998), and graduate student attrition as it relates to the advisor relationship (Lovitts, 2001; Nettles & Millett, 2006). Each of the six attrition categories provide insight into the experiences of graduate students, this dissertation will focus on the latter two: the graduate student socialization experience and the advisor relationship. Many authors have asserted that the graduate socialization experience holds vital aspects that help to define and grow a graduate student (Stein & Weidman, 1989; Baird, 1993; Weidman, Twale, & Stein 2001).

Graduate student socialization is imperative to a successful graduate student experience (Clark & Corcoran, 1986; Council of Graduate Schools, 2015). Vital to the connection between successful graduate student socialization and persistence, is the role of mentorship as a component of the socialization process. The literature that follows provides information about the graduate student attrition related to the socialization experience and graduate student attrition as it relates to the advisor relationship. With both the socialization experience and the advisor relationship, the research indicates there is a connection between doctoral student peer interaction (Stein & Weidman, 1989) and the notion of the faculty member as a mentor (Austin, 2002; Baird, 1992; Nettles & Millett, 2006).

Attrition and the Socialization Experience

In a longitudinal study of the graduate student experience, Austin (2002) asserted that "development of graduate students as prospective members of the faculty is shaped by many factors that take place in a nonlinear, complex way" (p. 102). Her data revealed that a number of personal attributes and contexts affected how individual graduate students experienced and developed in their graduate programs. Personal attributes and contexts that affected this experience included: age, educational background, family situation, and previous employment.

In addition to the personal attributes and contexts that influenced the graduate socialization process, Austin (2002) indicated that the individual graduate student's discipline and institution also influenced the socialization process. In Golde's (2005) study of the relationship between student departure and department requirements including the nature of research in the discipline, Golde found six attrition themes that connect student departure to department and/or discipline structure and/or culture. The attrition themes were: research practices did not match with student strengths (a component of the discipline), poor fit of expectations between student and department, mismatch between student and advisor, student perceived research faculty life incompatible with personal goals, student perceived job market poor; and structural isolation of student.

From Austin's (2002) and Golde's (1998 & 2005) studies, a number of key results shaped the understanding of graduate student attrition as it relates to the graduate socialization experience. First, graduate students' lives are complex; it is often difficult to separate attrition based on a single factor. Additionally, the discipline, institution, and department environments contributed to the quality of each graduate student's

socialization. The bidirectional influence of the social integration of the graduate student further complicated the interrelationship of the organization factors. In other words, it becomes difficult to tell if the departure started with a graduate student attribute and intersected with an organization's attrition theme or if the discipline, institution, or department was a mismatch for some reason that then created or enhanced a student's personal reason for departure.

While student experiences vary based on personal, institutional, and program factors that are unique to each student's experience, Austin's (2002) data revealed all students report their socialization process included observing, listening, and interacting with faculty; all parts also identified as functions of mentoring. Golde's (1998) data indicated that some department's or discipline's culture influenced departure due to an advisor mismatch, departmental mismatch from lack of community, and the reality of faculty life. The advisor mismatch that Golde's research discussed included difficulty for the graduate student in interacting and connecting with the faculty advisor, another component of the mentoring relationship.

Austin (2002) noted particular concern for the "lack of systematic professional development opportunities, minimal feedback and mentoring from faculty, and few opportunities for guided reflection" (p. 104). The advisor mismatch that Golde (1998) discussed indicated that program structure that required early selection of the graduate advisor led to mismatch and subsequently graduate student departure. Golde noted that the participants whose data aligned with this theme did not want to abandon their studies and ultimately transferred to institutions that were selected based on a strong affinity for the new advisor and ultimately a perceived mentor match.

Nettles and Millett (2006) used the lens of graduate socialization theory as a way to distinguish the various kinds of interaction involved in the socialization process and sought to understand the quality of the graduate student experience and a graduate student's personal connection to people and their discipline. Nettles and Millet incorporated the work of Weidman et al. (2001) as well as the work of Baird (1993) in order to frame the graduate socialization process using a lens focused on community and social interaction. In their study, Nettles and Millet (2006) defined five factors that make up the quality of the socialization experience for graduate students. These factors included: doctoral student perceptions of their social and academic interactions with faculty, their relationships with peers, relationships with mentors and advisors, and their career expectations. Of considerable note is Nettles and Millett's emphasis on the quality, ease, and satisfaction of graduate students' perceptions about their relationships with faculty in their programs as this creates a foundation for mentoring and role modeling by faculty in a student's department. Connected with this perceived faculty relationship, the study looked specifically at the academic interactions with faculty, the interaction with the adviser, and the need to identify and connect with a mentor, linking these factors of socialization to the concept of mentoring as a process imbedded in the successful socialization of graduate doctoral students.

Up to this point, the literature presented in this chapter has focused on studies that look to attrition as a marker for understanding graduate student socialization and by design the social interactions of that experience including mentoring or the lack of these interactions. There is a growing body of research that discusses the need for a model of graduate student persistence that shifts the conversation from graduate student departure to

that of progress towards degree completion. In order to better understand the significance positive mentoring relationships can have on student success, a review of the body of knowledge about student persistence and in particular graduate student persistence is central in moving the conversation from departure to completion.

Persistence

Student persistence in the educational setting is well defined at the undergraduate level (Strayhorn, 2005). The body of research focused on persistence is rooted in the understanding that a student's integration into the academic and social domains of the university are paramount to that individual student's persistence (Astin, 2001; Tinto 1993). Tinto (1993) concluded that a student enters college with precollege experiences and background traits that influence their expectations and commitments to the educational environment.

An overwhelming majority of the literature on student persistence in higher education is focused on the undergraduate student (Strayhorn, 2005). Persistence at the undergraduate level looks at predictors including: socioeconomic background, high school GPA, combined SAT scores, first semester grade point average, participation in financial aid programs, and initial impressions of the institution. Research shows that the two most significant predictors of undergraduate persistence to the sophomore year are first semester grade point average and the student's impression of others. Unlike the predictors associated with undergraduate persistence, Tinto (1993) indicated that the persistence model that graduate students encounter can be based off the same concept of a longitudinal experience compared to their undergraduate counterparts; however, the span of time,

sometimes up to ten years, creates a difference that must be factored in when considering graduate student persistence.

With much of the literature around women in STEM doctoral programs grounded in explorations of reasons for attrition, Tinto (1993) asserted that understanding the variables that aide in graduate student persistence afford academic institutions, graduate departments, academic disciplines, university administrators, faculty, and students an opportunity to create environments that can support students to degree completion. A key factor in Tinto's model on graduate student persistence suggested that the more a student's experiences integrate the student socially and intellectually into university life, department culture, and academic discipline norms, the more likely a student is to persist. In alignment with graduate socialization models, both persistence and socialization assert that while academic factors play a key role in student success, so too does the human relationships and connections made between graduate students and faculty advisors.

Graduate Student Persistence

In Tinto's (1993) work toward a theory of doctoral persistence, the researcher explained that the graduate experience differs from that of their undergraduate peer in that at the undergraduate level persistence can be directly linked to individual and institutional factors. However, at the graduate level, particularly the doctoral level, graduate persistence is influenced by several normative reference groups (local and external) with which the student identifies or integrates. Much like the work of Austin (2002), Tinto (1993) articulated "the process of doctoral persistence is more likely to reflect the specific character of student-faculty interactions than in undergraduate persistence" (p. 232). The influence of both the localized department and the national normative culture of the field of

study contributes to the integration and connectedness that doctoral students feel (Austin, 2009; Strayhorn, 2005; Tinto, 1993). Tinto (1993) compared this framework for graduate student persistence at the doctoral level to that of "being analogous to the conversations sociologists have about the processes of socialization to work and the role normative reference groups play in that process" (p. 233).

Based on the assertion that socialization plays a key role in doctoral student persistence (Austin, 2002; Gardner, 2008a; Tinto, 1993), researchers articulated anywhere from three to five stages of doctoral persistence. Tinto's 1993 writings indicated that each of the stages is tied to transition and adjustment and can be marked at those junctures of the academic journey: admission into the doctoral program; at the point of attaining candidacy; and at the completion of the research project leading to the confirmation of a doctoral degree. Nerad and Miller's 1996 research indicated four prominent points at which graduate student persistence should be ascertained: during coursework; preparation for the oral qualifying exam, finding a dissertation topic, and the dissertation research and writing process. The researchers go on to add a fifth point of reference, that of professional employment. Many of these transition points within persistence align with the research conducted on graduate student socialization and the stages outlined by Golde (Austin, 2002; Baird, 1969; Golde, 1998; Nyquist et al, 1999). The role of mentorship and role modeling during each stage of the persistence process (Girves & Wemmerus, 1998; Golde & Dore, 2001) along with each stage of the graduate socialization process (Austin & McDaniels, 2006; Gardner, 2008a; 2010; Golde, 2005) place emphasis on the importance of academic and non-academic communities and interpersonal support.

As noted earlier in this chapter, the ongoing research and attention paid to STEM enrollment in the United States has placed an emphasis on the reasons students leave STEM programs and in particular the reason for departure among women in STEM. American interest in creating a globally competitive job market rests on the country's ability to train and engage a diverse population of scientists in innovation and critical problem solving. The NSF data from 2006 to 2016 indicated a 23% growth in the graduation of female doctoral students. Additionally, the data reflected an 81% growth for doctoral degree completion of female domestic students. The data also indicated significant gains for women in non-math-intensive STEM fields; however, the continued disparity between degree completion for women and men in STEM fields is disappointing reflecting that the graduation rate for men across all STEM fields was 63% in 2016 compared to 44% for women. NSF (2016a) and U.S. Department of Commerce (2017) data showed a 35% completion gap between men and women in math-intensive sciences, but more staggering than the percentage, graduation for women in mathematics and computer science sat at 959 students while their male counterparts accounted for 2,998 doctoral degrees in the same field. These numbers hold consistent for engineering and physical sciences.

The current literature on graduate student socialization outlines the importance of ongoing engagement with discipline faculty. Additionally, relationship development and integration of students into local and external reference groups, as noted by Tinto (1993), provides a foundation for the importance of intentional mentoring relationships for female doctoral students in STEM (Austin et al., 2009; Gardner 2010; Golde & Dore, 2001). In addition to the role of relationship development of women in STEM, understanding that persistence of domestic female STEM doctoral students is valuable to the academic

institution and the American society as a whole, mentoring and mentoring relationships have been identified as a key aspect of both graduate student socialization and graduate student persistence. The following sections build on the history of mentorships and describes the types and functions of mentoring relationships. The section continues with a review of the influence female role models and mentors have on female graduate students. The outcomes of mentoring relationships for the protégé is also discussed. The mentoring section concludes with a discussion of the role mentoring plays when studied through the lens of graduate socialization.

In Depth Look at Mentoring

Mentoring is not simple, and research has yet to create a universal definition that encompasses all it variables. However, Kram (1985), identified four commonalities of the mentoring relationship.

> First, they allow individuals to address concerns about self, career, and family by providing opportunities to gain knowledge, skills, and competence, and to address personal and professional dilemmas. Second, they benefit both individuals; these relationships thrive precisely because they respond to current needs and concerns of the two people involved. Third, they occur in an organizational context that greatly influences when and how they unfold. Finally, these kinds of relationships are not readily available to most people in organizations; they remain a greatly needed but relatively rare occurrence in most work settings. (p. 2)

These four commonalities lay the foundation for the types of mentoring relationships that individuals engage in. The first two commonalities as outlined by Kram

can be found in both informal and formal mentoring relationships. The latter two are common to formal mentoring relationships established for organizational benefit.

Types of Mentoring

There are two identified types of mentoring relationships: formal and informal. The delineated differences in the two types of mentoring relationships focuses on three key differences: "how the relationship is initiated, the structure of the relationship, and the process involved in the relationship" (Ragins & Cotton, 1999, p. 530). The informal relationship occurs spontaneously and is voluntary for both parties. Structures of informal mentoring relationships are flexible and are loosely defined. In an informal mentoring relationship individuals mutually self-identify and the relationship grows closer over time (Rosser, 2004). In contrast, formal mentoring relationships are structured and monitored by an outside third party. These relationships are typically designed by an organization for the benefit of the organization, whether that be for retention, skill development, or some other organizational purpose. Ragins and Cotton (1999) indicated that the formal mentoring structure can vary from continual scheduled interactions to unplanned interactions. Research on mentoring suggests that formal mentoring relationships have been designed to replicate informal mentoring relationships as a way for organizations to capture the benefits of mentoring in a systematic way (Kram, 1988; Ragins & Cotton, 1999; Rosser & Egan, 2003). Although formal mentoring relationships are constructed to create similar experiences to those of informal mentoring relationships, there are distinct differences and those differences are outlined below in Table 1.

Table 1 ***Types of Mentoring Relationships***

Informal mentoring	Formal mentoring
Develop spontaneously and voluntarily	Assigned by third party
Flexible and loosely structured	Structured
Intrinsic rewards	Extrinsic rewards
Intimate and close	Professional
Mutual identification	Organizationally identified

Kram 1988; Ragins & Cotton 1999; Rosser & Egan, 2003

Informal Mentoring. Defined by a relationship of perceived competence and interpersonal comfort, informal mentoring relationships are often formed based on the mentor's ability to provide meaningful personal assistance (Ragins & Cotton, 1999). Shae (1994) indicated that the informal mentoring relationship is generally described by a mutual understanding and acceptance of the distinct roles each individual will play within the relationship. The learning outcome, whether stated or understood, is dependent on the competence, knowledge, skills, and abilities of the mentor. Typically in an informal mentoring relationship the mentor identifies the needs of the protégé and helps the protégé grow and develop the appropriate skills for the identified needs. Ragins, Cotton, and Miller (2000) asserted that informal mentoring relationships emphasize the achievement of a protégé's long-term personal and professional goals.

Formal Mentoring. In contrast to the informal mentoring relationship, the formal relationship is typically assigned to the members of the pairing by a third party (Ragins et al., 2000). Most times, the relationship is initiated before the mentor and protégé have met, creating an environment where interpersonal comfort is irrelevant. Because formal mentoring relationships are established by a third party, the mentor-protégé pairings are assigned based on information gathered as part of some formal process (Ragins et al.,

2000; Poldre, 1994). These formalized relationships define measurable goals for which the productivity of the relationship will be assessed (Shea, 1994). Additionally, a formal mentoring relationship, especially when set in a systematic and structured program, is typically driven by organizational needs. This organizational need drives a systematic approach to the mentoring relationship in order to determine who and what the relationship will encompass (Gibb, 1999). Unlike informal mentoring relationships that focuses on the long-term goals of the protégé, formal mentoring relationships emphasize the short-term career development of the protégé and the relationship usually lasts between six months and one year (Ragins & Cotton, 1999).

As noted above, the desired outcomes are distinctively different between that of a formal mentoring relationship and the informational mentoring relationship. A mentor in an informal mentoring relationship will invest considerable time to aid the protégé in the achievement of their long-term goals (Ragin et al., 2000). In contrast, formal mentors are usually enlisted to focus on a protégés short-term career development, which is typically applicable only to their current position. Within the formal mentoring relationship "there is a possibility the protégé could gain some personal and long-term benefit but, the organization is usually more focused on short-term results" (Rosser, 2004, p. 34).

Given the distinctive qualities of the informal and formal mentoring relationships, it could be argued that by the design of the faculty-graduate student relationship, the pairing aligns with the formal mentoring relationship. According to Baird (1969); Golde et al. (2006); and Austin (2009), key to the successful socialization of a graduate student is the apprenticeship of doctoral students for the purpose maturing students into the faculty role. For a graduate student to progress into this professional role they will traverse a

number of distinct milestones that define their growth and development both as a researcher in a member of the academic discipline. In addition the structured experience, graduate students usually identify a faculty-advisor prior to arriving at their doctoral institution. The relationship, while mutually agreed upon in most cases, begins with an abrupt start for both parties as they gain an understanding of each other while, formalizing the faculty-graduate student relationship.

In addition to the socialization of graduate students into the ranks of faculty, the key career goal of the faculty-graduate student relationship is to assist the graduate student in completing all the necessary steps to graduate from their program. This one-on-one relationship is formalized to complete this task at the institutional level but, also within the department and discipline. Simply stated a graduate student cannot complete a graduate degree without a faculty chair who approves courses, a degree plan, a research study, and takes responsibility in the verification that the graduate student has met all the requirements for the conferment of the degree.

Gardner's (2010) research on the graduate student experience within specific departments provides a rough outline for the variable nature of the faculty-graduate student relationship. Golde et al. (2006) asserted that the faculty mentor and the student have a "responsibility to help the relationship result in the desired learning. Apprenticeship relationships are more likely to flourish when they cultivate the qualities of respect, trust, and reciprocity" (p. 10). While the work of Gardner (2008a; 2010); Golde (2005); and Golde and Dore (2001) focus on the role of socialization, the data from each study, respectively, indicated that for some graduate students the formalized faculty-graduate

student relationship developed beyond short-term career goals while for others it remained flat or strained, in some instances.

Gardner's (2010) study of high and low-completing departments suggested that advisor relationships which exhibit role modeling and advising assist students beyond persistence within their programs and into more personal support and self-direction. In addition to Gardner's work, Austin et al.'s (2009) study on preparing STEM doctoral students for future faculty careers asserted that intentional program designs focused on key skill development can assist graduate students well beyond doctoral education and into early and mid-faculty career paths. Understanding that there is more taking place within the faculty-graduate student relationship then just a focus on academic progress to degree completion, the relationship indicates a better understanding of mentorship and the key functions of mentoring relationships may help explain the dynamic and complex variables.

Functions of Mentoring

Kram's (1983) research on the phases of the mentoring relationship indicated two broad categories of mentoring: career development and psychosocial functions. The career development function involves coaching, sponsorship, providing challenging assignments, protecting protégés from adverse forces, and fostering positive visibility in the field (Ragins, 1997). The psychosocial function of mentoring helps a protégé to develop a sense of identity, increase their sense of competence, and help promote their effectiveness in a professional role (Rosser, & Egan, 2003). Combined, these two functions of mentoring provide protégés with the professional skills and self-efficacy needed to be successful within the organization structure that the mentoring relationship takes place. Table 2 outlines the subfunctions of each of the two primary functions of mentoring.

Career Development Function. Much like the label states, the career development function of mentoring includes those pieces of the relationship that enhance "…learning the ropes and preparing for advancement in an organization" (Kram, 1985, p. 112). Kram's (1988) research developed five roles of the career development function: sponsorship, exposure-and-visibility, coaching, protection, and challenging work assignments. These roles can be distinct or overlap at any time depending on the knowledge and skill set of the mentor and the development of the protégé. Kram's research indicated that the individual subfunctions of the career development function do not exclusively align with any particular career, job, or role. Kram additionally indicated that the more roles a mentor is able to fulfill, the better developed the protégé will become.

Table 2 ***Functions of Mentoring Relationships***

Career development function	Psychosocial function
Sponsorship	Role modeling
Exposure and visibility	Acceptance and confirmation (self-efficacy)
Coaching	Counseling and advising
Protection	Friendship
Challenging assignments	

Kram 1988; Rosser, 2004

Sponsorship includes actively nominating an individual for formal opportunities. Sponsorship may involve nominations for jobs or promotions. It can also come in the form of recommendations to committees, working groups, or roles within professional organizations. Kram (1988) indicated "sponsorship occurs at formal committee meetings as well as informal discussions with peers, supervisors, and subordinates who participate in the promotion decisions" (p. 25). Rosser (2004) asserted sponsorship is a value gained

from mentoring and should not be a core reason for the formation of a mentoring relationship.

According to Johnson and Huwe (2003), “it is difficult to exaggerate the necessity of sponsorship for success in graduate school” (p. 20). When a faculty member or other mentor sponsors a graduate student, their nomination, endorsement, and promotion can be far reaching, both within and outside the graduate program. Sponsorship for a graduate student has two components. First the mentor’s sponsorship helps the graduate student protégé as they advance within their program. The sponsorship can assist the graduate student in navigating bureaucratic obstacles, may be essential for the advancement to a higher status within the graduate program, and may provide professional exposure within the academic discipline. The second component of sponsorship is that such a function is vital for the graduate student protégé as they seek post-doctoral training and employment. The sponsorship within the academic discipline and affiliated professional organizations set the framework for career advancement.

A second subfunction of career development is the role in which a mentor allows a protégé to demonstrate competence and high performance within an organization. This process is known as exposure-and-visibility (Kram, 1988). The purpose of exposure-and-visibility is to serve as a socializing force whereby the protégé gains needed exposure for career advancement. Through task assignment the protégé is able to develop relationships with key figures of the organization who may judge the protégé’s quality of work, knowledge, and skill sets to be considered for potential advancement. In addition to the intentionality place through the exposure-and-visibility of the protégé, this subfunction also allows the protégé to learn about different parts of the organization.

Exposure-and-visibility in graduate education can provide "opportunities in the form of research opportunities, challenging practica, or teaching and writing opportunities" (Johnson & Huwe, 2003, p. 21). Similarly situated to sponsorship, exposure-and-visibility create a level of risk for both the faculty mentor and the graduate student protégé. A graduate student therefore must be mindful of time commitments, work load, and other obligations to ensure new experiences and responsibilities produce success the faculty mentor can promote within and outside of the graduate program.

Coaching is seen as a central component of mentoring and the third subfunction of career advancement (Goleman, 2000). Coaching is defined as a process that aims to improve performance and focuses on the "here and now" rather than on the distant past or future (Witmore, 2002). Goleman (2000) stated that coaching involves helping others identify their unique strengths and weaknesses and connecting them to their personal and career aspirations. "Coaching is unlocking a person's potential to maximize their own performance. It is helping them to learn rather than teaching them" (Goleman, 2000, p. 87). As a component of career development, Kram (1988) compared coaching in a professional setting to that of an athletic coach, "the senior colleague suggests specific strategies for accomplishing work objectives, for achieving recognition, and for achieving career aspirations" (p. 28).

In continuing with the sports connection, graduate school could be viewed as an athletic event in which the player, the graduate student, looks to the coach, the faculty member, to provide knowledge of the sport, the academic discipline. Additionally, graduate students look to their faculty member, as a coach, for recommendation, consultation, motivation, and encouragement. The faculty member helps the graduate

student navigate department politics, recommend short and long-term career goals, and provide guidance throughout the research process (Johnson & Huwe, 2003).

Protection is a career development function in which the protégé is shielded from potential damaging performance or contacts that could derail or harm the protégé's opportunity for advancement. "Protection involves [the mentor] taking credit and blame in controversial situations" (Kram, 1988, p. 29). The mentor, in addition to this accountability role should intervene when the protégé is ill equipped to achieve satisfactory results.

Johnson and Huwe (2003) asserted that graduate school is occasionally a risky business and the faculty mentor should work to shield their graduate student from "hostility, nonconstructive criticism, or even threats to their status in the graduate program" (p. 23). Johnson and Huwe noted that concern does arise in that there is a fine line between protection and overprotection. Overprotection by a faculty member can lead to the perception that a graduate student is unable to function independently. The authors also asserted caution that overprotection can be particularly problematic for female graduate student protégé's in cross-gendered mentoring relationships as the overprotection can reinforce gender stereotypes.

The fifth and final subfunction of the career development function of mentoring is that of challenging assignments. Kram (1985) explained that essential to a protégé's development is the exposure to work assignments that encourage learning and enhance technical and managerial skills. "The assignments of challenging work, supported with technical training and ongoing performance feedback, enables the junior manager to develop specific competencies and to experience a sense of accomplishment in a professional role" (Kram, 1988, p. 31).

When looking at challenging assignments through the context of graduate school, the nature of graduate school creates a competitive environment where minimal competence and mediocre work produce a liability for the graduate student and the faculty member. Graduate students are expected to steadily improve their skills and must understand this high expectation of work in the academic environment (Johnson & Huwe, 2003). The faculty mentor, knowing the commitment to quality by the graduate student, should willingly provide challenging opportunities to promote their graduate student protégé's development throughout a number of essential tasks and skills related to the academic discipline.

The career functions of mentoring can be directly related back to the graduate student experience. Each subfunction promotes an aspect of the graduate student experience that is designed to enhance and support the academic achievement (persistence) and the career advancement (socialization to the discipline) of the graduate student. In understanding that faculty mentors, by the basic nature of the faculty-graduate student relationship, play a pivotal role in the career development function of their graduate student which aligns this function with a number of graduate social development stages. In addition to the career development functions, faculty members are looked to developing reliance and competence within their graduate students.

Psychosocial Function. Unlike career development, the psychosocial function of a mentoring relationship generally extend beyond organizational advancement and usually incorporates additional areas of a protégé's life (Kram, 1988). Crucial to the psychosocial function is the emotional bond that is developed between the mentor and the protégé. This strong interpersonal relationship allows the mentor to enhance the protégé's self-efficacy

through a process Kram labeled as acceptance-and-confirmation. In addition to the acceptance-and-confirmation role, Kram identified three additional subfunctions of the psychosocial function of mentoring: role modeling, counseling, and friendship.

The first of the four subfunctions of the psychosocial function of mentoring is role modeling. Role modeling is the most common subfunction and focuses on the mentor setting a desirable example for the protégé. When mentoring relationships facilitate mutual respect, protégés seek to mimic their mentor through gaining similar knowledge, demonstrating similar skills, and exhibiting similar decision making strategies. According to Kram (1985) "a senior colleague's attitudes, values, and behavior provide a model for the junior colleague to emulate" (p. 33). Kram (1988) emphasized that the success of role modeling is dependent on the emotional connection formed between the mentor and the protégé.

Like business and other levels of education, the graduate experience is infused with the importance of role modeling. Johnson and Huwe (2003) stated "the entire graduate school experience is often predicated on availability of excellent faculty role models" (p. 24). More often than not, a significant portion of the graduate socialization process is embedded in the routine demonstration of tasks including teaching, research, writing, presentations, publications, and grant application and acquisition. Based on observation and then repetitious execution, the graduate student masters the roles of the discipline and the faculty mentor becomes the object "of admiration, idealization, emulation, and respect" (Johnson & Huwe, 2003, p. 24).

The acceptance and confirmation subfunction provides both the protégé and mentor with a sense of self (Kram, 1988). Based on the positive regard conveyed by the mentor to

the protégé and a similar conveyance of care from the protégé to the mentor, a sense of self and a feeling of appreciation and worth develops. Kram's (1988) research suggested "a relationship that provides this function has a basic trust that encourages the young adult to take risks and to venture into unfamiliar ways of relating to the world of work without fear of rejection" (p. 35).

Graduate student protégés who receive acceptance from their faculty mentor are willing to trust their faculty mentor and this trust leads to engagement in new and challenging tasks. Clark, Harden, and Johnson (2000) found that acceptance and confirmation was the most frequently reported psychosocial function of mentoring provided to graduate students. Phillips-Jones (1982) indicated that protégés' believed the best mentors "encouraged them to be all they could be with prejudiced, unfailing confidence in them" (p. 35). This type of belief, when directed at a graduate student creates an environment where a graduate student protégé willingly takes more risks then they previously thought possible. Kram (1985) calls this behavior risk stretching and is a direct result of acceptance and confirmation.

The third subfunction of psychosocial functions of mentoring is that of counseling. In the counseling subfunction, the mentor takes on the role of counselor by providing the protégé a sounding board in which to explore ideas, share fears, and discuss any uncertainty the protégé is feeling. "The counseling function helps the individual to explore personal concerns that may interfere with a positive self-esteem" (Kram, 1988, p. 36). Kram also asserted that not only the content of the counsel but the process of the counsel was important to the subfunction of counseling. A mentor who can listen and provide

advice based on a similar experience creates a road map for the protégé to overcome internal conflicts and develop more advanced strategies for problem solving.

In accordance with the goals of counseling, the graduate student experience relies on this process as a way for the graduate student to reflect and adjust personal reasoning to better cope with the struggles of being a graduate student. The graduate journey inherently creates pragmatic and philosophical questions that resonate from the graduate student and are often explored through discussion and reflection (Johnson & Huwe, 2003). O'Neil and Wrightsman (2001) indicated that the good faculty mentor facilitates the counseling process by actively listening and reflecting on personal experiences and feelings. The faculty mentor should help clarify the graduate student decision-making strategies, assist with goal setting, help to fight and conquer a protégé's inner doubts, and work with the graduate student to articulate personal and professional dreams. The counseling subfunction can build a foundation for other subfunctions to operate from based on key components of trust and communication.

Friendship is the final subfunction of the psychosocial aspect of mentoring. Mentoring relationships typically do not start out as friendships. This is especially true for formal mentoring relationships that are established for the benefit of the organization and pairings are managed externally from the informal relationship. Overtime, with the investment of the mentor's experience and guidance, the protégé and mentor may engage in informal interactions and conversations that can lead to the protégé feeling more like a peer to the mentor than that of a subordinate or junior colleague (Kram, 1985). The developing friendship adds a deeper sense of enjoyment and connection for both parties. Kram asserted that while the mentoring relationship may evolve there can continue to be

intentional development by the mentor for the protégé with the added bonus of both parties having "someone [they] enjoy sharing personal experiences with, eating lunch with, or at times, someone to escape from the pressures of work with" (p. 38).

Mentorship relationships that evolve into friendships redefine themselves (Ragins & Cotton, 1999). For the faculty mentor and graduate student protégé friendship may be part of an endpoint for the mentoring relationship given the nature of the faculty-graduate student dynamic. There is a mutuality that exists in the development of the friendship subfunction. This mutuality "implies that both the faculty mentor and graduate protégé intentionally offer each other positive regard and trust while remaining sensitive to the other's personal and professional needs" (Johnson & Huwe, 2003, p. 25). The mentor and protégé value each other as individuals in much the same way that faculty colleagues value one another.

It is important to note that no mentor relationship embodies all of the functions of career development and that of psychosocial functioning. Levinson et al. (1978) noted that mentoring "is not defined in terms of formal roles but in terms of the character of the relationship and the functions it serves" (p. 98). In Clark et al.'s (2000) study of psychology graduate students, the data indicated that graduate students were most likely to receive a combination of both career development and psychosocial functions including: direct training and instruction; acceptance and confirmation; role modeling; and sponsorship. Austin and McDaniels' (2006) article addressing the preparation of the professoriate of the future stated that during the formal stage of socialization, the graduate student must seek clarity of expectations and standards, understand the nature of the activities in which they will participate; and the amount of time they have for trying out

new roles. Here the career development functions of direct training are outlined. It is noted that within the formal stage of socialization learning is experienced through observation. The same holds true for the third stage of socialization in which the graduate student learns about the informal role expectations of the academic discipline. The role modeling demonstrated by faculty as well as senior graduate students along with observation from the junior graduate student support the development of the informal socialization stage. In the fourth and final stage of socialization, the personal stage, the graduate student internalizes their new roles and integrates into their professional identity relying on their developed self-identity by utilizing the acceptance and confirmation of the mentor to establish this professional identity.

Women and Mentoring

Mentoring is intertwined with the cultural expectations of women as nurturers and caregivers (Bizzari, 1995). The 1983 work of Gilligan and Lyons focused on gender-related identity development. Their work, as cited by Belenky et al. (1997), has shown that the responsibility orientation, found in morality theory, "is more central to those whose conceptions of self are rooted in a sense of connection and relatedness to others, whereas the right orientation is more common to those who define themselves in terms of separation and autonomy" (p. 8). Mentorship can play a key role in fostering the responsibility orientation that is described in gender-related identity development theory. Because women's relationship to the responsibility orientation key aspects of successful mentorship is associated positive outcomes for women. The gender composition of the mentoring match has been shown to matter in supporting women to achieve a sense of connection and integrated experience to others.

In a 2009 study conducted by Fried and MacCleave, the researchers sought to understand the degree of influence mentoring and role modeling had on female graduate students' choice of science as a career. The data indicated that more men than women identified role models as influencing their career decision. Given that there are more male role models and prospective mentors in STEM, the researchers' purported that women scored higher on the mentoring factor scale then men but found engagement difficult. Fried and MacCleave (2009) asserted that "it was sufficient for men to observe and emulate someone they admire, whereas women required a more hands-on, personal approach of mentoring" (pp. 492-493). Additionally, the data suggested that women identified a greater desire for connection to a female academic advisor. This finding is not surprising considering that an individual is more likely to identify with a role model who is the same sex as oneself (Shapiro, Haseltine, & Rowe, 1978).

Settles, Cortina, Steward, and Malley's (2007) research looked at the role that voice or influence had on moderating the negative effects of a poor workplace climate for women in STEM. In their research, the authors found that women scientists who viewed their climate as more sexist, generally poorer, or more hostile were less satisfied with their jobs than those who viewed the climate as less negative. Additionally, the researchers found that women who felt they had voice in departmental matters articulated a reduced perception of negative work environments. Settles et al. found that mentors may increase an individual's sense that they have a voice or an ability to influence their work environment. "We assessed experiences of various types of mentoring (e.g. role modeling, advising, advocacy) from male and female mentors and found that the more mentoring that female scientists received from other women, the greater their sense of voice" (p. 278).

Mentoring theory indicated that same-gender mentor relationships provided both the protégé and the mentor a heightened awareness of connectedness, stronger communication, and sense of community (Ragins, 1997; Ragins & Cotton, 1999). While the research on mentoring reports more significant outcomes in same-gender mentor relationships, the possibility of female STEM doctoral students making these connections is limited. According to NSF (2017), female faculty filling full-time, full professor posts in the United States, only account for 22% of STEM faculty positions. There is hope for a stronger same-gender match when assistant and associate tenure track female faculty members are also considered. Women who identify in this broader STEM faculty category account for 35% of STEM faculty at all levels. Yet, the burden of navigating the tenure process finds these women reluctant to take on the support and mentorship of female STEM doctoral students (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007).

In research conducted by the United States Government Accountability Office (USGAO), reports produced by the office focused on both women's representation and support through federal grant funding as it relates to Title IX (USGAO, 2004), and information presented on men's and women's participation in higher education. The USGAO (2000) consistently indicated a value for increased participation of women in higher education, especially in the STEM fields. One key finding from the 2004 USGAO report indicated that women continue to report lower participation rates at advanced levels of higher education.

> Some of the women students and faculty with whom we talked reported that a strong mentor was a crucial part of their academic training. In fact

> some students and faculty told us they pursued advanced degrees because of the encouragement and support of mentors. Some felt having women mentors, who served as role models, was important for women considering careers in the sciences. Some pointed out that with few faculty women in some departments in the sciences, it was hard for women students to find women mentors. (pp. 19-20)

As women continue to be underrepresented in STEM majors and careers in most industrialized countries around the world, "concern[s] about America's ability to be competitive in the global economy has led to a number of calls to action to strengthen the pipeline in these fields" (Hill et al., 2010, p. 2). Given that cross-gender mentoring is especially likely for women scientists, simply because there are fewer women in science to serve as mentors, it is important for research to identify why male mentoring does not promote women protégés' voices according to the research conducted by Settles et al. (2007). Research indicates that the mentoring benefits of same-gender mentoring is substantial but the obstacles to realizing these matches is just as significant when assessing the landscape of STEM disciplines (Parker & Kram, 1993). In additional to the statistical evidence that indicates same-gender matches in STEM are scarce, Young, Cady, and Foxon (2006) maintained that when attachment theory was used to understand mentoring relationships, it provided a strong foundation for the study of gender differences in mentoring relationships. Young et al. indicated women developed general relationship skills differently than men. These skills helped identify an individual's ability to develop, maintain, and successfully transform relationships. Building on research that defines

success in cross-gendered mentoring relationship may enhance the persistence of domestic female doctoral students in STEM.

Outcomes of Mentoring

Werner and DeSimone (2009) connected mentoring to training and development and also suggested that mentoring contributes to both life development and career development. Research indicated that overall being a protégé has a favorable outcome on career and personal development. Positive outcomes associated with the protégé include: reduced initial entry shock; increased career guidance; increased visibility; and improved mental well-being (Rosser, 2004). These outcomes defined in terms of higher education are described as: "support during the transition from graduate school to faculty; having an institutional role model; gaining a deeper understanding of role expectations; being privy to insider information such as grant funding, research, and writing opportunities; receiving entry into networking circles; as well as simply having someone to assist with career decisions" (Holmes, Land, & Hinton-Hudson, 2007, p. 105).

What links mentoring outcomes to the persistence of female doctoral students in STEM is the connectedness that women specified as important in navigating the doctoral program. Austin (2002), Baird (1969), and Bruce (1995) all indicated that mentoring (which has also been articulated as role modeling in the literature) is a key competent of successful socialization and retention of graduate students. Kram (1985) identified four commonalities in mentoring relationships:

> First, they allow individuals to address concerns about self, career, and family by providing opportunities to gain knowledge, skills, and competence, and to address personal and professional dilemmas. Second, they benefit both individuals; these

> relationships thrive precisely because they respond to current needs and concerns of the two people involved. Third, they occur in an organizational context that greatly influences when and how they unfold. Finally, these kinds of relationships are not readily available to most people in organizations; they remain a greatly needed but relatively rare occurrence in most work settings. (p. 2)

Summary of the Review of Literature

Based on the results from Austin's research that graduate students reported minimal feedback and mentoring from faculty and understanding that mentoring and the functions of mentoring are intertwined throughout the stages of graduate student socialization, this study will focus on the role that mentoring plays in the persistence of female domestic STEM doctoral students through the lens of socialization. There continues to be a significant lapse in the number of female doctoral students that persist in STEM fields. Graduate students indicate that an important component of their experience involves their socialization into their field, and cite limited intentional and structured mentoring as part of the socialization process (Austin, 2002; Gardner, 2010) The gap begs the question about the importance that mentoring may play in the persistence of graduate students. Additionally, the literature on mentoring relationships suggests that the primary role of the faculty-graduate student relationship is formal, often initiated before a graduate student arrives at the institution and focused on formalized goals of academic coursework completion and degree attainment. Graduate student socialization literature asserts that graduate students identify other support mechanisms within their departments or academic disciplines that assist in individual success such as other faculty and staff within the department, other graduate students, or broader campus and community groups (Austin,

2002; Gardner, 2008a; Gardner, 2010; Golde, 1998; Tinto, 1993). Gardner (2010a) noted that graduate students indicated their primary outlet for support and connection is from their community of other graduate students.

Examining the role that mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization provided an opportunity for the exploration of complex connections between the graduate student experience in STEM fields and the integration of graduate students into the academic rigor of graduate education. Building on the review of literature outlined in this chapter, Chapter III introduces the qualitative research methodology used for this study and outlines the study design. The chapter concludes with a review of the data analysis process.

CHAPTER III

METHODOLOGY

The purpose of this chapter is to introduce the research methodology for this qualitative study regarding the role that mentoring plays in the persistence of female domestic STEM doctoral students through the lens of socialization. Specifically, the study focused on the mentoring relationships developed between female doctoral students and their faculty advisors. As outlined in Chapter II, the literature has indicated a connection between the process of graduate student socialization and the mentoring relationship developed between graduate students and their faculty advisors. This study explored the formal mentoring relationships developed with faculty advisors and the informal mentoring relationships developed with peers, other faculty, university administrators, and/or community members. The case study approach allowed for the research to be set by the boundary of female doctoral students in STEM fields. This boundary created an opportunity to understand the mentoring relationships these women had with others, particularly their faculty advisor.

This chapter begins with an overview of qualitative research methods, followed by an explanation of the social constructivist paradigm and the qualitative case study design. The research design section includes information on the methodology as it relates to the research questions, recruitment and selection of the study participants, information about the data collection methods, strategies used for ensuring trustworthiness, and a review of the data analysis techniques. Finally, the chapter concludes with a discussion of the research limitations.

Restatement of the Research Purpose and Questions

The purpose of this study was to examine the role that mentoring plays in the persistence of female domestic STEM doctoral students. This topic is significant for two reasons. First, little literature is available about the factors that lead to the persistence of female students in STEM. Second, in spite of increased number of women enrolling and moving through the STEM pipeline, many math-intensive STEM fields (engineering, computer science, math, and physical sciences) have significantly smaller enrollment and graduation rates of female students, particularly at the doctoral level. This study helped to explore structures of connection that can enhance enrollment and particularly persistence of women in doctoral STEM programs.

Graduate student socialization theory indicates that key to successful socialization in a field, a graduate student needs to make meaningful connections with their advisor and others in their field or program (Austin, 2002; Golde, 2005). This study was designed to address these issues by exploring the mentoring experiences of female domestic doctoral students. The following research questions guided the study:

1. What are the experiences of female domestic STEM doctoral students in mentoring relationships?
2. What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?
3. Does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students?

Social Constructivism

To better understand my own philosophical assumptions, I discuss Creswell's (2007) five philosophical assumptions: ontology, epistemology, axiology, rhetoric, and methodology. I identify my personal viewpoints and values as they relate to each of the assumptions presented.

Ontology is the study or concern about what kinds of things exist, what constitutes reality, "in other words, what is" (Scotland, 2012, p. 9). When considering an ontological stance, a researcher must explore if they believe social reality exists independently of the human understanding and interpretation. Ontological positions include realism, idealism, and materialism (Snape & Spencer, 2003). Realism claims that there is an external reality independent of what people may think or understand. Idealism maintains that reality can only be understood through the human mind and is therefore socially constructed. Materialism claims that there is a 'real world' but that world only consists of material and physical structures, indicating that other phenomena like beliefs, values, and experiences arise from the material world but do not shape the material world itself (Snape & Spencer, 2003). As a researcher, I take on an idealism framework believing that reality can only be understood through the social constructs and personal experiences brought on within the human mind; therefore, reality is subjective.

Epistemology is concerned with the nature and forms of knowledge (Scotland, 2012). Epistemological assumptions are concerned with how knowledge can be created, acquired and communicated; in other words, what it means to know (Guba & Lincoln, 1994). Theories within the field of epistemology include positivism and interpretivism. Constructivism and naturalistic inquiry are terms commonly used to refer to interpretivism.

Positivism holds that every assertion or belief can be scientifically validated and replicated. Interpretivism or constructivism is the basic principle that reality is socially constructed (Guba & Lincoln, 1994). My epistemological framework is that reality is constructed and based on one's own experiences and interactions with the world around them.

Axiology is the study of judgements about the value of something. According to Hill (1984), values are foundational for both knowledge-producing systems and social projects. This paradigm attempts to clarify if the researcher is trying to explain or predict the world or if the researcher only seeks to understand it. In simple terms, axiology focuses on what a researcher values in their research (Lee & Lings, 2008). For this study and in my personal research philosophy, research should seek to understand the world as it is constructed by others.

The rhetoric of research is the art of writing or speaking effectively. When looking to the rhetoric paradigm, Creswell (2007) indicated that the paradigm explores how language is used to express meaning. For positivist research, rhetoric employs experimental and correlational language to reduce error, bias, and other noise. For the constructivist researcher, rhetoric creates understanding through definitions of situations and thick, rich description that provides enough "description that the reader will be able to determine how closely their situations match the research situation" (Merriam, 1998, p. 211). Based on my ontological and epistemological beliefs, my research rhetoric values descriptive language used to explore, understand, and explain the experiences of others.

Creswell's (2007) final philosophical assumption is that of methodology. As noted in the introduction to qualitative research in this chapter, methodology "is a theory of how inquiry should proceed. It involves analysis of the assumptions, principles, and procedures

in a particular approach to inquiry (that, in turn, governs the use of particular methods)" (Schwandt, 2001, p. 161). The two large fields of methodology are defined as qualitative and quantitative research. Quantitative research includes experiments and survey research. Qualitative research uses observation, interviews, field work, among other data collection methods, to collect data. Of the many methods available for use with qualitative research, this research study used a case study approach to collect data.

Qualitative Research

Methodology "is a theory of how inquiry should proceed. It involves analysis of the assumptions, principles, and procedures in a particular approach to inquiry (that, in turn, governs the use of particular methods)" (Schwandt, 2001, p. 161). Creswell (2003) provided three broad methods for conducting research. The first is a quantitative approach. "Strategies of inquiry associated with quantitative research…invoke the post positivist perspective. These include the true experiments and the less rigorous experiments called quasi-experiments and correlational studies" (p. 13). The second research method is that of qualitative inquiry.

Qualitative research acts as an umbrella term covering several forms of inquiry that help to describe and explain the meaning of social phenomena with as little disruption of the natural setting as possible (Merriam, 1998). The literature on research methodologies indicates that when trying to understand people's experiences a qualitative research is best utilized to for those explorations (Denzin & Lincoln, 2000). Qualitative research is concerned with experiences as "they are 'lived' or 'felt' or 'undergone'" (Sherman & Webb, 2001, p.7). Merriam (1998) explained that qualitative researchers are "interested in understanding the meaning people have constructed that is how they make sense of their

world and the experiences they have in the world" (p. 6). Qualitative research according to Creswell (2003), can involve a number of research approaches: narratives, phenomenological studies, ethnographies, grounded theory, and case studies. The third research strategy that Creswell offers is that of the mixed method approach. In this approach the researcher engages in both the quantitative and qualitative strategies previously discussed.

Creswell (2003) provided eight characteristics of qualitative research: qualitative research takes place in the natural setting, it uses multiple methods that are interactive and humanistic, it is emergent rather than tightly prefigured, and it is fundamentally interpretive, qualitative researchers view social phenomena holistically. Additionally, qualitative researchers systematically reflect on who they are in the inquiry and are sensitive to their personal biography and how it shapes the study, they use complex reasoning that is multifaceted, and they adopt and use one or more strategies of inquiry as a guide for the procedures in the qualitative study. Merriam (1998) identified five characteristics of qualitative research that align with Creswell but provide a slightly different perspective. These five characteristics are explained as such: "that the key concern is understating the phenomena of interest from the participants point of view; the researcher is the primary instrument for data collection and analysis; the research usually involves field work; the research primarily employs an inductive research strategy; and the product of the research is richly descriptive" (pp. 6-8). In addition to the methodology itself, the research approach is also guided by the researcher.

A researcher's philosophical assumptions guide the research design. According to Creswell (2007) there are five philosophical assumptions the researcher makes that

determines the choice of research. The five philosophical assumptions are: ontology (the nature of reality), epistemology (the nature of knowledge), axiology (the role of values), rhetoric (the language of research) and methodology (the research process). The researcher identifies and takes a stance on each of the five assumptions drawing from personal beliefs and values. The stances and personal identification of the researcher is then applied to inform the research design (Creswell, 2007).

Case Study Approach

To best answer the research questions outlined in this study and to appropriately incorporate the research philosophies outlined above, a case study approach was used. Case studies have become a commonly used method to conduct qualitative research (Creswell, 2003; Merriam, 1998; Stake, 2000). In the Dictionary of Qualitative Inquiry, a case study method is defined as a "strategy for doing social inquiry…[where] the case is at center stage" (Schwandt, 2001, pp. 22-23). Merriam (1998) indicated that the case can be seen as a single entity or better described as a unit around which there are boundaries. Stake (2000) defined the case study strategy as one in which the research explores in depth a program, an event, an activity, a process, or one or more individuals.

"The case study can be further defined by its special features. Qualitative case studies can be characterized as being particularistic, descriptive, and heuristic" (Merriam, 1998, p. 29). Case studies are particularistic based on the ability to use them as a means to focus on a particular incident, event, program, or phenomenon. "The case itself is important for what it reveals about the phenomenon and for what it might represent" (p. 29). The characteristics surrounding the specificity of the focus (interior of the boundaries) make it "an especially good design for practical problems" (p. 29). The descriptive nature

of the case study methodology provides an end product full of thick, rich description about the case under study. The full, complete, literal description of the case being studied provides a clear, precise understanding of the phenomena. The rich and robust descriptions aid in the heuristic nature of the case. The heuristic nature of case studies implies an active role for the reader, in which the reader leaves with a greater understanding of the phenomenon under study. Researchers can "bring about the discovery of new meaning, extend the reader's experience, or confirm what is known" (Merriam, 1998, p. 30).

Merriam (1998) made clear that an essential element in choosing the case study as a methodological approach is the ability to identify the boundaries of the case. The researcher should be able to "fence in" what they wish to study. In this study the case is bounded by utilizing STEM fields at one university located in the Southern United States to set the initial boundary. Here, the research will look specifically at the case, or the unit, of female STEM doctoral students. By utilizing one university's STEM doctoral degree programs to recruit participants, as noted in the operational definitions located in Appendix A, a clear understanding of the integrated system is offered (Stake, 2000).

Research Design

The purpose of this research was to examine the role that mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization. The study adheres to the concept of interpretivism through the meaning these women make from their lived experiences and therefore should be researched through a qualitative method (Merriam, 1998). Given the concise parameters assigned to the participant experience, that of STEM doctoral study, the narrowed down pool of perspective eligible participants naturally lent itself to the use of case study methodology for the research

design. The use of this qualitative research methodology allowed for each female student's personal experiences with mentoring to be explored and explained from their individual perspectives, as well as developed common themes that the women articulated as shared experiences.

A single-institution case study was deemed appropriate to explore the phenomenon of mentoring among female domestic doctoral students in STEM. Choosing one institution and examining it through college and degree programs, culture, and graduate student experiences was ideal to provide additional boundaries to the case. Although a weakness of the single-institution case study is the limited generalizability of the results, the goal of the case study is particularization, not generalization (Merriam, 1998). The clear parameters set by the single-institution case study design allowed the researcher to explore the concepts of doctoral student mentoring in a well-defined setting. Enough variability of difference existed with the diversification of field of study and therefore participant's college affiliation using the single-institution case study reigned in the variation of additional academic and campus climate practices.

Merriam (1998) stated that "once the general problem has been identified, the task becomes to select the unit of analysis, the sample" (p. 60). Due to the volume of available sites and potential students to be interviewed, the researcher had to consider where, when, and whom to interview and observe.

Site Selection

Erlandson Harris, Skipper, and Allen (1993) suggested that "the selection of a suitable site is a critical decision in naturalistic research…Site selection affects the viability of the whole study, and great attention should be given to this process" (p. 53). Noted as

key factors in the determination of an ideal site are: is entry possible; is there a high probability for a rich mix of people, interactions, and structures being studied; is the researcher able to maintain an appropriate role for continuity as long as necessary; and is the data quality and credibility of the study reasonably assured. The identification of the site was selected to maximize the opportunity to engage with the identified population. Selecting a site with enough STEM doctoral programs, as well as domestic female students, was used to help determine the case study site.

The selected site was a large, public research institution that was constructed of 16 colleges, 11 of those being focused in research and doctoral education defined by NSF as STEM related. There were 78 graduate degree granting departments focused on STEM areas throughout the 11 colleges. During the fall of 2018 when female domestic doctoral students were recruited and interviewed, the university boasted a graduate enrollment of 12,591 students, approximately 47%, or 5,865 of those enrolled graduate students were doctoral students. Just under half, 2,631 doctoral students identified as female. Narrowing down that number to female domestic students produced 1,787 prospective participants. Finally, the available group of perspective participants was narrowed down to 997 graduate students when looking at enrollment amongst the 11 colleges offering STEM focused doctoral degrees.

Additional to the value of the prospective pool of participants available to the researcher, the already established connection to several members of the graduate community provided for the potential of easier identification and recruitment of participants. For this study, the site selection was based on the researcher's knowledge of the institution, recruitment, and availability of the researcher for interviews, follow-up, and

member checking. The Institutional Review Board approved the site location as a component of the qualitative research process (Appendix B).

Participant Recruitment and Selection

This study used a purposive sampling strategy for the recruitment of participants. Schwandt (2001) explained that in a sampling logic using purposive strategy, "units are chosen not for their representativeness but for their relevance to the research question, analytical framework, and explanation or account being developed in the research" (p. 232). Here, the unit was the participants. The purposive strategy was to identify female STEM doctoral students with at least three years of enrollment in their graduate program. The three plus year enrollment mark was selected for two reasons. According to the data presented by the Committee on Maximizing the Potential of Women in Academic Science and Engineering (2006), women's departure from STEM doctoral programs primarily happens in two phases. The research labeled those who leave within their first two years as early departures. Students that fall into this category typically report either a mismatch with their perceptions of the field and their interests or they determine that doctoral education is not for them.

In contrast to early departures, women's departure from STEM doctoral programs any time after the completion of the second years are categorized as late departures. Data from the U. S. Department of Education (2000) confirmed that female STEM doctoral students delay longer in their educational programs than do their male counterparts. The choice of three years allowed for this study to focus on those whose educational desires aligned with their current academic pursuits but may have become delayed to graduation due to factors related to late departure. The second reason the minimum of three years of

enrollment was chosen was that including persistence for three or more years, yielded a higher likelihood that the student participant had developed a mentoring relationship and therefore was able to articulate experiences that enhanced or inhibited their educational pursuit.

The boundaries of the case required that participants be enrolled full-time in a STEM doctoral program. Students were recruited from a Doctoral University – Very High Research located in the Southern U.S. The selection of this institution focused on the fact that the institution was a large public institution offering 75 plus doctoral programs in NSF's defined STEM fields, many of which are highly ranked. The institution boasted more than 25 STEM doctoral programs, of the 75, ranked in the top 50 of their respective discipline. High ranking programs included: Aerospace/Aeronautical/Astronautical Engineering, Biological/Agricultural Engineering, Nuclear Engineering, Petroleum Engineering, Chemistry, Physics, and Statistics, to name a few. Additionally, the institution was first in its state and 12th in the nation to graduate the most women in STEM. Based on the significant institutional standing for STEM education, my goal was to identify 10-15 female domestic doctoral students currently pursuing their degrees at this Research University – Very High and considered a top tier institution.

Qualitative research employs purposive sampling to define the parameters of the population. Erlandson et al. (1993) defined this process as different then the random sampling used in quantitative studies because naturalistic research:

> … requires a procedure that is governed by emerging insights about what is relevant to the study based on the focus determined by the problem and purposively

> seeks both the typical and divergent data to maximize the range of information obtained about the context. (p. 148)

Purposive sampling strategies are non-random approaches used to ensure that a particular category or categories of cases are placed within the research sample. Robinson (2014) asserted that the researcher employing a naturalistic method assumes that certain categories of individuals have unique insight and experiences about the topic being studied.

In addition to purposive sampling, a snowball sampling approach was used to identify participants. Snowball sampling is a method used to recruit participants in a research study where already identified research participants are asked to identify other participants eligible for the study. Snowball sampling is used when potential participants are hard to find and is called snowball because once a researcher has identified one or two participants, those participants get the ball rolling; as the recruitment ball rolls, it picks up more "snow" (potential participants) along the way, becoming larger and larger (Robinson, 2014).

To begin the recruitment of participants for this research study, I provided an email for participants to the officers and delegates of the graduate student government. The use of this organization allowed for dissemination of the request to all STEM doctoral degree granting programs through the department graduate delegates. As delegates were able to identify several graduate students who met the participant criteria, I asked delegates to send an invitation to the prospective participants about the study (Appendix C) and how to connect with me. Additionally, as participants identified themselves to me as meeting the criteria for participation and expressed an interest to participate, they were asked to identify other female STEM doctoral students eligible for the study based on the criteria. In

addition to the graduate student government email as a means of recruitment, faculty members affiliated with STEM programs were asked to identify and invite prospective participants to learn more about the study.

The formal invitation email (Appendix C) contained an overview of the study and was sent to 15 graduate student government officers. The officers both forwarded the email to the 80 plus delegates of the organization as well as to perspective participants in their own programs. Additionally, the graduate student body president shared the email with the president of the Women in Science and Engineering (WISE) student organization who subsequently shared it on the organization listserv.

The purpose of the sample size was to maximize new information received (Lincoln & Guba, 1985). Central to the core of the sample size was to reach redundancy. Initially 18 women self-identified to participate in the study. Not part of the initial design or research questions, but a pleasant surprise from the recruitment strategy was that initial interested participates represented at least one participant from each of the 11 colleges offering STEM doctoral degrees. After scheduling logistics of interviews and reviewing the consent document with the perspective, 13 women were interviewed for the study. Seven of the 11 colleges offering STEM doctoral degrees are represented in the pool. Additionally, one participant chose to be removed from the research study after her interview, leaving the data set at 12. No additional participants were recruited as interviews began to yield similar responses to the development, cultivation, and preservation of mentoring relationships.

Data Collection

Erlandson et al. (1993) asserted that the naturalistic researcher conducting qualitative research understands that objectivity in research is an illusion, thus freeing the researcher to truly collect and analyze data. The authors asserted that the researcher using themselves as a human instrument, to both collect and analyze the data, provides advantages that far outweigh the perceived disadvantages of loss of objectivity. Since the primary purpose of gathering data in a naturalistic study is to "gain the ability to construct reality in ways that are consistent and compatible with the constructions of the setting's inhabitants" (p. 81), the researcher employed a natural human process of obtaining data and making tentative meaning of the data. As new data was obtained, the researcher revised and refined the constructed meaning. This process is how humans solve problems daily. Unlike the quantitative researcher, who follows a rigid and prescriptive protocol to data collection and analysis, the qualitative researcher followed guidelines that are modified and refined throughout the study, this aided in the improvement of understanding the constructive experiences related to the research question.

Qualitative research prescribes to three major sources of data collection: interviews, observations, and documents (Merriam, 2002). Data collection in a naturalistic study typically occurs through interviews and a review of documents and reports (Creswell 2007, Merriam, 2002). Merriam (2002) stated that interviews in a qualitative study can range from highly structured to unstructured. The highly structured interview follows a predetermined prescriptive approach where the questions, the order, and any additional arrangement are determined ahead of time. The unstructured interview has no structured questions or order but instead uses topical areas to explore the information presented.

"Most interviews fall somewhere in between" (p. 13). The semi-structured interviews contains a mix of some structure and predetermined questions but they are used to guide the conversation instead of direct. Usually within a semi-structured interview, there are specific questions or topics the researcher wants to obtain from all participants, however, the how and when those questions are answered is fluid.

Interviews

As the interview is a "conversation with a purpose" (Dexter, 1970, p. 136), this study used individual interviews of 45-60 minutes per participant. According to Merriam (1998), person-to-person interviews are the most common encounter to elicit information from one individual to another. The interviews were conducted in a semi-structured format. "A semi-structured interview is guided by a set of basic questions and issues to be explored, but neither the exact wording nor the order of questions is predetermined" (Merriam, 1998, p. 74). Interview questions were semi-structured in order to invite the participants to reflect on their mentor/mentee relationship from the time the participant could identify that the mentoring relationship began to the present day. An interview protocol was developed to aid in the semi-structured sessions (Appendix D). I developed the interview protocol based off the reviewed literature on socialization theory, mentoring theory, and STEM data gathered from NSF. The tone of the interviews was conversational, allowing the participant the opportunity to set the pace and tone for their sharing, allowing them to determine what was comfortable to share. Based on Merriam's (1998) guidance, the first questions were intended to help set the participant at ease and establish rapport.

Each interview began with a review of the purpose of the research study and the intent behind the interview to understand the participants' relationships with mentors as

appropriate. As part of the interview protocol, a review of the consent form was conducted. Participants were asked for permission to audio record interviews. The interviews were conducted as a conversation using the questions in the interview protocol as a guide and were not prescriptive. Interview questions were designed to be informal and open-ended to permit participants the opportunity to take the interview in their own direction and to express themselves through words in whatever manner they deemed appropriate (Patton, 2002). Additionally, during the interviews I took notes. Merriam (1998) indicated that note taking is not required of recorded sessions but can be used as a way for the researcher to record their reactions to something the participant said, to provide a visual perception to the participant that what is being shared is important or to pace the interview. At the end of each interview, I asked the participant if they wanted to add any information to the conversation that might not have been addressed.

Documents

Documents and records are useful sources of information for triangulation within a naturalistic study. According to Merriam (2009), documents include "a wide range of written, visual, and physical material relevant to the study at hand" (p. 112). Three major types of documents are usually available for analysis: public records, personal documents, and physical materials. The analysis of documents and records is a systematic procedure for both the review and evaluation of printed and electronic material (Bowen, 2009). "Documents provide background and context, additional questions to be asked, supplementary data, a means of tracking change and development, and verification of findings from other data sources (p. 30).

For this study, prior to participant selection, public records about the institution's enrollment and degree programs were reviewed. The document review provided institutional context for the study. Additionally, doctoral degree granting programs in STEM fields at the institution were reviewed to provide context for the competiveness of the program through national rankings, current enrollment numbers, number of degrees conferred, and number of women enrolled in each program. The document review and evaluation was used to both understand institutional context, and as a means to generate additional questions specific to college and program culture when engaging in interviews with participants.

Data Analysis

In qualitative research, data analysis begins at the point data is collected. Merriam (1998) stated that a primary characteristic of qualitative research is that the researcher is the primary instrument for data collection and analysis. The researcher operating as the instrument and data analyst allows for the human instrument to gather information and begin analysis as an interactive process (Erlandson et al., 1993). The researcher uses a normal process that humans use to solve problems and constantly analyzes and reassesses the data as new data are received to determine the path of inquiry.

> Data analysis is the process of making sense out of the data. And making sense out of the data involves consolidating, reducing, and interpreting what people have said and what the researcher has seen and read – it is the process of making meaning. Data analysis is a complex process that involves moving back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning, between description

> and interpretation. These meanings or understandings or insights constitute the findings of a study. Findings can be in the form of organized descriptive accounts, themes, or categories that cut across the data, or in the form of models and theories that explain the data. (Merriam, 1998, p. 178)

Analysis of the data involves transcription of the interview recordings, repeated readings of each transcript, the development, refinement, and use of coding. "Coding is a procedure that disaggregates the data, breaks it down into manageable segments, and identifies or names those segments" (Schwandt, 2001, p. 26). Prior to coding, each piece of data is broken down into the smallest unit possible. Lincoln and Guba (1985) stated that a unit should be heuristic, or should reveal information relevant to the study and stimulate the reader to think beyond the particular bit of information, and according to Merriam (1998) a unit should be "the smallest piece of information about something that can stand by itself" (pp. 179-180).

Each interview was audio recorded and then transcribed. Prior to transcription, each interview received a code to allow for ease of finding specific interviews and organization of the data. Merriam (1998) stated that "coding is nothing more than assigning some sort of shorthand designation to various aspects of your data so that you can easily retrieve specific pieces of the data" (p. 164). Transcription of all 12 interviews was completed in the spring of 2019. When a transcript was completed it was sent to the participant for modification and/or verification. After participants returned their transcriptions, the researcher re-read the transcript for clarity and began to unitize the data. This process involved disaggregating data into the smallest piece of information that is broken down into a stand-alone thought (Erlandson et al., 1993). Each piece of unitized data was printed

on a 4x6 index card with the assigned coding at the top of each card. This step helped prepare for the next step in data analysis – categorization.

The constant comparative method of data analysis was used to form categories, known as focused coding, where the researcher begins to group codes into categories. Data was continued to be re-examined even after categories were established to see if further subcategories emerged. Through this categorization, the researcher began to identify concepts and construct realities based on the thematic evolution of the unitized data.

Trustworthiness

Unlike quantitative studies that look for validation, both internal validity and external validity, as well as reliability, and objectivity; trustworthiness provides a criteria appropriate to that of naturalistic inquiry in which the researcher can establish confidence in the truth of the findings (Lincoln, & Guba, 1985). In place of internal validity, qualitative research seeks to create credibility; transferability is used in place of external validity; dependability is used to replace reliability; and confirmability is used to replace objectivity.

Credibility

"Credibility addresses the issue of the researcher providing assurances of the fit between respondents' views of their life experiences and the researcher's reconstruction and representation of same" (Schwandt, 2001, p. 58). Credibility seeks to assure research findings match reality. There are six ways, according the Merriam (1998), for a researcher to enhance credibility: triangulation, member checks, peer examination, participatory or collaborative modes of research, and clarification of researcher biases. In this study, the

researcher used triangulation, member checks, and peer examination to establish the credibility of the study.

Triangulation. Triangulation is a way for the researcher to check the "integrity of the inferences one draws (Schwandt, 2001, p. 257). In other words, the researcher will use multiple data sources, multiple investigators, or multiple methods to confirm the alignment of findings (Merriam, 1998). Mathison (1988) outlined three types of triangulation: data triangulation, investigator triangulation, and methodological triangulation. Data triangulation "refers simply to using several data sources, the obvious example being the inclusion of more than one individual as a source of data" (p. 14). Investigator triangulation involves more than one investigator in the research process. Finally, methodological triangulation "refers to the use of multiple methods in the examination of a social phenomenon" (p. 14). For this study, the researcher used the data triangulation aspect of triangulation. By interviewing 12 female domestic STEM doctoral students and working with the premise that the participants were at varying stages in their program (while maintaining the criteria that they have been enrolled for at least three years), data triangulation was achieved.

Member checks. A key aspect of credibility is confirming consistency between the researchers interpretation of the data and aligning that with the intent of the subject. This is achieved through a process known as member checks. Schwandt (2001) described the process of member checking as one where the researcher solicits feedback about the researcher's findings from the interviewed participants. Creswell (2003) stated that the "use of member checking [helps] to determine the accuracy of the qualitative findings through taking the final report or specific descriptions or themes back to the participants

and determining whether these participants feel that they are accurate" (p. 196). In this study the researcher sought feedback from the study's participants on the accuracy of their transcriptions and the accuracy of the emerging themes. Additionally, the researcher asked participants to review the initial write up of the findings to confirm they felt their realities where represented in the description of the data.

Peer examination. Peer examination, also known as peer debriefing, is the final tool that the researcher used to enhance credibility within the study. Merriam (1998) simply stated that peer examination is "asking colleagues to comment on the findings as they emerge" (p. 204). Schwandt (2001) defined peer debriefing as a procedure where the researcher "confides in trusted and knowledgeable colleagues and uses them as a sounding board for one or more purposes" (p. 188). Purposes for peer debrief may include ethical or political dilemmas, sharing ideas about procedures, and may include sharing the evolving analysis of qualitative data for validation. The researcher reached out to graduate and professional student administrators on the research site to talk through political and administrative barriers students were expressing. Additionally, conversations with these administrators were used to debrief on evolving themes to inform the data analysis and the researcher's subjectivity about the preconceived expectations of the research data.

Transferability

With transferability, the domain is set to determine how the results/findings can be generalized. Merriam (1998) asserted that transferability or external validity "is concerned with the extent to which the findings of one study can be applied to other situations" (p. 207). Generalizations should only be made within specific levels of confidence as generalizable data cannot be applied in the same way quantitative date is related. "A

generalization is a broad, encompassing statement or proposition made by drawing an inference from observation of the particular" (Schwandt, 2001, p. 105). Qualitative researchers must consider how the results generated from their research are relevant and can be applied beyond the "specific context in which it was conducted" (p. 106). It is important to note that there are concerns around generalizability. Merriam (1998) indicated that the issue "centers on whether it is possible to generalize from a single case, or from qualitative inquiry in general…" (p. 208). Merriam goes on to assert that if generalizability of a qualitative study is a possibility, the results must use thick, rich description, provide modal category, and should come from a multisite design. To enhance the possibility of applying the findings from this case study to other groups, the researcher attempted to provide enough description to allow future researchers the opportunity to compare the situation of this case study with their research situation to determine if results would be transferable.

Dependability

Dependability is focused on the process of the research, ensuring that the process was logical, traceable and documented (Schwandt, 2001). To look for dependability, examining the process of how data was collected and analyzed can help determine how a study might be replicated. Dependability in a qualitative study can be assessed by reviewing the process that data was collected and analyzed. Qualitative researchers should ensure that interview questions, observations, and interviews themselves were reliably and validly constructed; that documents and other data were properly analyzed; and that the findings are correct interpretations of the data (Merriam, 1998). Techniques used to ensure

results are dependable include the investigator's opinion, the use of triangulation, and an audit trail.

Confirmability

Parallel to objectivity, confirmability is "concerned with establishing the fact that the data and interpretations of an inquiry are not merely figments of the inquirer's imagination" (Schwandt, 2001, pp. 258-259). Auditing, member checks, and peer debriefings are strategies used to build confirmability. "Confirmability means obtaining direct and often repeated affirmations of what the researcher has heard, seen, or experienced with respect to the phenomena under study" (Leininger, 1994, p. 105). The goal or outcome of confirmability is to verify what researchers have seen, heard, or experienced in a way that is consistent with what others might see, hear, or experience. Through the use of triangulation, member checks, and peer debriefings, the data was reviewed for confirmability.

Summary

As describe in this chapter, a qualitative research methodology known as case study was used to provide the foundation for the study. The case was bounded by the focus on female STEM doctoral students. Utilizing the STEM doctoral degree programs as defined by the NSF assisted in further defining the boundary of the case. Purposive sampling was used to recruit and interview 12 female domestic STEM doctoral students. Participants were enrolled full-time in a STEM doctoral program with three or more years of persistence in their degree of study at the time of their interview. Interviews served as the foundation for data collection and were conducted using a semi-structured format. Once data was collected, interviews were coded, transcribed, unitized, and categorized which

lead to the development of themes. Finally, to ensure trustworthiness of the results, I used triangulation, member checks, and peer examination to provide credibility to the results.

Chapter IV follows and provides an in depth look at the participants and the themes that arose from the interview data. Themes are shared through the lens of each research questions. In additional to a review of the themes, participant quotes are provided to help examine the departmental culture and experience of each participant. The chapter concludes with a summary of the themes and an introduction into the major findings.

CHAPTER IV

PRESENTATION OF THE DATA

The purpose of this study was to examine the role mentoring plays in the persistence of domestic female STEM doctoral students through the lens of socialization. This study used a constant comparative method of analysis for the case study data (Merriam, 1998). The study was designed to address three research questions:

1. What are the experiences of female domestic STEM doctoral students in mentoring relationships?
2. What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?
3. Does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students?

To address these questions, 13 domestic female doctoral students enrolled in STEM doctoral programs at a Doctoral University – Very High Research, public land grant institution in the south were interviewed. After the interviews were complete, one participant withdrew her interview data from the study. The remaining 12 interviews generated 241 pages of transcription and just under 1800 unitized index cards of data, taken verbatim from the transcripts of the participants.

In this chapter, the major findings of analysis from the qualitative data provided through the interviews are presented as they relate to the three research questions. The chapter begins with participant profiles. A pseudonym for each participant was selected for

the purpose of confidentiality. The participant profiles have been developed in an effort to provide context and understanding about the participants and their comments provided throughout the remainder of this chapter. Following the descriptive participant profiles, the data are presented as themes based on each of the three research questions outlined in this study.

Profiles of the Individual Participants

Twelve participants were interviewed in this study; at the time of the interviews, all of the participants were enrolled in STEM doctoral programs at the same institution. Furthermore, they were all located in the southern portion of the United States, were United States citizens, and enrolled in their current programs for at least three years or had completed half their program. Each woman's individual journey into their doctoral program varied. Their fields of study at the college, departmental, and research levels spanned a wide range of STEM topics, and several of the women had made an academic transition from one field of study to another upon entering their doctoral program. Table 3 provides a snapshot of the participants. The participant profiles presented below provide context in which major themes emerged through the data analysis process. Direct quotes from the interviews are included to provide additional understanding about each participant. A code identifies each quote (e.g., Donna, IC215), indicating the participant and the index card the direct quote was found. Institutional names, advisor names, and other individuals' names have been changed to further provide confidentiality to each participant.

Table 3 ***Participant Information***

Participant[1]	College	Doctoral Program	Number of Years in Program[2]	Female/Male Advisor
Charlotte	Agriculture & Life Science Engineering	Biological & Agricultural Engineering	5	Female
Donna	Agriculture & Life Science	Soil Science	4	Female
Jemilla	Geosciences	Atmospheric Science	4	Female
Zelma	Engineering	Biomedical Engineering	6	Male
Kerri	Veterinary Medicine and Biomedical Sciences	Toxicology	3	Male
Elle Nyx	Science	Astronomy	7	Female
Tatum	Geosciences	Atmospheric Science	3	Female
Nancy	Science	Mathematics	4	Female
Rebecca	Science	Statistics	4	Male
Synthia	Science	Astronomy	3	Female
Lauren	Geosciences	Geography	4	Male
Valerie	Health Science Center	Medicine	5	Female

[1]Pseudonym assigned to participant for confidentiality purposes
[2]Number of years in program at time of the interview

Charlotte

Charlotte was a doctoral student working on a degree in biological and agricultural engineering. At the time of her interview, Charlotte was entering the sixth year of her program and indicated that it was her final year of funding. Charlotte self-disclosed that

she felt very isolated within her program. She attributed her feelings of isolation to the intersectionality of her identities.

> There are not very many women in engineering to begin with. You know being a domestic graduate student also put me in a minority. You know and I am an African-American female and that put[s] me in a tiny minority. And, then you throw on top of that that I'm in a relationship with a woman, I'm married to a woman, that especially in my department, that puts me in a really tiny niche. (Charlotte, IC187)

Additionally, Charlotte disclosed she was a non-traditional student. She indicated that she took a 12-year break between high school and starting her undergraduate degree after a failed first semester freshman year at the age of 18. Charlotte also indicated that she was a mother with one young child at home.

In addition to Charlotte's personal attributes, she disclosed that she was in a very bad place with her department, and it affected her perceptions of support and her ability to persist. After an 18-month investigation into sexual harassment allegations lodged by another female graduate student against Charlotte's advisor, Charlotte's advisor left the institution taking the three male graduate students in his lab with him. This left Charlotte without a chair, a lab, or direction.

> Caveat, I am very bitter about my department, so you are just going to have to know that. You are going to hear a lot of that. My chair and this may be interesting because I think its part [and] parcel the reason [women] in STEM especially in engineering struggle but my chair sexually harassed one of my colleagues. I was involved in an investigation. There was a decision. He was fired. He tried to appeal.

> He eventually resigned. So, I'm at the end of like an 18-month ordeal with that. (Charlotte, IC50 and IC183)

To push through this barrier, Charlotte talked about support from university administration, other faculty, and campus staff that provided structure, accountability, and encouragement to keep moving forward.

> So basically as I came in contact with various people. You know they come into your life in various ways and you just foster relationships with them. You know Destiny Havard is one of them. And, she's good people. And, Dr. Kristen Bulgar, I've been involved in various programs [through her office] and the PIs or the directors of the program [are supportive]. (Charlotte, IC85)

Donna

Donna was a doctoral student in soil science and at the time of her interview was in the fourth year of her program. Unlike many of the women interviewed, Donna had completed her master's in 2013 and gone to work full-time in a research center as a program manager. While working full-time at the research center, Donna indicated that a number of unresolved questions regarding research application kept plaguing her work, which lead her to go back to school to pursue a Ph.D.

> I actually went to work for the soil research [facility] and so I was a project manager and I mostly did, trying to find homes for intellectual property that was generated by researchers in agriculture. … People would ask me in my master's, "Oh you're working on this model, what can you do with it?" I would say something like oh farmers can use it to whatever xyz and in my time working in commercialization I realized that was so far from the truth. … so I was beginning

to be interested in this idea that a lot of research is not used and a lot of knowledge is not translated and how do we do that. (Donna, IC23)

Donna indicated that she came from a low-income background, having put herself through her undergraduate degree, starting first at a junior college and then transferring to a major research institution to complete her bachelor's degree. She landed in soil science through a student worker position at a research station near the junior college she attended.

> … There was a research station there, so I thought maybe they will have something where I can work with animals and I love to work outside. So I applied but there was only one student worker position open and it was in a soil fertility lab and after about two weeks I thought well I know one thing and that is that I will not be a soil scientist …then when I got to do field work and do forage samples I was more and more interested in it. (Donna, IC129)

Additionally, Donna was married, and her husband was enrolled in a doctoral program at the same institution. Donna stated that he had enrolled in his program two years prior to her decision to go back to school for her Ph.D.

Jemilla

Jemilla was a fourth-year doctoral student in atmospheric science. She completed a bachelor's degree in chemistry and taught high school science for six years before deciding to head back to school for a doctoral degree. During her interview, Jemilla indicated she had chosen teaching as a profession because she had a great love for science, but after several years in the classroom, she had grown disenfranchised with the idea of teaching.

> Like I went into teaching because I liked chemistry and I wanted to share that with people like how cool that could be. But teaching, teaching ends up being a lot more

> babysitting and making people follow rules and I was the mad science teacher who wanted to do more stuff and it gets, like it kind of wears you down. You want to do this cool stuff with science but then you have to worry about if someone is on their phone, or drinking water, or if they are chewing gum, or if they are a few minutes late to class. It is tiring because that is not what I wanted. (Jemilla, IC73)

She started out teaching chemistry but due to her teaching certification was assigned to teach environmental science for a number of years. She indicated that through the teaching of environmental science she developed an interest in the connection between atmospheric science and chemistry.

Jemilla is a twin and expressed some sadness and competition between her twin sister and herself. Her sister was enrolled in medical school at the time of the interview. Jemilla identified difficulty developing interpersonal relationships with anyone, even her twin sister, and felt that the lack of female emotional support often left her feeling isolated.

> [My best friend provides me] like, it is going to sound strange but emotional intimacy. Like even with my twin sister, my twin sister has always been very cold towards me. And always made it clear that she is the superior one and the thing is that I never cared about that but having someone who just feels like a partner like we trust each other a lot. We, I do not know it is just kind of like she is my other half almost that was just out there and I never found yet. (Jemillla, IC589)

Zelma

Zelma was in her sixth year as a doctoral student in biomedical engineering. Like several of the other participants in this study, she took a non-linear path to her Ph.D. After

graduating with a bachelor's of science in biology, Zelma worked as a scientist in the Bering Sea Fish Fleet on a commercial fishing vessel for three years.

> When I graduated, I went to Alaska. They were hiring scientists for the fishing boats up there. I think anyone with a pulse was hired ... a pulse and biology degree. So I spent three years in the Bering Sea Fish Fleet as the only woman on board, a commercial fishing vessel. I knew I needed to get out at two years because you either get out at two years or stay forever. I found out how much engineers make compared to biologist and was like that is a lot more. So I was really focusing. I wanted to do biomechanics and some schools put it in the biology departments and some schools put it in their engineering departments. (Zelma, IC14)

Because Zelma switched academic fields after her undergraduate degree, she had to complete a number of leveling courses to catch up on academic work within her program. She spoke toward her persistence in wanting an engineering degree and doing whatever it took to get into a program. During her interview, she referenced the department head's viewpoint of her non-traditional path into engineering.

> I flew down from Alaska when I was off the boats. I just walked into the office. I was like I don't have the GPA, I don't have the GRE scores and I don't have an engineering background but I want to be in your program. I just survived two years in the Bering Sea; I think I can do it. I got my acceptance in March so that is like, everybody else had either been accepted or rejected like I was just sitting on that pile and I got accepted. In the space of three months I moved from Alaska [and] started [school]. The head of my department came up to me at the welcome social

> and was like I like non-traditional paths. I like taking gambles, now it is your opportunity to not fuck up. (Zelma, IC23)

Zelma expressed an added sense of pressure because the department head had taken a chance on her. Zelma was married at the time of the interview. Her husband lived about a three hours' drive away from the campus. She was commuting back in forth, living with her husband on weekends and living in the college town during the week. Zelma indicated that she was tired but would do whatever it took to finish her degree.

Kerri

At the time of the interview, Kerri had just defended her proposal that summer and been admitted to candidacy. She was in the third year of her toxicology program. Like many of the other participants, Kerri had switched her field of study between her bachelor's degree and entering her doctoral program. She changed from an undergraduate degree in neuroscience to a doctoral degree in toxicology.

> So, my switch was I, maybe my junior, yea junior/senior year I was able to get an internship at a Wildlife Clinic in Massachusetts. And while I was there I had a fantastic mentor and he introduced me to wildlife pathology and wildlife toxicology. He was the one that was arm deep in some type of necropsy and he welcomed me over, grabbed a pair of gloves, throw on some goggles, go at it type of thing and ask questions, observe if you want and then ask questions afterwards and then if we have any other ones like feel free to come drop by after you've done any of the other work that you have to do. So that's where I got interested in wildlife toxicology (Kerri, IC50).

Kerry had originally planned to attend veterinary school after her undergraduate degree. After the application process, Kerry was not admitted into any veterinary programs. On the advice of her mentors shed into toxicology programs.

> So when I went back to [my] undergrad I'm like alright well I wanted to go to vet school so I can in a sense do what I just did but professionally. So the goal was vet school ... applied, went through all the stresses of it, got denied and all of my veterinary mentors they were like don't worry its normal [to not be accepted on a first round application]. (Kerri, IC50)

When offered a doctoral track in toxicology she decided to take that path instead of vet school in order to remain enrolled in school and to keep forward momentum professionally.

Kerri expressed frustration with her program's lack of structured support for graduate students and over the course of the year leading up to her interview had become vocal about the disenfranchisement with her program and the program coordinators.

> It was more or less I had no other place to go. There was not anywhere else that I could potentially take into a lab and that has been like recommended … I'm like alright well I'm going to ask you what you do with this situation with a mentor. Like lack of mentorship because that is what I have had. And they're like well is there a way for you to switch and I'm like yeah that would be nice but I don't have that opportunity because all of the new first years now have taken all the open spots. (Kerri, IC199)

To help manage her lack of connection to the program and her lab, Kerri decided to get involved on campus through student leadership opportunities within student organizations.

She indicated that she found it was a way to feel a part of the campus community and to meet other people.

> The other thing that I have been working with is I have branched out of my department. I did student ambassadors as an undergrad and so I found that there's actually the campus ambassadors here and I applied just thinking well what the heck [the worst] they can say [is] no. And I got accepted … it's one way for me to engage with other people because I don't like being within like my confined walls. (Kerri, IC27)

Elle Nyx

Elle Nyx was in her last year of her program, her seventh year, at the time of her interview. She had switched her field of study to astronomy while still an undergrad. She took a traditional academic career trajectory by going straight from undergraduate work to graduate school. At year three of her program, Elle Nyx completed a non-thesis master's degree while working on her doctoral degree.

She talked about the pressure of completing her degree because her advisor had left the university and was working at an institution of higher education in Australia. At the time of her interview, Elle Nyx indicated interest in trying to acquire a post-doc in Australia to continue research with her advisor. Part of this affinity with Elle Nyx's advisor was the program's approach to finding fit with a research project and an advisor. Elle Nyx's advisor at the time of the interview was her second advisor, having switched after her first year in the program.

> They explicitly say, if you are, if this is not something you are extremely passionate about you should switch. … If the advising style does not work for you, an advising

> style may not work for everyone, switch. You need the good communication, also if you have done research in another field, it can be very helpful when you switch fields, to look at something from a different angle, and if you decide to go back no big deal. (Elle Nyx, IC310)

Additionally, Elle Nyx talked about being one of the oldest graduate students by tenure in her program. She indicated that astronomy was a small subset of physics and that the graduate student cohort in astronomy was only about 20 graduate students. Because of the small intimate size of the graduate population, Elle Nyx felt responsible for the newer graduate students as a senior member of the cohort.

> I feel like that's one of the things that I've sort of failed at, now that I sorta joke that I am the queen of the graduate students, I am the most senior and then there was a gap the year after me, and there is nobody else in my year. So something I feel like I failed at was not noticing when people were having some issues, because they didn't talk about them, and I would like to know so I can help. I mean there is only so much I can do, but [the department culture expects older graduate students to help newer students]. (Elle Nyx, IC476)

Tatum

Tatum was in her third year of the doctoral program when she interviewed for the study. She had just defended her master's about a month before the interview. She considered herself a traditional student going from completing an undergraduate degree in earth system science with a focus in atmospheric science straight into a doctoral program in atmospheric science.

Tatum was eager to get into graduate school and indicated that she applied to 11 graduate programs in the last year of her undergraduate degree.

> You know I applied to a lot of different schools, think 11 total and my biggest fear and why I applied to so many was that I wasn't going to get in. Typically in my field you only apply to four or five. I was just so scared I wasn't going to get into one. Well I ended up getting into like four. (Tatum, IC60)

When asked how she narrowed down her offers and finally selected the university she shared her answer was simple, her advisor. Tatum, unlike any of the other participants had the most positive relationship with her doctoral advisor.

> I came for another visit once I got in. I fell in love with my advisor. I fell in love with the school. I fell in love with the graduate students here which I think is a pretty big portion of graduate studies. It was between here and another school. It came down to the advisor for me so that is why I chose this university. (Tatum, IC71)

When looking at Kram's (1988) research on the functions of mentoring, Tatum expressed deep connection with her mentor in atmospheric science, not just through the career function of advisement but also in the psychosocial functions. It was apparent in her interview that Tatum felt a strong mentor-protégé relationship.

> But it really was the advisor. She picked me up from the airport. We went to lunch that day. She did not say you are working on this that is it. She gave me three different choices of topics that I wanted to work on and said "this is your project you pick it." And, my project completely changed from all three of those because she got late funding on something. But, she was just open and honest and willing

> to hear my feedback too. She was not just like you will do work for me and this is what you will do. (Tatum, 162)

Nancy

As a fourth-year doctoral student in math, Nancy spoke about the competitiveness of math as a STEM degree program. Nancy indicated that within her department a little over a quarter of the graduate students were female. She also stated that only a handful, less than ten women were domestic or naturalized citizens.

> I think in my cohort, which has 25 Ph.D. students there are four or five of us [women] a semester and that was the same thing with this incoming class there are only four female students, so probably 30, 20-30%. Maybe one, maybe two or three domestic women in the last two years. There is also a divide departmentally, domestic and international because even with the men, the international students outnumber the domestic ones. (Nancy, IC582)

In addition to being one of a few domestic women, Nancy shared that she was a racial minority, married, and her husband was of a different ethnic background from hers. Nancy talked about the burden of being a woman in math and coming from an ethnically diverse background.

> It's weird in math because it is a "known problem that in mathematics men do better in math." I'm putting quotes, "men do better in math" and this is just a known stereotype and people know this so much that there are all these programs that are designed to increase the representation of women and minorities in mathematics, right? Then you get this weird flip side where your male colleagues are like "oh you only got that fellowship, or you only got this program, or this funding because

you are a woman," It is not because you are a woman. You know they would always say I didn't get that fellowship because they [program/funding coordinators] had to give it to a woman instead. So there is this odd, there are these programs that you want to use you want to help promote but then you get this weird backlash from men, like oh why do you have women in math lunches when we don't have men in math lunches. (Nancy, IC353)

Nancy was very positive about her advisor relationship. She indicated in her master's and in her doctoral program, she had selected women for both advisor roles. "I personally feel more comfortable with a female in power. I just feel there is someone who will hear you out more, won't judge you as much" (Nancy, IC335). Nancy was very passionate about connecting women and female minorities in math together. Nancy's connection with her master's advisor afforded her the opportunity to connect with other female incoming doctoral students in math.

I feel like we should have more programs to encourage minorities. I go out of my way to go to outreach events to put myself out there as a young woman of color who does mathematics … 36-It is important. (Nancy, IC368)

Rebecca

Rebecca was a fourth year doctoral student at the time of the interview. She had just defended her master's thesis a month before the meeting. Rebecca had started out as a political science major in her undergraduate institution but after a summer internship in Washington D.C. came back to her institution and changed her major, feeling disenfranchised with the whole of politics, the pay for the work, and a better understanding of the instability of the political job market. She first looked at economics but was advised

by faculty to major in statistics as a more robust mathematical program. Based on this advisement, Rebecca switched her major to statistics and had to take a number of leveling courses to catch up academically in order to graduate on time.

Rebecca expressed this change in major as a significant challenge because math had always been her weakest subject in high school, was her lowest scoring section on college placement exams, and in general, she was not very interested in STEM fields or course work. “So, I am not a woman who grew up building robots or being real interested in STEM. Never was, up until college. And as now a math, a statistics, a math person I’m still not” (Rebecca, IC63).

Rebecca also indicated that as her math skills grew, so did her interest in other STEM areas.

> I did an internship at NASA and [I] did another internship at Lockheed Martin and I really liked the software development of things but I didn't want to be a code monkey and so I always liked statistics. I mean that's the part of economics that is fun. [I] may be a little bias but like statistician[s] can be just as good of an economist as an economist. And they have more technical training and so I was like okay I will do something that is a little more technical and if I want to do econ I can, if I want to do machine learning I can. I can do all types of things. (Rebecca, IC121)

Synthia

Synthia was in the third year of her doctoral program in astronomy at the time of her interview. Like a few other participants interviewed, Synthia expressed a significant amount of pressure to succeed in part due to a sense of overcoming her past. Synthia

started the interview by stating that she was a non-traditional student and went into a significant amount of detail about herself.

> The entire reason that I got here ... I'm a non-traditional student. So, when I originally started college at 18, I'm a first gen. All of the things that set you up for failure, I have most of those things. So, I tried to go to a [private school in the same state close to home] because it was the only place I successfully [got into], I was offered scholarships from places but that was the only place I successfully got [in]to … So I ended up failing and I panicked. I don't even think I finished my second semester there. I just left. Like I, I was working three jobs at the time. So, set up for failure. Bounced around, went crazy, had a kid.

After bouncing around from job to job for a while and trying to care for a small child, Synthia decided she needed to go back to school.

> Decided I needed to go back to school … So, I happened to go to a school that caters to non-traditional students. It is now kind of in their advertising. They cater to students who probably would [not] succeed in other places, so come here, your hard work will pay off and I graduated with a bachelor's degree in physic and astronomy. (Synthia, IC16, and IC24)

Synthia acknowledged that she had opportunities through the McNair Scholar's Program to engage in research, and those representatives from the program helped her apply and be accepted to graduate school.

> When the McNair Scholars Program sent a representative to the physics 101 class. They sent a representative and … she presented to the class [that] we are looking for first gen, underrepresented, indigent students to come. We want to talk to you,

> we want to give you research opportunities. I didn't know what it meant. I was like you know what, that describes me. Let's just do it. I'm impulsive. So, I went, I talked to them. I didn't know what I was signing up for. (Synthia, IC44)

At the time of the interview, Synthia indicated she was living with her boyfriend and raising her son. She talked about a sense of isolation because most of the graduate students in her program were single, and there were no other parents. She had her significant other who she had followed to graduate school but their relationship was deteriorating which compounded her sense of isolation.

> One, I got a diversity fellowship here. So I get paid maybe 10k more than the average graduate student does, and I only have to work twice as hard or half as hard. [The other school] wanted me enough and … They came close [to matching this offer] and what it comes down to is, I had a boyfriend and he only got accepted here. He didn't get accepted to [the other school] and I knew better but I did it anyway … that's why I ended up here instead of [the other school], because of the boyfriend. (Synthia, IC292)

Lauren

Lauren was a fourth year doctoral student at the time of her interview. She considered herself a traditional student. She completed a bachelor of science in meteorology at one school, moved states, and completed a master's of science in oceanography at another institution, moved states and institutions again to work on a doctoral degree in climatology. She expressed a love for weather and the ocean and wanted to study the interaction between the atmosphere, the ocean, and its effects on global warming.

Lauren indicated that she came from a well-educated home. Both her parents held advanced degrees and she traveled a lot as a child with their work.

> I always knew I was going to go to grad school just because of my parents. For a few years my family lived in Asia and we would deal with the monsoon rains. My parents are both higher educated with advanced degrees and would tell me what was going on at a very, very early age. That short of stuck with me as how do these things work. I was always very scientifically minded. (Lauren, IC46)

Additionally, Lauren indicated that she was in a relationship at the time of her interview. Her boyfriend was another doctoral student at the university in the same program as herself. They met in a class and have been together for two years.

> So, my boyfriend is also in the department. He is the one I talk [to] the most here at school. Outside of the program we talk a lot of [department] politics with him because he is very politically minded, sometimes infuriatingly so. (Lauren, IC105).

Valerie

At the time of her interview, Valerie was in the fifth year of her Ph.D. program in medicine. Valerie self-identified as a non-traditional student because she came into her doctoral program with a master's in hand.

> And, I had kind of an unorthodox start because I came in with my master's so that kind of propelled me further than most students. I got my master's at a different institution and when I started a job as a lab tech here I was able to get into the program for the Ph.D. and then start with my research project pretty immediately. (Valerie, IC95)

In addition to her master's degree, Valerie indicated she actually had worked full-time after completing her undergraduate degrees before going on for her master's. Valerie dual majored in STEM Biology and Spanish as an undergrad, completing both degrees in five years. She returned for further education at the age of 26.

> Typically, you have students that graduate young from their undergraduate institution and then apply for a graduate institution and start their Ph.D.s really early. I decided to take some time off and I moved away from home and then realized I did have a passion for science. I wanted to go back into it and I got my master's first at 27 and then eventually moved into a Ph.D. program at 28 which is a bit older than most people because most people graduate with their Ph.D.s at 26, 25. So I'm a bit older at the start and I'll be older at the finish. (Valerie, IC126)

Valerie worked as a lab tech as a component of her research program which helped to pay for school. She indicated that she was located at a distance campus in small town a few hours from the university's main campus and lived alone. One of Valerie's passions was the promotion and advocacy for children to engage in STEM. She had a particular passion around promoting STEM education and careers to girls and women.

> Well I guess most of my feedback or giving back has been with younger students in science. Like in my master's program, I was a volunteer teacher in low-income community centers and I did kitchen chemistry and marine biology courses but currently I guess I am not focusing on women. In undergrad, I helped form this women extravaganza where we invited Girl Scout troops to earn badges by going through all of these science activities. (Valerie, IC777)

Summary

Each of the 12 participants had very different experiences that lead them to graduate school. They each brought different educational backgrounds, personal life experiences, and varying outside influences that contributed and/or inhibited their academic pursuits. Despite the uniqueness of their individual stories, the participants shared some common experiences: nine of the 12 participants had female advisors; all but three of the 12 advisors held the rank of full professor, and all the women identified mentorship as a key component of persistence in their programs. The following sections offer the major themes that emerged from the data analysis: what these female graduate students reported about how they have persisted, who supports them through coaching, guidance, community, and mentorship, and their desire for positive female influences in their academic lives. The first section reviews the multifaceted experiences reported by the participants that address the first research question: *What are the experiences of female domestic STEM doctoral students in mentoring relationships?*

The Domestic Female STEM Doctoral Student Experience

All of the women in this study expressed a variety of mentoring experiences. They not only commented on the types of mentorship using words like engaged, consistent, and available to express an individual mentor's level of involvement, but they also commented on the variety of individuals who provided mentorship. A few examples included former faculty, current faculty, and other graduates.

Based on the participants' responses, four major themes emerged involving relationship experiences that provided support and guidance. Table 4 presents an overview of the findings related to the first research question. Primarily participants looked to either

faculty or staff from both their previous institutions/degrees (master's or bachelor's) and to current advisors for support. Nine of the 12 participants talked about fostering an ongoing relationship with faculty from a previous institution as a way to navigate the complexities of the doctoral experience.

Prior Mentoring

The first major theme to emerge was about the mentoring that happened before the women had started their doctoral programs. When asked to describe the journey into their doctoral fields, the participants used words and phrases like exploring, seeking advice, and a place to ask many questions. For most of the participants, nine of the 12, they described a mentor who had taken an interest in their academic success and encouraged each of them to pursue advanced education. Charlotte expressed this deep-rooted admiration of her first advisor who also happened to be her undergraduate advisor.

> He was the reason I was in graduate school. He was the one who praised my work. He was the one who was impressed. He was the one and you know he was the primary one who really was that source of "of course you can." "And you are doing this and I trust you with these publications and this and that and the other." (Charlotte, IC576)

For many of the women, the encouragement from these mentors made them believe they could succeed in graduate school. Most shared experiences were described as directive in nature to promote their efforts to apply to graduate school. Zelma spoke of her undergraduate advisor, Oscar, and his direct approach to boost her belief in herself and apply to graduate school.

> He was the one every year in Alaska he would call me, when are you going to grad school and [I'd] be like next year Oscar, next year. When are you going to grad school, here I will send you my letter of recommendation so you can see how great you are. When are we applying to grad school? (Zelma, IC647)

For a few of the women, this encouragement and accountability came from others that were not faculty. Synthia's experience with the McNair Scholar's Program and the staff on her campus that ran the program played a significant role in both her actual application and her self-view about her own ability to conduct research and be successful in graduate school.

> The relationships that I developed [with] my advisors and supervisors, they helped me with the rec letters. They helped carry me through. They would literally look at me and say "this is what you are doing. Look at you. You are smart. Clearly you are smart." They had conversations with me like I was a person. It builds something inside of you. (Synthia, IC172)

As the women spoke about the people who invested time and energy into them, the women used words and phrases to describe those experiences such as: trained, taught, valued me, helped me connect, and elevated me. Three sub-themes emerged as key components of these prior mentoring relationships: training, support, and networking.

Table 4 ***Overview of Findings: Research Question 1***

Research Question 1:	What are the experiences of female domestic STEM doctoral students in mentoring relationships?
Major Themes	Subthemes
Prior Mentoring	Training Support Networking
Structured Mentoring	Advisor Selection Relationship Mentorship Lottery
Department as a Mentor	Program Structure and Faculty Department Community Network
Mentoring Others	Women Other Graduate Students

Training

In addition to providing guidance and advice on the doctoral application process, the women spoke to two types of training: career training and academic process coaching. Career training occurred in two forms, skill building as a successful student researcher and training as an instructor/teacher. Several women indicated that the exposure to research early on helped grow their interests in their chosen field. This early inclusion also helped them see themselves as competent and capable researchers. Zelma acknowledged that her undergraduate advisor would include her in a lot of skill development.

> He taught me how to do a Western Blot and all of these lab, like the sheer, now looking back, the sheer volume of lab techniques he taught me is unprecedented in

> any undergraduate thing I've ever seen. Any technique he would show me. He would like leave me alone with microscopes then. It would make me very nervous with how much they cost but he was like you are a researcher, I trust you. (Zelma, IC629)

In addition to skill development as the student researcher, a number of the interviewees spoke about the importance of their prior mentoring, building them up as a student. The positive affirmation and the overt love for the subject matter cast a great influence on the women's approach to teaching and learning; Tatum expressed the importance of this. "I think that he had such an influence on me and the fact that we are still in contact today. He really changed me. He got me interested in tropical meteorology and helped me apply to graduate schools and [I] realized what this field was all about" (Tatum, IC502).

The women also talked about the investment of time and training they received from their mentor to appreciate their subject matter. The mentors' enthusiasm and pure joy of teaching and sharing their chosen disciplines with their students stood out to the women. This passion for teaching pushed the women to desire the skills needed to teach and emulate their mentors. Often this pedagogical training happened indirectly through observation by the participant, application through practice, and repetition of the behaviors and skills they valued in their mentors. Donna's doctoral advisor was also one of her undergraduate mentors. Donna spoke to the benefit she had in talking to her chair about the transition in trying to teach and do research and make it look easy like her chair did.

> I do really, really love teaching though. I just don't know how to do both at the same time though apparently. I've been teaching this semester and so trying to do

> research and teach at the same time has been tricky. So I told her, I am doing okay I just feel like I could be doing more. She said yeah, you are on par for the course. Every so often when I feel like I'm not in a good place and I talk to her about it, she reminds me these are the things you have accomplished so far. Yeah, you may be struggling and feel like you aren't getting very far but you have done these things. These are the things you are working on right now. It is a good reminder, definitely. (Donna, IC671)

Donna's quote also speaks to the coaching and support these early mentors played in the academic success of the participants. The last component of training that all nine of the women spoke to was that of support, coaching, and guidance that occurred in preparation for graduate school. Many of the women spoke about guidance on what schools and programs to look into, mentors provided recommendation letters, advice on how to research prospective faculty advisors, and the likes. For Synthia this support came in the form of physical research and publication building to help bolster her résumé and applications.

> They hustle you in the interview process and then [the] proposal process and they hold your hand without you realizing what exactly is going on. At the time, looking back I was like I'm just going to fill out this form whatever, I don't really care. But it was [a] proposal. It was my first proposal for a research document. And I spent through them, I got like 2/2.5 years' worth of research which was significantly more research than undergrads get. It was fantastic. They are undergrad papers but still I ended up with two first author papers. Very minor. And two second author papers. Undergrads don't get this opportunity. (Synthia, IC50)

Support

Another sub-theme that emerged was that of support. The essence of support is to provide assistance. According to The Merriam-Webster.com dictionary (2020) a support system is "a network of people who provide an individual with practical or emotional support" (Support System, 2020). Kram (1988) discussed the value of the psychosocial functions of mentoring relationships and asserted that support in mentoring comes from role modeling, acceptance and confirmation, counseling, and friendship. In this sub-theme the women spoke to the careful, thoughtful, and direct ways they experienced support from their pre-doctoral mentoring relationships. Phrases that sum up this theme of support included affirmation for unpopular decisions, openness to discussions on difficult conversations or decisions, and a reciprocal sense of community and advancement. For Valerie, the support from her undergraduate advisor came when she made an intentional decision to leave the pre-med program. During her interview, she spoke about the pressure and feeling a pit in her stomach after telling her advisor about her desire to change majors when it required his approval for the degree plan change.

> But my advisor in undergrad, he has his Ph.D. in microbiology, and he was really excited that he had a student he was advising that wasn't pre-med anymore. So he pushed me into applying to a lot internships and pushed me to an independent research project that would help me eventually go into graduate school since that's the trajectory that I had selected after selecting to not be pre-med. He showed me the path. (Valerie, IC226)

Sometimes support came as authentic joy and investments in the accomplishments of the participants. Sometimes the support came in time spent talking through

disappointment or obstacles. Of the nine women who spoke to the prior mentoring theme, all spoke to the nurturing that happened between their support person and them. For Tatum, her undergraduate advisor expressed great delight at each step closer to graduate school and the pursuit of her Ph.D.

> I remember after my phone conversation with [my doctoral advisor]. I had it right outside his office and as soon as I hung up the phone he jumped out of his office and was like "let's talk about it." He was so excited to hear about, you know, just all the stuff. Even now, I just defended like a month ago and he was my first text that I got – "hey congratulations, that's seriously so awesome, I'm so proud of you." (Tatum, IC314)

Tatum's words also spoke to the ongoing relationship that many students have with their mentors. Several of the participants acknowledged that they had maintained connections to these early mentors, some with regular contact, others as time and space permitted. While all the women acknowledged the relationships had evolved, for many of them contact and communication were vital. Nancy expressed it when she said, "it has been a while since I have talked to him. He is now the chair of the department so he is busy and I have been here. But, I am planning to make a visit when I go home, just to touch base, just to reconnect" (Nancy IC125).

Networking

All of the women talked about a subset of the graduate school application process, the experience of finding an advisor, often with the added pressure that the graduate advisor must be able and willing to fund the student. Several of the women talked about the struggle to identify prospective advisors, how to connect with them (usually from

another state), and how to acquire a spot with funding in their lab. These prior mentor relationships played a key role in introductions and connections for the participants. For Zelma, that was every available lab tech job Oscar came across. “Mentoring undergraduates was Oscar’s life's goal. He always kept up. Every couple of months he would email me every person looking for a lab tech, he would send me their way” (Zelma, IC640).

In some cases, the networking support came through travel funds, attending academic conferences with others in the field, or other symposia activities that could help create exposure. A number of the participants indicated they traveled to conferences with their undergraduate mentor. For Nancy, she was introduced to other faculty and researchers while at conferences. Nancy indicated that her former advisor was connecting Nancy with perspective doctoral students as a way to grow their networks, much like she had done for Nancy.

> She did, she took me to conferences. She paid for my trips. I was her first student also so we helped each other I think. I've met some of her students at conferences actually. They will say wait your Elizabeth's student, are you the Nancy that I've heard of, and I will say yeah, I was her first student. And, she's kind of big in the field that I work in. She's a big name; a lot of people know her. So when you mention her name they go “oh like wow you worked with her.” (Nancy, IC206)

The networking even helped participants find jobs or research opportunities. Donna indicated the lead researcher from the social research lab she worked at while at the junior college really helped her get her foot in the door. “He was on the hiring committee for my current advisor and so he knew her. I think because of my family background he felt like

she would be empathetic and supportive, and so he said you're going to go get a job with her. He reached out to her and so I did [get a job with her]" (Donna, IC146).

For the nine women who talked about the support and coaching they received in their previous degrees, all expressed a clear understanding of the importance those early pre-doctoral mentors contributed to their success. The mentors were able to demystify process and bureaucracy, define and afford specific experiences that prepared the participants for more rigorous academic pursuits, and many shared a gift for the love of teaching and learning. Most importantly, all nine women attributed a sense of self-efficacy because they knew their mentor believed in them.

Structured Mentoring

The second major major theme that arose from the data analysis was the concept of structured mentoring. Levinson, Darrow, Klein, Levinson, and McKee (1978) discussed how mentoring relationships are often formal in nature, especially when they arise in a work or career setting. In this theme, the participants addressed both the formal design of the faculty-graduate student relationship and the bureaucratic processes that underpinned the relationships with formality and structure to their advisor. In the quote that follows, Rebecca talked about the difficulty she had connecting with faculty.

> Professors' purpose here is different. Their job is to write research, to do research and they are really good at it. But as a result, your access to them is very limited. So you know you email them first. You only stop by during their office hours or you verbally make sure like "hey if I come by at this time is that okay?" (Rebecca, IC417)

While Rebecca's statement created a sense of non-personable connection between faculty members and graduate students, Nancy addressed the same type of structured presence in a more awe-struck manner. "My current advisor is very, very organized. I really like that about her and I admire it. She has a lot of papers. She knows a lot of people. She networks very well. She's really a role model, the kind of person she is" (Nancy, IC460).

The participants linked this structured advisement to the culture of the graduate school process. They articulated that by design finding an advisor, the immediacy of the relationship pairing, and the desired relationship versus the reality of their advisor relationship, created this more formal, sometimes forced connection with a faculty member.

Advisor Selection

All the women talked about the experiences of looking for an advisor. Most of the women discussed the advisor initiation and selection process as the beginning of this formalized, direct mentoring. They described the initiation process as starting with an investigation into the faculty that taught in their respective programs and then understanding the research agenda of each faculty member. The participants then would make contact, typically through email with a specific faculty member to see if that faculty member had space in their lab, funding, and would be interested in hiring the participant if they were accepted into the program. Jemilla shared her experience of being accepted by her advisor. "I mean before I applied I emailed her and I went to visit with her and she was yes, yes, yes, come work here. So like we kind of accepted each other. So when I was accepted she also accepted me" (Jemilla, IC775).

Kerri talked about the difficulty of the advisor search. “Another professor, I had just missed the potential of getting into his lab. He had just hired another tech and he’s ‘like if you had come to me a little bit earlier you might have been able to get in but I just hired somebody else so I don’t have any positions’” (Kerri, IC187). In addition to finding a faculty member to accept them, the participants emphasized the stress and pressure the search process created. Zelma talked about the competitive nature of securing a lab spot and funding within her program. She entered into her first year as a doctoral student without an advisor and was living off savings to pay for school. When she heard about a position in one of the labs, Zelma had to act fast.

> There was a position open. He had just been given a grant. He knew he would be taking a grad student. The other unattached grad students were all like “yeah, I guess that sounds interesting.” They were all like 22 just out of undergrad. I just spent two years on a fishing boat learning how to stand up for myself. I was like “oh yeah you should email him.” Then I ran out the door and knocked on his door. So he said he would take me on, unfunded, for a semester. (Zelma, IC186)

While half the female participants expressed a sense of a good match with their selected advisor, the others experienced the trepidation of trying to secure an advisor that they felt could support them formally through the doctoral student experience. “Most people go through like two or three people before they find an advisor. Some people find one their first semester. Most people probably two years in, they have probably finished the master’s stuff by the time they pick a Ph.D. advisor. But it is totally different for everyone” (Rebecca, IC206).

For at least the participants in astronomy and toxicology, the participants indicated that switching advisors and labs was supported and encouraged to help promote persistence and success for the students. At the time of her interview, Synthia was in the process of changing labs.

> In the best circumstances I will have a blank slate with her [new advisor] and helping me succeed and mentor me. She will do the things necessary to help me have a successful career and while that might or might not change my reputation here [in the program] specifically, it will hopefully set me up to have a good career anyways somewhere else because she will make sure I have the necessary tools and experiences. (Synthia, IC817)

Kerri felt her advisor selection was actually an appointment. “I’ll be one of those other stories. It was not by choice. It was more or less [a] forced [advisor appointment]” (Kerri, IC141). While Kerri expressed displeasure with the state of her advisor relationship, she felt stuck in her current lab. Unlike Synthia whose department had from the onset encouraged advisor switching, Kerri needed more support, especially in the form of financial support, and while the program told her she could move to another lab the transition would have been an unfunded move. “They're like well is there a way for you to switch and I’m like yeah that would be nice but I don't have that opportunity because all of the new first years now have taken all the open spots” (Kerri, IC207). So, while the opportunity to switch advisors and labs was available, Kerri believed it was not really an option do to financial constraints.

Relationship

Moving beyond the *selection* of their advisors, the participants talked about the *relationship* with their advisors. Eleven of the 12 had some discomfort in talking about their faculty-graduate student relationship. Most had relationships that could be classified as functional but strained. Jemilla said it was difficult to talk about the relationship with her advisor. She explained that there had been a lot of tension but the tension had begun to lift.

> Oh, that is tough. As of right now which is what I hope it is going to continue to be, I would say polite and functioning. My advisor's time is filled up with [personal] things and [they] are important and the thing is it is fine with me because when I'm working on my stuff if I ask her if was can meet at some point we usually get to meet at some point because she wants me to get a paper published. (Jemilla, IC624)

Charlotte was establishing a new faculty relationship due to the departure of her first faculty advisor. Charlotte indicated she was struggling with trusting this new advisor because she had been on faculty during the investigation of her former advisor and, like the other faculty in the department had appeared less than supportive to Charlotte or the other female graduate student.

> So, I have this new advisor, female advisor, and I really kind of approach that as an all business relationship. I try to keep it above board and professional. Everything documented as possible because I just don't trust her. So, that's been slow going and she's done a lot of things in the interim. (Charlotte, IC354)

The diversity of advisor relationships the participants shared spanned the full continuum of a formal, professional, focused business across the spectrum to friendship and social

connection. Donna, who by all accounts valued the relationship she had with her advisor, also categorized the relationship as that of taking on habits or beliefs that may not be completely healthy.

> The irony of the fact that I'm kind of following in the footsteps of the Ph.D. student who was a mentor of me and my advisor who was also a mentor of me is that it was actually their success but maybe their stress levels that initially convinced me that I wasn't capable of doing that. So, in many ways I'm moving in the same space, I feel very strongly I can't be them. (Donna, IC686)

For Valerie, she met the evolving relationship with her advisor from a place of awareness. As an older student, Valerie acknowledged that she was able to understand her experiences with her faculty advisor would provide individual opportunities and tailored experiences of herself. She articulated that she was at a place developmentally where she could respect her doctoral advisor but also acknowledge that the person her advisor was had changed for Valerie. As an undergrad, Valerie saw her advisor as infallible, now as a doctoral student, Valerie expressed gratitude and relief to see her advisor as a whole person.

> I would say that working for her has kind of, I do not want to sound rude, humbled my opinion of her. Because before in undergrad I was just like she is this Viking shemale. She is so powerful. You know she makes mistakes and she's a human and I've learned that working with her now. You know? So that has been, I would not say it is bad because it definitely makes me realize, so okay my mistakes are fine because everybody makes them. (Valerie, IC462)

On the other end of the professional to friend continuum was Tatum. Tatum was the only graduate student that expressed a true connection, deep understanding, and sense of support for her whole self from her advisor.

> She has not only become an advisor she has become a friend too. I think that is great. Like, I do not think that relationship works for everyone but with my advisor, she stops by my office every single morning and is like "Hey how is it going? How was your night last night, did you get good sleep?" (Tatum, IC171)

Tatum acknowledged that her advisor relationship was less common than most, even within her department, but indicated that she believed her advisor had the type of relationship she described with all the students in the lab.

Mentorship Lottery

Most of the participants felt like the advisor relationship was a luck of the draw. Based on the nature of the advisor selection process, participants understood that fundamentally they could not complete a doctoral program without an advisor; therefore, selecting and securing an advisor was more important than the mentoring match. "I think that the need to find a mentor is something we don't know innately. We kind of think we either got it, we had it, and we don't, or we got lucky or we didn't" (Donna, IC628).

The participants all expressed a desire for a mentoring match that provided more of the outcomes associated with informal mentoring relationships. Several of the women spoke about their desire to have a close intimate relationship with their advisor; one that would produce both extrinsic and intrinsic rewards. Because of this desire, the participants gave examples of faculty-graduate student relationships they saw around them and what they yearned for from those relationships.

> I came in with another woman and she has a very different personality than I do. She is highly successful and she is in the diverse group, so, the things that we do on paper mirror each other. We co-founded the same group. We are part of the same outreach. We took the same classes. Working on projects at the same time. You know various things at the same time. And you watched her career go like this or reputation and relationships with faculty go like this and mine just kind of go like that. So hers go up and mine sink. And, I think this in part has to do with her advisor. (Synthia, IC840).

While Synthia felt her academic career was impacted by the selection in institutions, she also felt the selection of her advisor played a key role affecting her success and her current professional reputation. Lauren expressed a similar sense of loss for camaraderie and research problem solving; she indicated that she did not have someone to turn to for process and connection. “My boyfriend knows quite a lot. But you know, as I have mentioned he is able to talk to his advisor in a very scientifically minded way. She is like on point with how she responds to him. He is like okay sigh of relief. And I really love that for him, but I know I don’t have that” (Lauren, IC499).

The structured nature of the mentoring relationship was complex for the participants to discuss. All the women desired a relationship of mutual respect and connection. They all understood and valued the importance the formal nature of a faculty-graduate student relationship and that the desired outcome from that formalized relationship was the completion of their degrees. Tatum understood she had a much closer advisor relationship than most of her peers. Elle Nyx and Valerie, being further along in their academic pursuits, presented an elevated understanding of how their advisor

relationships had evolved with time and investment. For the remainder of the participants, they held their relationships at a distance, many yearning for more intimate connections but at the same time unable to find ways to connect with their advisors. Ultimately, some turned to others outside the advisor relationship to fill their perceived support gaps.

Department as Mentor

The participants acknowledged they had more needs then one person could fulfill. More than half acknowledged that their departments provided a source of community and connection through planned activities, other faculty in the department, or the department graduate student cohorts. A few participants found navigating departmental culture and politics as complex as trying to create more personal relationships with their advisors. Regardless of how favorably the participants viewed the support and development offered by departmental clusters outside their advisor, individuals within departments made efforts to provide support and guidance for the participants.

Jemilla indicated that if she needed help she could ask someone in the department. However, she did not always know where to go and felt that the lack of clarity was cumbersome. “The program might support people, I don’t really know how much I can comment on that because I generally don’t [get support]. If I want support I have to ask a specific question to somebody who just knows more than I do and generally I don’t turn to faculty” (Jemilla, IC681). In contrast, other participants felt the department was a significantly positive connection. For Rebecca there was a balance needed from leaning into the department for support after spending 40 or more hours a week with the same people.

> I firmly believe I have like the kindest department but like it's hard because you want to get to connect with your department but at the same time if you are spending nine to five with the same people every day, the last thing I want to do is go hang out with stats people. I want to find other people. (Rebecca, IC273)

Program Structure and Faculty

Based on the participant interviews, community within the department depended on the structure of the academic program. Participants from smaller programs with 20-30 graduate students total tended to talk more about a sense of camaraderie and connection. Participants from larger departments with 70 or more graduate students focused more on lab or cluster groups as a place of support. In addition to the way a department breaks down its structure, the ability to connect with other faculty arose as important.

> So it's a very informal thing. There was a professor in our cluster who was just more proactive about doing things. He's now at a different university and that sort of role had sort of fallen onto my advisor. I don't know if that was willingly or not. So, it's definitely been different almost every single semester I've been here. (Lauren, IC575)

While Lauren was able to acknowledge some formal structure of support within her cluster, she did not really understand its purpose. Lauren recognized and valued the approach the former cluster faculty member had taken and spoke to his intentionality with the cluster meetings. However, she was unable to connect those meetings under the former faculty member or her advisor as beneficial to her graduate career.

Valerie spoke to the positive influence a female faculty member, and department head, provided during joint lab meetings within her discipline. The outside faculty

member's ability to help her grow as a researcher also helped Valerie form a positive mentor relationship with a faculty member beyond her chair. That relationship provided her a valuable place to process her experiences as a researcher and as a woman in academia.

> We would have joint lab meetings despite having different research going on. And I remember she, the first couple of presentations I made she was really, I felt like I was being attacked. She was really stern, asking all these probing questions. I remember getting my feelings hurt and then later, after the second time where she had done that, she was like you know you understand more than you let yourself explain and she was like you need to stop reverting to Zuber [Valarie's chair] and answer the question because I know you know the answer. And then after I realized that she was just trying to get me to be better I kind of had a new found understanding and appreciation for her and then I started going to her for advice and different expectations for women in science. (Valerie, IC269)

Some of the participants, like Lauren and Valerie, spoke to the formal departmental or program structures that allowed them to connect with other faculty in particular. A few of the women looked for ways to seek out those connections because the department structure did not immediately afford access or connection to other faculty. As Synthia coped with a deteriorated advisor relationship and a blemished professional reputation with her department, she knew she needed guidance. Synthia understood that the only way she was going to get the coaching she needed was to seek it out herself.

> The most diverse group of graduate students is led by a white male. It is the most successful group. They are the only [grads] thriving. So the advisor in the diverse

> group, he [is] probably the only professor, I went to have a conversation with him, I was just struggling. We ended up talking about several things … [he] is the only person that I've talked to that I actually felt listened to. (Synthia, IC760)

The self-described isolation about half the participants talked about was indicative of a complex need for human support buried in departmental culture that was hard to access or ascertain on their own. As each participate spoke, Golde's (2005) research on the impact the discipline and the department play on the socialization experiences of graduate students was evident.

Department as Community

Through the 12 interviews the interconnection between the participant and the department was a constant part of each woman's journey. Several of the graduate students assisted in facilitating department socials, lecture series, and even graduate student recruitment efforts. Tatum was particularly involved within the department. "So, of the graduate students I think I am just very involved in the department. And, we only have about 40 graduate students so it is not a terribly big department either. So, we have a lot of events that happen within the department and it is really easy to get to know each other." (Tatum, IC284)

While Tatum talked about a relatively small department, Nancy indicated she found community within a large department. Her secret to connection, showing up.

> Oh I go to every single colloquia basically. In related fields. I mean we have a big department. There are a lot of sub categories of math but I go to three weekly, four weekly seminars. … so professors can expect that I will be there to the point where I won an award last year in the society of industrial and applied math and all of the

> awardees were told they were getting an award except for me. … The professor, when he was giving me this award he said "oh I didn't tell this person that she was getting an award because I knew she was going to be here." (Nancy, IC287)

Much like the program structure, an interplay between faculty and the department as community arose for the participants. Tatum openly talked about faculty interfacing with graduate students. "You know we have department happy hour today. Another faculty member had approached me about setting that up. She and another faculty member are the two, only faculty members that show up." (Tatum, IC366)

It was apparent from all 12 participants that the size of the department, the culture of the discipline, and the access to and exchange with faculty, or lack thereof, were key influences on the department community. Charlotte addressed the complex role of the department community when she spoke about the dual position between the College of Agriculture and Life Sciences and the College of Engineering.

> I landed in this department and yes it is an Engineering department, but it was more familial I guess than some of the other departments. Not as ruthless, you did not feel like … a head of cattle as you are trying to get through and get assistance for various things. So, I kind of liked that and I kind of owed it to, attributed it to the fact that my department sits in both Engineering and the College of Agrilife Science. (Charlotte, IC157)

While Charlotte acknowledged that engineering as a discipline and a department could be formal, almost distant she attributed the community within her program to the influence for the College of Agrilife.

> So, there is something about that Agriculture culture ... still cannot put my finger on that, but there is something there. Anyway, it seemed more familial even though I was still kind of on the outside looking in. I had like two people and one I just saw last week. We are still buds, but so as an undergrad you get to go speak to professors and everything seemed you know, it seemed friendly like, even if you weren't part of the friendliness. I could recognize that there was some sort of community that held these people together that was different from what my other friends were experiencing in other Engineering fields (Charlotte, IC157)

Evident in Charlotte's comparison of the two colleges that her program resides in, is this astute awareness that the colleges, departments, and disciplines are influenced by the culture. As an undergraduate student she was able to engage is a community grounded in the agricultural community. Transitioning to her doctoral program, Charlotte had an abrupt realization about the engineering culture and its negative influence on the department.

> Transitioning as a graduate student, I saw that [culture/community] just crash the hell down. I found that professors you know would pass each other in the hall and not speak. I found out that my department is not a friendly collegial department. People have their little niches but they do not get together and they do not celebrate achievements. (Charlotte, IC17).

Network

The third subtheme that emerged within the department as a mentor was that of networking. The participants talked about the importance of networking both within the department and with others outside the department. Depending on the department,

networking opportunities were facilitated in house or in some cases, departments provided funding as a way to support participants networking with others.

About half of the participants spoke to some type of structured departmental event as providing networking opportunities. Many of the events occurred regularly on either a week or monthly basis. “We have department seminars every week where an invited speaker comes and then before that we have drinks and snacks together, or at least we are invited to” (Jemilla, IC697). Rebecca talked about a similar type of structure but indicated that many of the graduate students did not attend because there was a separation between the faculty and graduate students around food.

> There's a seminar every Friday with food but only faculty get [the] food and so grad students are like if we aren't getting [food] why are we gonna [go]? Like you have to go if you are in the class and have to go to seminar but if you aren't in that class it's like why would I show up on a Friday. I think food is a really good way to motivate grad students but the department wants it to be the discussion. (Rebecca, IC569)

For other students, networking meant connecting with others in the field or other graduate students. By far, Charlotte engaged the most in networking opportunities supported by her department.

> I have a decent amount of experience and contacts in that respect [to the field and teaching]. And, I also every fall, and this is through AGAP [Alliance for Graduate Education in the Professoriate] they [the department] sponsor a bunch of us to go to the institute of teaching and mentoring which is minority Ph.D.s [from] all across [the country]. (Charlotte, IC746)

Zelma spoke to the role of interdepartmental networking. Because Zelma's lab was a joint research lab with a portion of the research being conducting in Biomedical Engineering and the other portion housed out of a different college, the graduate student researchers had to facilitate ways to network and make connections. Zelma talked about the complex nature of transferring data and samples between two distinctive labs across a large campus.

> [My advisor] has been collaborating for 20 years with a professor in the Kinesiology department. So her lab does all of the bone biology microscope work and our lab does all the engineering breaking forces, mechanics of bones. So, there is very little definition between those two labs. Our bosses are terrible at setting expectations and no one knows what is expected of them. Some people carry way more of the work and other people have defended because they are selfish and the others of us who do not defend, this does not seem to be working out. We have had a lot of interpersonal conflicts that just blow up. Everyone is mad and then we just wait until someone graduates. It got to a point the senior graduate students from the two labs intervened and now we are all friends. We all help each other. (Zelma, IC298)

Every participant articulated a connection with their department for support, community, guidance, and institutional processes. The individual experiences were divergent from each other. Participants that came from the same departments spoke to similar challenges and opportunities indicated the culture and departmental structure to support spanned the department. Significant differences existed across the participants as it

related to unique departments. Based on the women's experiences, there appeared to be conflicting support and community between departments housed in the same colleges.

Mentoring Others

The final theme that arose when looking at the experiences of female domestic STEM doctoral students in mentoring relationships was the concept of mentoring others. During the interviews, questions about mentoring, coaching, guidance, and support were asked with an open-ended style so participants were able to talk about what they received from their mentor relationship, what they felt was lacking, and what they desired. One area of shared experience amongst the participants was a sense of responsibility to mentor others. While a few of the women talked about lab responsibilities that included mentoring undergraduates, most participants saw that responsibility more as supervision than mentorship. Elle Nyx was the sole outlier; she indicated that she found great joy in mentoring undergraduate students. Elle Nyx and many of the other participants talked about mentoring other women and mentoring graduate students as a responsibility of their role as a graduate student.

Valerie, Elle Nyx, and Nancy talked about the value they placed and promoting STEM as a path for girls and women. Specifically, the participants indicated they made intentional efforts to engage in Women and Science and Engineering (WISE) programming as a way to help support community and mentor others. Valarie talked about lecturing at elementary schools or development events and activities for girl scouts. Nancy's mentoring focused on women and minority women. She spoke of the importance in supporting undergraduate women in the application and interviewing process while applying for graduate schools. Nancy also noted the importance of supporting other

graduate students by being a positive presence for them at seminars, conferences, or within the classroom.

Women

Part in parcel with the concept of being a woman in STEM, the women felt it important to support each other. There was a significant unspoken understanding that each participant addressed in which support for one another as women was of greater importance than the academic competition. For more than half of those interviewed, seven women articulated a sense of responsibility to listen, support, coach, and provide guidance to other women within, both their discipline and across campus. Rebecca opened up about being a woman in statistics. She indicated that her cohort was an anomaly because there were 14 graduate students admitted, four of the 14 were domestic students, and three of the four domestic students were women, a significant number of domestic women for a field that is predominantly male and international. Rebecca indicated that domestic doctoral students, regardless of gender, do not have high retention rates in statistics. When asked why domestic students persist at low rates she was not able to provide a concrete answer but mused that American students knew that if it was too hard they could leave and get a job in industry while their international counterparts were bound by visa regulations. When asked about her perceived feeling of difficulty in her program she stated,

> After our first midterms [this semester], there's one girl, we have one particularly horrible class and this one girl and I were talking and I guess I was feeling extra tired or something and I mentioned how just discouraged I had been and she opened up to and she was like "I have been so discouraged. I feel like a failure and I just want to get this semester over." … it would just be so nice if there was like a

> system where older students adopted a younger student, maybe once a week they went out for lunch or twice a month went out for lunch or something. (Rebecca, IC911)

When prompted further about the idea of student peer mentoring. Rebecca stated that since female advisors were hard to come by it would be nice to have another female take interest in what she did. “I work hard to take interest in the work the other women in my cohort are doing. But mostly they come to me for advice and of course I try to help them but then I don’t feel like I have someone to turn to.” (Rebecca, IC1030)

Valerie, like Rebecca, believed she had a responsibility as a woman to support other women. “I think part of my role is to help other women. I think that by letting them know that all of their efforts are worth something and not just something that you receive feedback on” (Valerie, IC684). Valerie explained that she had this deep sense of responsibility to mentor other women because she had been fortunate at all three levels of her academic career to have strong female mentors.

Elle Nyx, too, expressed a since of responsibility in mentoring undergraduates and graduate students. She particularly felt mentoring was a role she was meant to fulfill. Elle Nyx attributed her success in mentoring to the mentorship and coaching she received from her advisor. “I like doing mentoring, which, in my current group, I mean I got an undergraduate research mentoring award, umm my advisor puts me in a mentorship position with a lot of the undergraduates, I developed a plan for that. So we, so she mentors me on mentoring [them]” (Elle Nyx, IC380).

Donna’s strained relationship with the male faculty in her program had a slightly different experience on her value of mentoring other women. She felt a desire on her part

to be available to support other women in academia, particularly within her college and department. When asked about mentorship of women, Donna indicated that she believed mentorship was something one worked at and was acquired not a given. She also acknowledged that she had to be part of the solution through role modeling and mentorship of others.

> I think that that need to find a mentor is something we don't know innately. We kind of think we either got it, we had it and we don't, or we got lucky or we didn't. And just, I think that's one of the hopes we can encourage people to have higher expectations of at least the kind of constellation of people that they have even if one doesn't prove useful and maybe that's okay. I think that particularly with the still the low numbers that we see of women in Ag that you need someone who you can envision being like you. And that particularly relating to others above you and beside you are really important, so that's what I try to do be that person, that woman (Donna, IC628).

There was a clear interplay between supporting and mentoring women and that of supporting and mentoring other graduate students. As the participants talked about their experiences, they consistently clustered the two groups together. When asked if they believed there were differences, Kerri explained that she would engage and support any female student, undergraduate, graduate, or post doc. She expressed a more intentional type of support for the graduate students in her program; less about being friends with them and more about being a good colleague.

Other Graduate Students

Isolation has been identified as a problem in graduate school and a critical problem for underrepresented faculty such as women (Rosser, 2004). It has been noted that mentoring and immersion actives into graduate students' disciplines provided evidence that graduate students can achieve successful careers. Without connection, graduate students report a sense of loneliness, anxiety, and are more likely to be depressed (Gardner, 2008a). Rebecca and Lauren both indicated that they generally felt isolated and often alone. Rebecca expressed a significant desire to be mentored by faculty and graduate students. She expressed a sense of obligation to support the other graduate women in statistics. She did not indicate that same sense of responsibility to support other graduate students. Rebecca expressed a deep desire for female connection.

Throughout Lauren's interview, she talked about staying to herself, avoiding departmental social gatherings, and keeping a professional distance with her lab mat. Lauren indicated that outside of her boyfriend, her social life was non-existent. "I do not feel there is anybody in the program, my lab, or other faculty that can support me" (Lauren, IC197).

Outside of Lauren and Rebecca, the ten women interviewed spoke directly to the importance of building supportive graduate student relationships. The participants indicated that an individual graduate student's success depended on building positive relationships with others. In their interviews, the ten women indicated that they needed a place to vent their frustrations, seek guidance for unrealistic expectations from their advisors and to seek support while conducting independent research that by nature was isolating. Nancy indicated that building a support system and making connections was key

to academic progress. “It is a social [department]. We have 100 grad students in the department which is large and per year there's at least 10-15 of us that are around and willing to hang out and eat candy together or pizza. It is important because these are the people trudging with you. Better to be together then alone” (Nancy, IC544).

Having dealt with animosity from the department, Donna felt it was important to support her fellow graduate students. While Donna was not a person to dwell on outside negativity, she understood the impact of struggling with faculty and wanted to be available to listen.

> I've known one woman this semester one last semester who was in a situation where their advisor was really kind of antagonistic to them and my advice is well you can quit. You can go someplace else but you need to get a surrogate mentor and find someone, male or female, who's willing to help you write a paper together or do something. Because you have to have an advocate to do well when you leave here. (Donna, IC622)

Donna expressed a clear belief that community of support meant direct, honest, and clear feedback. She articulated that she had a doctoral student who mentored her while she was in her master’s program, and that person was her primary source of motivation to help others. “The irony of the fact is that I’m kind of following in [my] Ph.D. student mentor’s guidance. I can’t fix it but I can support them” (Donna, IC684).

Like Donna, Elle Nyx expressed a sense of obligation to support her fellow graduate students in astronomy. She indicated that overall astronomy was a small cohort of graduate students, between 15 and 20 total, and that astronomy is a subset of the physics graduate student body. By the structural nature of being a subset within a larger

organization, the departmental culture supported astronomy graduate students sticking together. Elle Nyx described a culture where the more senior graduate students served to onboard the newer students. This informal onboarding occurred through graduate student socials, a standing happy hour on Fridays, and other personalized outreach. Elle Nyx indicated that the department culture had shifted in the last two years and she felt responsible for missing the queues that problems had emerged. “So something I feel like I failed at was not noticing when people were having some issues, because they didn't talk about them, and I would like to know so I can help. I mean there's only so much I can do, but [the department culture expects older graduate students to help newer students]” (Elle Nyx, IC476).

While a smaller theme compared to the other two major themes about the experiences of domestic female doctoral students, mentoring others provided almost all the participants with an avenue to give back, create additional interpersonal connections, and help foster community. For six of the ten women who worked to mentor individuals, it provided outside their discipline and connected with other entities across campus.

Summary

This next section reviews the multifaceted experiences reported by the participants that addresses the second research question: *What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?* There is clear overlap between the participants’ experiences as doctoral students and the positive mentoring relationships identified from the data.

Positive Mentoring Relationships

This next section explores the themes that arose from the participants' discussion of positive mentoring relationships. As discussed in the first section of this chapter, the experiences of domestic female STEM doctoral students was influenced by several factors including: receiving prior mentoring, the type of relationship the participant had with their advisor (a formal/structured relationship versus an informal/loosely structured one), the size and structure of the department, the disciplinary culture, and connections with others. These four themes were apparent throughout the data, and when participants were asked to discuss positive support they received to bolster their academic pursuits, the women identified five major areas of positive mentoring. The areas included advisors as mentors, university administration/staff as mentors, self as mentor, graduate students as community, and family as community. The five themes are outlined in Table 5, which also provides a brief summary of each theme is discussed in this chapter.

Advisor as Mentor

It became evident during the sorting and member check process that the uniqueness between discipline and program influenced the participants' expectations of what the faculty-graduate student relationship should be and what their lived experience was. The structured mentoring theme discussed in the experiences of graduate student section identified a formal relationship established with STEM doctoral education that provided a framework for the faculty-graduate student relationship. The disciplines represented by the participants in this study all appeared to use the words advisor and mentor interchangeably. This lead the participants to develop unspoken expectations of what the advisor relationship should have been.

Table 5 ***Overview of Findings: Research Question 2***

Research Question 2:	What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?
Theme	Theme Summary
Advisor as Mentor	Regardless of academic discipline, participants indicated that the faculty-graduate student relationship is at the core of the graduate student experience. However, the structure and type of relationship as well as perceived outcomes was influenced by the unique department cultures.
University Administrator and Staff as Mentor	A collective of individuals uniquely cultivated by each participant to provide mentorship and support across a number of academic and personal functions. Participants used these relationships to backfill missing skills, guidance, or connections were appropriate
Self as Mentor	The embodiment of grit and perseverance that every participant expressed as a fundamental personal attribute that must exist in order to persist through difficult times and stay focused on the end goal
Graduate Students as Community	A positive connection between graduate students within a program and across departments or colleges that provided a community that exhibited the essence of social and interpersonal support
Family as Community	Participants reflected on the role and connection they maintained to family members as a place to express frustrations, seek guidance, and receive affirmation during times of stress or set-backs

Nine of the 12 participants commented on positive mentoring relationships that propelled them into graduate school. When asked to describe their current faculty-advisor relationship as doctoral students 10 of the 12 chose descriptive words such as strained, abysmal, delicate, awkward, and professional. Every women indicated a desire for more

connection, support, and investment. In trying to describe what they thought the advisor relationship would be, the participants resorted to describing their prior mentoring relationships or spoke about peers who had a desirable model of the advisor relationship.

For Lauren, she did not describe her relationship with her advisor as bad but did express disappointment about what it had developed into. Lauren left a master's advisor who was at the end of her career, ready to retire, and was absentee according to Lauren. She entered her doctoral program hopeful for more support and a better connection. Her immediate response when asked to describe her advisor and their relationship was to identify the lack of research support.

> His research is more complimentary to mine. So a lot of the questions I have scientifically he does not know. … That's fine in some ways now that I'm progressing much further along, writing things up, doing experiments, but that's almost become demoralizing. Because I cannot ask him a question and you know whenever we meet it is less than four minutes because he's like well you are going to have to figure it out, I can't help you. And that is very bothersome, that sucks. (Lauren, IC188)

When Lauren was asked to clarify what she desired the relationship to be she described her boyfriend's relationship with his master's advisor, which was still ongoing at the time of the interview.

> So his master's advisor is fairly new to her career and is writing high powered grants doing really fascinating research and she's still to this day working with him so he's been able to do quite a bit of consulting work which is an additional sort of pay bump. He's been able to go to conferences with her internationally. She is a

> huge support role for him still. …. He is even putting out several papers a year with her. And I am struggling to get 1 paper out of master's thesis. Which my [master's] advisor is like beating me over the head with. And I have nothing in place with my doctoral advisor. (Lauren, IC137)

Lauren was not unique in her desired anticipated relationship and disappointment with the reality of the advisor relationship. Zelma had spent three years on Alaskan fishing boat, the whole time receiving cards and emails from her undergraduate advisor about the importance of her continuing her education. She worked hard to get into her program, beat down doors to earn her assistantship only to discover that her advisor was absent from the lab and the research. Her initial description of him expressed frustration with the lack of structure, accountability, and direction for both the research and her doctoral program.

> Yeah, so he is a very nice man. He cares about his family. He cares about my family. … As a mentor, he is not good. He is very scatterbrained. So, he never does anything until 2am the day it is due at 8am. I am like, if it is three days before the deadline and it is not finished, I am having a panic attack. It has been very difficult to work with "I'm not even going to pay attention until the day it is due … Lab meetings are an absolute waste of time, absolute waste of time. 1:1 meeting is a waste of time. … My methods chapter landed on his desk last December. He has not read it yet. So, we are at 11 months. Yeah! (Zelma, IC313)

Jemilla, Kerri, Nancy, Rebecca, and Synthia all gave similar initial assessments of their advisor relationships as described by Lauren and Zelma. When asked to clarify what they wanted, they all provided answers that described role modeling, counseling or

guiding, and friendship. Rosser's 2004 research on the formal and informal mentoring relationships outlined four attributes of the informal mentoring relationship which were: counseling, acceptance-and-confirmation, role modeling, and friendship. These attributes very much align with the participants descriptions.

While the data indicated disconnect for seven of the 12 participants. Charlotte, Elle Nyx, and Valerie were able to speak to the evolution and maturation of their advisor relationships. When asked to describe her advisor relationship, Elle Nyx indicated it was an intentional process that started out structured and over time afforded her a lot of autonomy as a researcher.

> She started out pretty hands on which I appreciated. I had no idea what I was doing so she started out with some small projects to see if I could [complete them] … I have noticed that since I have been working with her now for five years she is sort of 'I'm moving my hands away." She is a bit more hands off now. There has been less direction slash micromanagement now. There is a bit more when I contact her challenging my work, which is, which makes sense. She is now trying to treat me like a researcher rather than a student. (Elle Nyx, IC109 & IC115)

Valerie described a similar experience with her advisor to the one Elle Nyx described. Valerie's doctoral advisor was her undergraduate advisor. After graduating with her bachelor degrees, she went into industry for a few years but missed the research. Decided to go back to school and worked for a male faculty advisor during her master's program. When Valerie made the decision to apply to doctoral programs, a research spot as a lab tech was available in her former undergraduate advisor's lab. Valerie acknowledged

that their relationship had grown between undergrad and grad school but she actually had not stayed in touch in the period between the degrees.

> She is very supportive. … She pushes us to be free thinking which is kind of hard. I am not sure if this applies to everyone. It is hard for me to come up with something new, like a new novel idea, but she definitely tries to facilitate that. So she will give you a seed and keep watering it and expect that plant to grow. …You work hard and you publish a lot and that is something she does and pushes us all to do too when we are working with her or our first students. (Valerie, IC385)

Similar to Valerie and Elle Nyx, Tatum had a positive experience with her advising relationship. Unlike the other 11 participants, Tatum described her advisor relationship as a friendship. She indicated that her whole reason for choosing the university she did was to work with her advisor. When asked the same question to describe her advisor, Tatum used words like incredible, personable, supportive, and understanding.

> Incredible. I actually just adopted a cat from her on Sunday. She has not only become an advisor she has become a friend too. I think that is great. Like, I do not think that relationship works for everyone but with my advisor, she stops by my office every single morning and is like "Hey how is it going like how [was] your night last night? Did you get good sleep?" She asked about the kitten yesterday, like you know different things. She is just very personable. … We love our advisor and we talk about her so highly but we still are somewhat scared to go to her about things. She is our advisor, you know? [Tatum, IC171 & IC264]

To better understand the advisor-graduate student relationship, the participants were asked to describe what they believed to be the role of their advisor. All 12

participants described the role of the graduate advisor as crucial to their academic success. They all articulated an understanding of the complex relationship between faculty member as teacher, supervisor, and mentor. “But as a graduate student you are not just a student there, you are also an employee so it is more of a relationship rather than just someone you go see when you have a problem and then that’s all you are to each other” (Jemilla, IC579).

Like Jemilla, Charlotte acknowledged the multilayered relationship of the faculty-graduate student connection and spoke to the roles she assigned her advisor, not roles that were mutually agreed upon.

> He was my primary connection to my field. He was my primary connection to what I thought was a lot of things. So that, you know, being cut out from under me has been a long process to kind of get through. So, I started thinking about it like. In the beginning I was like oh well I don't have a mentor. You know and I never considered my chair you know my mentor. He was my research advisor and I admired him in a lot of ways but I never really viewed him with that sort of I don't know with that sort of, connection. I never viewed him with that role, you know formally at least in my mind. (Charlotte, IC58 & IC80)

Charlotte had struggled with her emotions about her advisor and talking about him. When she went back to the beginning, she recognized support, inclusion, investment, and encouragement as some of the key descriptors to describe their relationship. After it deteriorated and he left the institution, she indicated a great sense of loss, confusion, and lack of purpose.

Tatum sums up the theme of the advisor as mentor by indicating that the advisor is a key positive influence to the graduate mentor experience. “If you don’t love the advisor and/or project you are not going to thrive in graduate school and in fact you are probably going to move on. If you don’t love your relationship with them it is hard to do work in general or if you don’t love your project it is hard to do work at all” (Tatum, IC516).

University Administration and Staff as Mentor

The participants acknowledged that within the university setting often they relied on staff or other university administrators to help play a role and providing support, community, and mentorship. A handful of the participants spoke about relationships with university or college administration that helped them feel connected to more than just academics. Additionally, a few participants talked about connections to staff or other faculty within their program or their college that they looked to for support and guidance regarding administrative bureaucracy, department politics, or other campus dynamics.

Kerri expressed this constant struggle between trying to connect with her program but needed more to round out her experience. For her, making connections across the campus was very important. “I'm not that person that likes to stay within a small sect. While I like my colleagues, truthfully there's so much drama in there that I'm just like y'all stick with it. I'm gonna go talk with these people” (Kerri, IC560). So, Kerry joined a campus wide student organization, volunteered for a number of recruiting and hosting events across campus and worked to make connections with staff in student affairs and at the university alumni center.

> That's what I'm really enjoying about the, with the Student Ambassadors just the dynamic group because I think um this past month we had our distinguished alumni

> gala and the ambassadors we were just helping out kinda getting everything set up. You could not have asked for like meeting more unique people than the distinguished alums and you do not really get to meet them always in person. So it, it's fun being able to do that too. (Kerri, IC667)

Kerri did acknowledge that her involvement outside her program and department created tension with her lab. She has often felt judged about how she spends her time but indicated that the connections beyond her program are vital to her success in her program.

Charlotte took a different approach to making connections across the campus. As a minority student on a predominately-white campus, Charlotte initially took advantage of programs designed to support underrepresented students. What she did not expect to happen from engaging in these programs was the support network she created for herself as she developed these relationships. After Charlotte's advisor left the institution, she found herself turning to this diverse pool of staff and administrators for guidance and support.

> I had a lot of well-placed people … that if I was struggling with this I would go talk to them about that or if I was struggling with this, I had these kind of people that I could go to. … And I needed some of them in such huge ways and literally that is the only reason I'm still here is because several of those people had to step into the gap and keep me here. (Charlotte, IC92)

Nancy also spoke to importance of broadening her network. Nancy understood that by making herself available through department and college seminars and taking in active role at the graduate student level on campus she had people who she could turn to. Unlike Charlotte, who had come to rely on this wider network for support, Nancy has used her university network for career and academic advancement.

> So I think just getting involved has helped me have my name out there. So everyone knows when they see my email that it is me. They know what my name is. They know if they have a question or if they need to consider someone for something that I am available for that or I could be interested or I will know the right person. I think that all came from networking and going to, not being afraid to talking to people … (Nancy, IC296)

While only three women spoke directly to connecting with staff and university administration outside of their program, many of the participants acknowledge that getting to know the staff in their department helped them navigate paperwork, being paid, teaching assignments, and other baseline red tape that was an essential part of the graduate student experience. Some participants took those connections further and used them to help provide community and support beyond the boundaries of their advisor, lab, or research groups.

Self as Mentor

Every participant interviewed spoke of an internal drive that motivated them to achieve. More than half of the participants spoke about a sense of responsibility to themselves to finish what they had started. Eight of the 12 women described an inner voice that they looked to for guidance, motivation, and perseverance. After the qualitative sort, the participants were asked to review both the major and secondary themes of the data. Every participant but Elle Nyx, who was unable to review the themes due to her graduation and departure from the institution, commented on the theme of self as mentor and indicated to the researcher that this theme deeply resonated with each of them.

While none of the women articulated words like grit, perseverance, persistence, courage, or resilience, each one of them spoke to their sheer internal drive to finish their degrees. Synthia summed up this inner strength when she was asked what or who kept her going. Her response. “I do. Regardless of what I have to go through to get there, regardless of how long it takes, I can get a Ph.D. at the end of this. I have already started this process. I have put this much time into it, and how do you quit at this point?” (Synthia, IC625). Lauren spoke to a similar internal conversation to keep moving forward. “I know that at the end it will be worth it, but it just really sucks right now. So I think it’s still more of an internal dialogue rather than an external like oh I want to do it because of xyz. Self-motivating I think, but like that motivation is a roller coaster” (Lauren, IC660).

The participants addressed the value of their time, energy, and financial investment as reasons to dig down deep and keep going. “Part of it is just inertia like I’ve been here might as well get something out of the time I’ve spent here. Sometimes that is all it is [one foot in front of the other]. Like just getting a little done, a little more than the day before” (Jemilla, IC799). Zelma actually talked about being raised not to quit. She then spoke to the investment of her time and the investment that her program took when they admitted her.

> In my childhood, not quitting a sports team [you] did not quit. Oh yeah, I never quit anything in my life. I quit track my senior year of college after 18-months of hell. Like, looking back at what it took me to bring me to the point to where I walked away from my team was insane. I am like I should have quit long ago. The number one reason I have toughed it out for six years, to prove that the admission was worth it. There are people who are much better qualified than I am who have

> dropped out. When I found that out I was like, I am sorry what? That will not be me. (Zelma, IC689)

In addition to this sense of mental toughness that each participant discussed several of the women detailed learning to let things go and giving themselves permission to do that. Often the letting go was not internal conversations, it was about finding a way to acknowledge their own worth and that their value did not reside with their department, their chair, their committee, or other graduate students. While Synthia was navigating an advisor change and trying to finally produce some research material for review she recognized she didn't have to do it a certain way, she needed to complete the document her way and that she had value and legitimacy in the program and as a researcher.

> And so this paper has been a series of myself saying no I have the writing, no I have the writing, two weeks ago I finally realized, I don't know why this sounds really stupid, it is my paper which means I can write it the way that I want to and it doesn't have to be written a certain way to be published. I should write it the way I convey science because that is going to be the best thing I can do and then have someone edit it and that has been the most successful iteration so far. But, how long did it take, it took me a year and a half to get to that tiny spot, you know? (Synthia, IC463)

In answering the research question: *what types of relationships have a positive impact on academic persistence in STEM doctoral programs?* Self-efficacy, self-support, and perseverance were evident with every participant. There is a space that each women had to create to be her own cheerleader, her own coach, and her own guide. Many of the participants spoke about being guarding and not allowing their full authentic self to be

displayed anywhere. “I wouldn’t say there is any one particular person that I can like just unload it all.” (Lauren, IC498). Rebecca talked about the isolation that the doctoral program has created.

> Honestly, not anywhere I can go [for guidance]. Like undergrad going to a small private school, anytime I had questions I could go into faculty's office or I could talk to. There was always someone to talk to. I had friends everywhere and in all the departments and I had people who would go get coffee with me and invite me over to their home. And now, it's like, well. I guess I could email my professor and ask to set up an appointment but there is not a ton yet. (Rebecca, IC354)

This isolation or fear of revealing one’s true vulnerability created a place for self-doubt. In that void, the women all recognized they could either fill it with a voice that tore them down or built them up. Navigating that balance has required them to be their own mentors.

Graduate Students as Community

The fourth theme that emerged from the data when focused on positive mentoring relationships that the participants discussed was relationships with of other graduate students. While not inherently a model of a mentoring relationship, participants were clear that the pockets of community and support cultivated amongst graduate students encompassed some functions of mentoring including role modeling, coaching, counseling and advising. Nine of the 12 participants spoke about the importance of making connections with other graduate students. Many focused on the other graduate student in their labs or those other graduate students working with their advisor. Some spoke to connections with other graduate students within their cohort or in smaller departments,

across all graduate students. Three participants spoke about making connections with graduate students outside of their program and across the campus. In all nine conversations, the women spoke about community, connection, encouragement, and camaraderie.

Kerri spoke about the importance of relying on other graduate students to help her figure things out. She acknowledged that the other graduate students in her lab were integral to her acclimation to the program and the research lab. “I was still new in the lab so I didn’t really know people. Well, I grew with my lab and I got to know them and I know their quirks, they know my quirks and so they’ve been helping me figure out the techniques and learning the different analysis that need[s] to be done” (Kerri, IC321).

While Kerri spoke directly to the training and onboarding she received from the other graduate students in her lab, Synthia looked to her graduate student peers for emotional support. With a difficult transition into her doctoral program and facing a number of difficult interactions with her advisor, Synthia understood that the graduate students in her program were helping to keep her afloat, move forward, and transition to a new advisor.

> I would say that most of the encouragement that I get is from graduate students and it is mostly emotional bolstering and stuff like that. Because we all have to remind each other, hey you are fantastic. You know how you think you are not working, I see you working. We do this for each other and that is part of what makes my program great. We do have a great community. (Synthia, IC553)

In addition to Synthia’s reflection on her graduate student community, Charlotte also expressed the importance of this community. “We have research group meetings which

helps us form community. I could recognize [from the beginning] that there was some sort of community that held these people together that was different from what my other friends were experiencing in other engineering fields"(Charlotte, IC174 & IC371). For Nancy, that graduate student connection and support began during the recruitment and application process that lead her to accept an offer within her department.

> So probably one of the biggest reasons for me to push me over the edge to accept the department here is that I was hosted by a current graduate students. She is two years my senior but I just fell in love with her. She is just amazing. She hosted me, she took me around to everything. We have been living next to each other for three years now. We are just best friends now which is really great. Because she has so much knowledge that she has to share too. She has been in the program. We do not have many woman in the program. (Nancy, IC509)

There was clearly a positive connection the participants felt with other graduate students. It was not just with the students in their labs or within their programs. Several of the participants spoke about needing to connect to graduate students across their departments, colleges, or the campus. Tatum spoke to her social nature and connecting with graduate students in her department. "Yeah, so, of the graduate students I think I am just very involved in the department. And, we only have about 40 graduate students so it is not a terribly big department either. So, we have a lot of events that happen within the department and it is really easy to get to know each other" (Tatum, IC284).

Rebecca had a similar need to make connections. She talked about trying to make connections within her department and college by connecting to others in her coursework. "I set-up a GroupMe for our entire class so we can try and communicate. I try and get

people's numbers and make a list of all the places that I wanted to take people. So we started taking the international students to like get queso and hamburgers and milkshakes and all the types of things that an American would have had" (Rebecca, IC328).

Even for the three women who did not speak directly to the need for connection and support from other graduate students, they talked about the integral role that graduate peers play in supporting each other. Jemilla, who acknowledge from the beginning of her interview that she was struggling with connection, spoke about her lab mate as a place of academic support.

> We [my lab mate and I] don't like hang out outside of school really because she and I are both are people who like to have private lives. But we go to each other whenever we need help or like she came to me earlier this week and talked to me about how she was worried about how she was doing on one of her classes. I really wish I could do something to help her. But yeah, she and I really do get along well. (Jemilla, IC541)

Across all 12 interviews, the participants incorporated conversations about other graduate students as a key component of their graduate school experience. They acknowledged that connection to other graduate students was an essential part of the doctoral experience. For nine of the 12 students, the graduate student connection created a small, intimate pockets of community that they depended on for skill building, support, guidance, and friendship.

Family as Community

Seven of the 12 participants spoke directly to the importance of family as a place of support and encouragement. While most of the participants that talked about family

members providing support, being cheerleaders, and sometimes providing accountability, only a couple of the participants acknowledged that their family member understood what they were experiencing. For Lauren, her father had a Ph.D. and she was able to discuss ideas and struggles more directly since he had been through the process. "So I'm very close with my dad. He also has his Ph.D. My dad ends up being more of a support in particular because my mom is more social sciences minded where as my dad is more physical. I can use him as a sounding board but he doesn't really know a lot about what I am doing" (Lauren, IC45).

Similar to Lauren, Donna's husband provided a place of reprieve and shared understanding as a currently enrolled doctoral student himself. Donna indicated that while he was also in graduate school and he had a connection to the experience, their fields of study were different and she looked to him more for professional guidance then for discussion of research or academic topics. "I once said to my husband, you know it's just frustrating that they [faculty] don't see this the way I see it. And he said 'well, that makes a lot of sense because they don't have all the information and won't. They don't know your personal life, they don't know your family situation, they don't know the why'" (Donna, IC304).

For several of the participants they really rely on their family to be cheerleaders, to provide respite, and to help motivate. Synthia talked about how hard it was to feel so isolated in her doctoral program as the only mother balancing the rigors of doctoral coursework and research along with parenting. "One of the best ways for me recharge is to go home and be reminded that I am not the only person like me. So when it gets really bad, I take advantage of weekends because my parents only live four hours away and I go hang

out with family where I can look around and be like yes you are like me. I can talk to you" (Synthia, IC677).

Like Synthia, Zelma uses family has a place of support and recharge. Zelma spoke specifically to two family members that she depends on to help fulfill the mentor as support role. She spoke about her husband indicating that he had been a huge cheerleader for her. "Year three to four I was like maybe I will just master's out. He was like no because then you are going to get a job for two years and you are going to be like man I want that Ph.D. and then we will have to start this all over" (Zelma, IC696). Additionally, Zelma articulated that her sister works to motivate her to persist and finish her degree. "My older sister has been kicking me in the ass since I was three. She was the one who made [my private undergraduate education] possible. She was like "I've been investing in your education for 20 years, financially, emotionally, you are finishing." (Zelma, IC703)

For Valerie her mother played a significant role in all of her education. Valerie indicated that growing up her mother consistently told her she was smart and could do anything she put her mind to. "In my family my mom [is my support] although she does not know a lick about science. She is very good at getting the answer out of me even though I don't know I have it" (Valerie, IC720).

Much like the other participants outlined in this section, Charlotte depends on her wife for support and encouragement. And much like Zelma, Charlotte's wife provides the needed words of guidance to persist when she wanted to quit. "My wife is my support. Honestly if she was not there I would, I would really be struggling. I knew that she has been a companion and supporter. And, especially through those 18-months where she

basically had to live and take all those bruises and cuts along with me and in the end she has kept me going and supported my decisions" (Charlotte, IC653).

In sorting and collapsing the data into themes, there was a clear place for family to provide positive community. While these relationships did not necessarily provide academic guidance, they did offer a number of the relational attributes the participants expressed needing. This included a sense of pride, a confidence that someone believed in them, and in all cases were caring and respectful to the academic pursuits of the participants.

The third and final research question associated with this study: *does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students*? The final section of this chapter looks at the data provided by the participants to answer this question. Much of their answers align closes with the sense they have developed for their own self-advocacy and persistence.

Female-to-Female Mentoring Relationships: Gender Matters

Role modeling is the most common psychosocial role of mentoring and involves the mentor setting a desirable example for the protégé (Kram, 1988). According to Hill, Corbett, and St. Rose (2010), mentorship is often cited as a key strategy for exciting, supporting, and keeping students and young scientists and engineers in the fields of science, technology, engineering, and math. This is particularly true for individuals who have not historically participated in these areas – such as young women and underrepresented minorities. The respect and admiration many of the participants expressed for either their female advisors or female faculty they made connections with was important. Most women spoke about female faculty in significant detail. Eight of the

12 women had female chairs and seven of those eight indicated that they looked specifically for a female advisor. Of the four with male chairs, three indicated that they would have preferred a female but due to the lack of female faculty in their programs or a need for a faculty member engaged in a certain area of research they tried to find the best personality fit they could. Additionally, each participant spoke about observing female faculty in their field and in several instances trying to create connection to those faculty members. Table 6 outlines the four themes that arose from conversations with the participants about gender differences. Table 6 also provides a brief summary of each theme.

Importance of Female Faculty

The participants in this study expressed value in connecting with female faculty. Rebecca, the statistical doctoral student was open about her desire to connect with women. Rebecca had a male advisor for her chair. She indicated that the relationship was strained and given statistics is a predominately-male field, she felt like she needed to connect with female faculty members as a way find positive female role models who understood what she was going through. Because Rebecca had a desire to work as an economist after completing her degree, she was intentional in connecting and developing relationships with faculty and graduate students in economics.

> I talked with a female economics professor a couple of weeks ago and I mentioned to her how I wish there was some type of female mentorship in the department and she said that you can't expect female faculty to be mentors just because they are female faculty. That [it] is an unfair burden to place on them. And, I've been kind

of wrestling with that thought because I am not sure how I feel about it. (Rebecca, IC901)

Table 6 ***Overview of Findings: Research Question 3***

Research Question 3:	Does gender differences between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students?
Theme	Theme Summary
Importance of Female Faculty	Participants expressed the importance of identifying with female faculty members. There was a clear yearning to see women who are successful in each academic discipline and a desire to develop relationships with those women
Battling the Imposter Syndrome	Female graduate students expressed emotions inundated with self-doubt and a sense of false success. Participants indicated that one strategy to challenge this thinking is to build a community of other female scientists and academics
Stereotypes, Gender Bias, and Sexual Harassment	Participants openly discussed departmental and academic disciplines that fostered cultures designed to devalue women, promote forms of gender bias, and in some cases ignore overt sexual harassment within STEM disciplines
A Leaky Pipeline to Faculty	This theme reviews the experiences of female graduate students as a component of the leaky pipeline from doctoral education to faculty roles.

Rebecca was clear that she had a desire to hear from a support person, not just from a faculty member, and not just from a woman. Rebecca expressed the importance of hearing from and seeing a female faculty navigate academic life and affirm her struggles as a female graduate student are normal. Rebecca yearned for a female role model that she

could identify with as a woman, someone that she could picture being like, and could build a connection with.

Women significantly underrepresent the field of astronomy when it comes to comparing gender make-up of the field. The International Astronomical Union (IAU) indicated that of United States members to the organization in 2010 only 12% were women (Cesarsky & Walker, 2010). During her interview, Elle Nyx tried to downplay to role that female faculty play within astronomy. However, as the conversation progressed, Elle Nyx indicated that she was aware of the small number of women in her field. She acknowledged that she monitored the female faculty and graduate students in her program as a way to follow trends.

> I do think that it is interesting that a lot of women in our field end up with female advisors. We are not quite sure why because we never choose someone because they are female. My first group here was led by a man. I have had male um mentors, most…at least when I started in astronomy most of the graduate students were men who mentored me, now it's been sort of different, um, we've had two majority female incoming classes which is interesting. (Elle Nyx, IC582)

Nancy's interview took a similar approach to Elle Nyx that in the beginning she downplayed the connection she had to female faculty. Nancy valued the fact that her doctoral advisor was both a female and a minority like herself but placed more emphasis on the fact that her advisor was professionally well positioned to help Nancy's career post-graduation.

> I just sort of, steer clear of sort of the majority that exists in mathematics. Just because I am a woman of color who is [in] math and is technically

> underrepresented and I believe we should promote other people as well. I do not think I went out of my way to find a female advisor or like my current advisor is a minority as well I guess. It just so happens these are powerful people. Honestly, they just do great math and they can accomplish all these other things. So, I think it is important. (Nancy, IC342)

Research shows that mentoring practices and relationships are most effective when they account for an individual's differences and use contextual factors such as gender and race to match mentors and protégés (Bogat & Liang, 2005). While the primary purpose of this study was not to explore gender differences in mentoring, the third research question was established to determine if any evidence existed in the idea that female domestic STEM doctoral students developed more positive relationships that promoted persistence if the faculty-graduate student pairings aligned contextual factors such as gender. As noted by the participants' comments above, they were aware and in sync with the need to connect with female faculty.

Throughout Charlotte's interview, she indicated immense isolation as an African-American, lesbian, non-traditional aged graduate student. When asked about her new committee make-up, Charlotte's demeanor became more positive as she spoke about her newest addition to her doctoral committee.

> Interestingly enough, the young faculty member brand new in my department is an African American female. The first one they have ever hired. They cannot stop breaking their own damn arm patting themselves on the back over it. And I am like you know y'all should be effing ashamed. It is 2017, this is the first black person you have ever hired ... I am sorry I'm not ready to kiss your ass over that because

> you think this is so fabulous. You know ... I mean, God bless her. She is very young and excited. So, I actually have an African American female on my committee which is absolutely insane. (Charlotte, IC511)

As Charlotte pondered the make-up of her new committee she identified a change, her first committee, under her old advisor, was made up entirely of men. After the 18-month investigation and then resignation of her advisor, Charlotte's sense of worth and her own experience with gender bias and sexual harassment in the workplace had shaken her self-efficacy. Unbeknownst to her conscious self, at least in the interview, she appeared to have the realization of whom she had asked to join her new committee, her committee of entirely women. She selected a female faculty member who had been vocal and open about the challenges faced by women in engineering and the status quo. A young junior faculty member who is also an African-American women, which Charlotte repeated no less than five times that she had an African-American women on her committee. Charlotte's committee was chaired by a full professor who earned tenure based primarily on teaching according to Charlotte, charting her own course to define success rather than the normed research to publication track.

While a number of the participants were explicit in their desire to be advised and supported by a female faculty member, the importance of female faculty became evident as the women pondered their interactions and experiences with other women. As evidenced by Charlotte, Nancy, and Elle Nyx, often they dismissed any immediate importance to gender but upon further reflection, they all acknowledged they were paying attention to gender in the faculty role.

Battling the Imposter Syndrome

The concept of imposter syndrome was discussed by ten of the 12 participants. Notably, Jemilla and Lauren, both from departments within the College of Geosciences, did not address any feelings of inadequacy or phoniness. With no direct prompt about imposter syndrome within the questions, the other ten participants initiated conversations around imposter syndrome, how they have coped with their feelings of insecurity about their worth as an academic and how they have sought out constructive validation. "Even though I have a lot of self-doubt and anxiety about things, I know I have a scientifically designed mind, and I am also going to want to know more. It would just be nice to see other females express this" (Lauren, IC645).

Nancy had the opportunity to attend a pre-doctoral seminar the summer before she started her doctoral program. The program was created by female mathematicians for female students with a goal of strengthening the ability of women students to successfully complete Ph.D. programs in the mathematical sciences. Known as the EDGE Program, it is also designed to place more women in visible leadership roles in the mathematics community.

> Enhancing Diversity in Graduate Education (EDGE) was an amazing [experience]. I do not know why I didn't bring this up. It is a mentoring program. So it is all women who are instructors. You do basically a week of algebra, a week of linear algebra, a week of analysis, a week of measure theory, also four different classes taught in a week. We had homework. We worked through the night on these problems just for our own edification. All of our instructors were female. I believe

> there were 18 of us women headed to Ph.D. programs and we still keep in contact with each other. (Nancy, IC377)

Nancy verbalized the value she had for the women in the program by talking about her ability to share frustrations, seek guidance when struggling, and be validated as a valued member of the mathematics community. She noted that the cohort and faculty communicates regularly via a group chat program and while it will go dormant, every so often a member seeks support and the community rallies. When asked what she sought most from this network of women Nancy did not hesitate with her response "to know I belong, it is a very safe space to talk" (Nancy IC387).

While Nancy looked to the EDGE program cohort to help create her sense of belonging, Tatum spoke about the challenges associated with the competitiveness of graduate school in general.

> I definitely think like a lot of people I had a very competitive mindset coming into graduate school and I would look at my other classmates and think they are doing so much more than me, like why can't I be like that? My advisor is so good to support me when I'm down. You know I can't compare myself to others in grad school. She helps me see that. (Tatum, IC458)

In Tatum's quote lies the great contributor to imposter syndrome, comparison. Noted earlier in this chapter was the way participants in this study compared their advisor relationship to that of peers or significant others. Here we see how graduate students compare their own output and success with those around them. Valerie spoke to her imposter syndrome by minimizing her value and contributions as a scientist.

> I actually recently noticed this about myself. I know I have imposter syndrome because I do not think I belong here and how did I fool everybody to thinking I am smart enough to be here right. And like I got this talk and oh my God I just fooled everybody. They think I can give the talk, they are stupid, like what? (Valerie, IC624)

Donna also expressed her struggle with her own value and belonging in an advanced academic area. For Donna, her first realization that she belonged in higher education was after she went to work full-time post her master's degree. Like Valerie and Tatum, Donna found herself outwardly downplaying her value.

> I really was not sure that soil science was the thing, but I did not have any other things and I really liked systems and so I could see how it worked and how it made sense. And it was not until leaving and working for a while and kind of thinking of myself well I'm not that much of a soil scientist and then being around everyone else and I am. So, I kind of joke of whatever room I am in, I am the least of that room. My advisor, she has to constantly tell me to stop my comparisons. (Donna, IC161)

Every participant that spoke about feelings of inadequacy and false success also mentioned that they needed others, particularly those that they perceived successful and had earned that success, to validate and remind them of their own worth. None of the ten women indicated that this validation came from men. In all cases, they sought validation from women and in many cases female faculty worked actively to keep the chronic self-doubt at bay for their students.

Participants expressed the emotional strain that imposter syndrome had on their concepts of self and of success. In addition to this demoralizing self-doubt that fostered feelings of being less than and not good enough, many of the participants openly discussed antagonistic department and disciplinary cultures that devalued them as women and female scientists. The participants asserted that female faculty were key to combating cultures that promoting stereotypes, gender bias, and covert as well as overt sexual harassment.

Stereotypes, Gender Bias, and Sexual Harassment

While significant efforts have been made by universities, colleges, departments, even K-12 education to combat the notion that girls and women are not as good in math and science as boys and men, the stereotype still exists. All but one of the participants spoke to gender bias within their programs. The one outlier, Zelma, actually acknowledged that she knew gender bias existed and was rampant in engineering. She recognized that her understanding was probably skewed by her experience at her undergraduate alma mater and her awareness of that unique experience. “I just received mail from my undergraduate institution and [it] stated they produced more Ph.D.s, and women in STEM Ph.D.s than any other institution in the country. So, it was just very much the culture. Like everyone was getting a Ph.D. in STEM, everyone was really smart, and everyone liked science” (Zelma, IC48).

For at least three of the participants: Donna, Charlotte, and Nancy, the gender bias was overt. Nancy was quoted earlier in her participant profile of this chapter having referenced her encounter with the explicit bias male students in mathematics expressed to her.

> You get this weird flip side where your male colleagues are like "oh you only got that fellowship, or you only got this program, or this funding because you are a woman," It is not because you are a woman. You know they would always say I did not get that fellowship because they [program/funding coordinators] had to give it to a woman instead. (Nancy, IC353)

While Nancy talked about the gender bias coming directly from other graduate students, Donna spoke about the gender bias she experienced from male faculty within her department. Donna's doctoral advisor was female and by Donna's description of the relationship was friendly and positive. Donna had received significant pushback since being admitted to her program with regard to funding and research access and the relationship with her advisor had been sited on a number of occasions as a point of concern.

> I think there is a group of men over 60 who are established in our department who look at that and find it to be so different than any mentoring relationship that they have ever had with a student that they probably in their best moments genuinely question whether or not that can be a good mentoring relationship because it fits no boxes. And, and it is jovial and un-seemingly not, it's like well how can this person possibly correct you if they're your friend. And the answer is frequently and very easily … I do not want to think that they know that it is potentially successful and reasonably healthy and just hate it and I think that is actually probably, I think that is true. (Donna, IC291)

In addition to the pushback Donna expressed for selecting a female advisor Donna also spoke to this culture within her department that viewed traits perceived to be feminine as

weak and unprofessional. For Donna, navigating this complex academic culture around ideas of professionalism, maturity, and there for academic collided with her value of authenticity.

> And so, we've been told by our faculty that if that is indeed, if being emotional is a feminine trait which we can argue back and forth … you [as a man] can yell that's usually not as big of a problem then we've been told directly and very clearly that that level of emotion is not professional and it's immature of us and that it's an overreaction. We lose credibility when we are empathetic. We lose credibility when we are vulnerable and so if we [create] those in ourselves. Then I think we find ways to couch them in other ways or we get rid of them (Donna, IC607).

For Jemilla, the gender bias was not as direct but she acknowledged that it was there. She found it difficult to work with a number of men in her program. As time passed, she indicated that she witnessed the ease in which the men would work together and support each other but for the women in the research group the competition and cold shoulder became apparent.

> There was a guy [in my lab] who seemed really nice when I first met him but then he became like really condescending and just not very, not very nice. In science, there's a lot of people who feel the need to be very competitive and put other people down and it is basically like I'm very smart and if anyone says anything that is a little wrong or that I disagree with them they must be stupid and then there was another guy who was like that but even worse. They really liked each other because the rest of us were girls. (Jemilla, IC527)

Elle Nyx and Charlotte both openly talked about the sexual harassment that occurred in their fields. For Charlotte the sexual harassment was a lived experience she witnessed between her first advisor and the only other female graduate student in her lab. This experience and direct quotes from Charlotte have been noted throughout this chapter as impactful and life altering for her. For Elle Nyx the discussion on sexual harassment was about the pervasiveness of it in the field of astronomy. Elle Nyx noted the national news stories about the widespread harassment reported in astronomy over the last several years and expressed awareness that she would navigate this her entire career.

> I guess it helps that my current advisor is female, because she will sometimes, like you've heard about the astronomy harassment stuff, she'll sort of know who not to work with, and who is okay. [The] astronomy sexual harassment has been going on for the last few years; people have been getting expelled from programs because of sexual harassment and grabbing people. I appreciate that my chair helps. (Elle Nyx, IC550)

The participants in this study recognized that there is a need to see women move up the faculty roles in order to help combat the overt and ongoing gender bias and sexual harassment that exists in most STEM fields. As noted at the beginning of the *female-to-female mentoring relationship section*, eight of the 12 participants in this study had female advisors yet all but one participant spoke directly to gender bias in STEM. The pervasive bias that envelops certain fields only further supports the importance of female faculty relationships for female doctoral students. As noted in this section, the participants turned to female faculty and female administration for guidance on navigating and addressing their experiences with stereotyping, gender bias, and sexual harassment.

Leaky Pipeline to Faculty

Finally, there is this continued investment by higher education, the federal government, and many for-profit and not-for-profit organizations to help stop the loss of women in science at every transition point from one education or career level to another. While not the primary focus of this study, the disproportionate departure of women in STEM from the undergraduate to graduate level and then from the graduate level to the faculty role is alarming. The participants in this study were clear about their experiences as doctoral students and the impact that those experiences had on their future career trajectories. Seven of the 12 participants made it clear they had no desire to pursue faculty positions of any type after graduating and five of the seven hoped to be conducting research outside of the academic setting as a career. Three of remaining five participates vacillated between applying for faculty positions and looking for research positions within or outside of higher education. Of the two who indicated they hoped to acquire faculty positions post-graduation both specifically indicated a desire to find teaching position not tied to research production.

Zelma, Elle Nyx, Lauren, Jemilla, Kerri, Rebecca, and Nancy spoke directly to career opportunities that would not include faculty positions. For Elle Nyx and Zelma, conducting research either in post-doctoral positions or in higher education research labs was an option but neither had a desire to pursue faculty roles. Zelma's experience on her research project in her program helped her to define her research path. "I have no interest in becoming a faculty member. I have become super passionate about women's health and pelvic floor. I went to this thing on Tuesday night, Wednesday night this week and it turns out everything I have ever dreamed of, is happening [in] the town my husband is living.

The university there is building it. I hope that is my next stop to conduct research surrounding the improvement of women's health" (Zelma, IC747).

For Elle Nyx, she acknowledged that she did not fit into the prescribe mold that institutions of higher education were looking for when it came to faculty. While she expressed a great love for mentoring and supporting students, she indicated an understanding of the political environment surrounding faculty positions. "Do I look like the teaching type? I do not fit academia's mold. They would not let someone with this many piercings and tattoos teach. I would like to keep my Mohawk. I know. In astronomy, it might be okay as a graduate student but not as faculty" (Elle Nyx, IC654). Additionally, Elle Nyx indicated it was very hard to find a faculty positions in astronomy and that the openness of her advisor about the expectations of faculty, Elle Nyx had no desire to be faculty. "My advisor's been very honest about the stuff that she has to do as faculty and I'm not that interested in doing a lot of what she does. She loves it, but it's not what I'm looking for" (Elle Nyx, IC354).

Lauren acknowledge that with her background in climate the insurance or airline industry was her desired career path. She also acknowledged that she had explored a number of science driven companies that could afford her a higher paid career choice then faculty. However, Lauren did note that the force behind her career exploration was not primarily money, she did not want to teach or do research.

> I can go into any sort of insurance firm. I can go into any airline industry. There is a particular company up in Oklahoma that organizes shipping transportation routes. So they need to know what's going with the ocean. They need to know what is going on with the atmosphere for say hurricanes, that sort of thing. I can work for

> say NASA or the weather service or any sort of science, scientifically minded company. Like the big GIS company, Esri, they hire science people. [Asked how did you learn about these career paths?] I did my own research to figure out what I could do to not teach or do research. (Lauren, IC437)

For Jemilla and Nancy their experiences in their respective fields had shifted their career paths. “I’m not quite sure yet what I want [to do after school]. I have looked at national labs. I definitely do not want to stay in academics” (Jemilla, IC439). When asked why the strong avoidance to an academic future Jemilla indicated that she valued her doctoral experience and the time with her faculty advisor but for the time commitment, pay, and pressure she knew a faculty position was not for her. Like Jemilla, Nancy had come to the realization that after the time put into her education and her experience with the people in her program; she was shifting her career options. “Before I was going to be a professor of mathematics in California that was my plan. But after being in the program and [observing] how mean people can be, now I am thinking maybe I should make money. So I am considering maybe some sort of software developing position” (Nancy, IC664).

For Valerie, Donna, and Synthia they all three expressed a desire to pursue faculty positions but none were set on that as their only option. All three indicated that they would consider research position in an academic setting but were also open to opportunities outside the academic environment. “There’s lots of fears [about considering a faculty position] just with knowing what the stress level is and that this kind of a gender issue that be ongoing. That is kind of depressing to think about. That will probably manifest itself wherever I go but I just don’t know” (Donna, IC649). It was hard for the participants to desire a career that left a bitter taste in their mouth. “Yeah, I very much fall into the

category of a parent who, like I want to live my life. My initial motivation was improving my son's life. In the end, they will call me doctor. What I do after that, I don't know" (Synthia, IC718).

There was a consistent theme from 10 of the 12 participants, the experiences that they had during their academic pursuits lead them to career choices that would mostly culminate in jobs outside of higher education and they would not join the ranks of faculty. For Tatum and Charlotte, both expressed a desire to find faculty positions after graduation. Interestingly, both women specifically identified teaching as the desired primary function of the faculty positions they would consider. For Charlotte, she entered her doctoral program expressing a love of research with a hope to help people. After five years in her program, she indicated that she had found a passion for teaching engineering.

> Honestly in the beginning when I went to get the Ph.D., I knew that academia was where I wanted to go. I wanted to research awesome things, help humanity. And, I wanted to teach because honestly teaching engineering is a big ole deal. … I do not want to have to do a postdoc because a post doc would take me away from my family most definitely and that just scares the bajeebies out of me. Hopefully, I am well positioned to find something where I can teach. (Charlotte, IC790)

Tatum expressed some similar opinions to that of Charlotte about future faculty positions. "So I think I'm even a little bit different than the normal student because I want to be an instructional professor. So, a lot of what I want to do in graduate school is teach and because you still have to do research for a Ph.D. it will probably delay my dissertation, so I can get teaching experience" (Tatum, IC483). When asked why she desired instructional faculty over a traditional faculty position Tatum stated, "I want to be like that

advisor I had. He had such an influence on me and the fact that we are still in contact today. He really changed me" (Tatum, IC502).

Summary

Based on the experiences of the 12 women who participated in this research study, their answers about mentorship, success, and navigating STEM fields indicated that while a heterogeneous gender match in an advisor relationship did not preclude success as a graduate student the participates articulated the importance of connecting with and seeing female faculty succeed. Imposter syndrome and its damaging effects was rampant among the participants and while some indicated male advisors or role models providing guidance and support they sought validation and acceptance from other women and women of faculty rank. In addition to navigating the imposter syndrome, participants emphasized the importance of the presence of female faculty to role model, guide, and provide support in navigating overt and covert gender bias present in many STEM fields. In many ways, gender does matter.

Chapter Summary

This chapter presented the lived experiences of 12 domestic female doctoral students in STEM fields. Their stories as doctoral students provided valuable insight into their motivations and efforts to persist with their academic pursuits. For all 12 participants, they acknowledged that they had people in their lives that took on roles of support, coach, and mentor to help them succeed. The mentoring relationships developed by each participant varied but fundamentally the development of specific relationships were attributed to their academic pursuits and persistence.

For most of the participants, there was a strong connection to faculty or advisors from undergraduate or master's programs that created the foundation for each woman to pursue doctoral degrees. Most of the women also talked about the multifaceted role the former advisor took in supporting their ongoing success. This former advisor role was viewed significantly different from the role of the current graduate advisor for all but one participant.

Most of the women expressed some level of disappointment about the formal structured nature of the relationship with their doctoral advisor. They expressed a desire for a mentoring relationship that exhibited attributes aligned more closely with informal or loosely structured mentoring. The formality of the doctoral program and the expeditious nature of the advisor selection process created barriers to obtaining this type of desired mentor/mentee relationship for most. Several of the more advanced doctoral students in this study acknowledged that the mentoring relationship with their doctoral advisor had evolved over time, moving away from a very formal relationship to a more informal one.

All the women who participated in this study accredited their ability to persist as coming from the support of others. The identified positive mentoring relationships that garnered the most consistent reflection and acknowledge of support included the formalized advisor relationship; other graduate students within their programs, departments, or colleges; other university staff and administrators; and family members. Additionally, 11 of the participants indicated a strong connection to the idea that persistence in their doctoral programs also depended on their own grit and ability to rebound during adversity and persevere.

The chapter concluded by exploring the answers participants shared about the nature of gender differences in mentoring and the importance of female faculty within STEM programs. The continual pressure to retain women into the faculty role is valid with seven of the 12 participants indicating a clear desire to find jobs outside of the academy. Additionally, of the five remaining participants, only two participants expressed desire to pursue faculty positions and both indicated a desire for non-tenure track instructional positions. All the participants expressed experience with gender bias within their doctoral programs. Many articulated the importance of female faculty in assisting with navigating and combating both the overt and covert bias.

What follows next is an exploration of the data and the major findings of the study. Chapter V discusses the four major findings: prior mentoring matters; managing mentoring wants versus reality; personal grit and self-motivation as a component of success; and women role models matter. In addition to the presentation of the major findings, the chapter looks at the role of mentoring through the lens of socialization tied to each of the findings. The chapter concludes with a discussion of areas for future research and practical application.

CHAPTER V

DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

The purpose of this case study was to examine the role that mentoring plays in the persistence of domestic female STEM doctoral students. Twelve domestic women enrolled in STEM doctoral programs at a Doctoral University – Very High Research located in the south were interviewed. A case study approach was used to frame the research and develop an understanding of the mentoring experiences of domestic female STEM doctoral students. The study sought to answer the following research questions:

1. What are the experiences of female domestic STEM doctoral students in mentoring relationships?
2. What types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs?
3. Does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students?

This chapter includes discussion of major findings as related to the literature on female doctoral students in STEM fields, the role of socialization theory in the persistence of doctoral students, and the importance of mentoring as a key aspect of graduate socialization. Also included is a discussion on the role grit played in the persistent of domestic female doctoral students. The chapter concludes with a discussion of areas for future research and a brief summary of the chapter.

Discussion of Key Findings

The object of this study was to identify what components of mentoring play a role in the persistence of domestic female doctoral students in STEM. Additionally, through the research questions, the study was designed to explore the connections women make to female mentors through the examination of each individual mentoring journey. The twelve interviews conducted in this study were unitized, coded, and themed to answer each of the three research questions. Research question one, *what are the experiences of female domestic STEM doctoral students in mentoring relationships,* generated four major themes: prior mentoring, structured mentoring, department as a mentor, and mentoring others. When sorting the data to answer research question two: *what types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs*; five major themes were identified. These themes included: advisor as mentor, university administration and staff as mentor, graduate students as community, family as community, and self as mentor. Four major themes were identified when the data was sorted to answer research question three: *does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral students*? The four themes included: the importance of female faculty, battling the imposter syndrome, stereotypes, gender bias, and sexual harassment, and finally the leaky pipeline to faculty. An examination of the themes that arose out of Chapter IV resulted in the emergence of four major findings.

The first two findings serve to answer the first research question. Finding 1, *prior mentoring matters*, which focuses on the importance of connection and mentorship that the women in this study used to navigate the experiences they had within their doctoral

programs. *Prior mentoring matters* underpins the importance of early socialization into the academic environment and is a key experience for most of the women who participated in this study. Finding 2, *managing mentoring wants versus reality*, recognizes the complexity of mentoring relationships. Mentoring theories address the complex nature of informal mentoring compared to formal mentoring, and this finding expresses the intricate advisor-graduate student relationship through both mentoring lenses. In looking at the second research question: *what types of mentoring relationships have a positive impact on academic persistence in STEM doctoral programs*, Finding 3, *personal grit and self-motivation as a component of success*, recognizes the importance of perseverance as a component of persistence. This finding acknowledges that an individual's grit is integral into sticking with the doctoral process. Finally, Finding 4, *women role models matter*, addresses the third research question and asserts the importance of women faculty. Based on the data, the 12 women who participated in this study sought to see women succeed in academics both as a way to navigate the academic environment and also to find community and connection. Table 7 presents an overview of the four major findings related to this study. These findings are discussed in further detail throughout this chapter. Table 7 provides a summary of the findings.

Prior Mentoring Matters

The women in this study reported that their relationships with former faculty, advisors, or other previous academic connections were important to their ongoing success as students. While all the women acknowledged they relied on their current advisors for guidance, three-fourths indicated their past academic connections created a safety net they turned to when doctoral work was difficult. Most of the women maintained some form of

regular communication with their prior mentor as an outlet for processing, guidance, and support.

Table 7 ***Summary of Major Findings***

Major Finding	Descriptors
Prior Mentoring Matters	Domestic female STEM doctoral students look to academic support from previous positive educational experiences as a primary way to navigate and succeed in the doctoral pursuit.
Managing Mentoring Wants versus Reality	The concept of mentoring carries two different constructs for domestic female STEM doctoral students as they negotiate the reality of a formal-structured graduate advisor relationship to the aspirant close connect information mentor-mentee relationship.
Personal Grit and Self-Motivation as a Component of Success	Domestic female STEM doctoral students rely on an intrinsic motivator known as grit to push through difficult patches in their doctoral journey in order to sustain persistence in their long term goal of earning a Ph.D.
Women Role Models Matter	Same-gender role models are helpful for women in STEM particularly when navigating negative stereotypes of women in STEM and with described sexual harassment environments.

Mentoring research has noted that mentoring relationships may be especially important for women in organizations, helping women to overcome gender-related barriers and making networking connections to further their careers (Noe, 1988; Ragins, 1989). Parker and Kram (1993) noted that it is particularly important for women to have multiple sequential mentors, while Ragins (1989) noted that research indicated women tend to have fewer mentors than men but are more dependent on the relationship with established

mentors. The female participants in this study cited the need for these prior mentoring relationships, as they were established, consistent, dependable, and encouraging.

All of the participants in this study indicated that having a mentor was essential to their academic success. For most of the participants, the training, networking, and encouragement they received from their prior mentors allowed them to develop or enhance their self-confidence: Nancy noted, "[my] confidence, that is all I had, she [my master's advisor] embellished it a little more, and she is the reason I am here, she continues to motivate me" (IC194). Additionally, participants noted that during stressful times their prior mentor helped them mentally navigate the issue at hand and find positive ways to address the problem. It has been noted, while there is limited research on the value mentoring has on psychological health, studies have revealed the social support received through mentoring enhances the health and well-being of the mentee and mentor (Allen, 2007; Cohen & Wills, 1985). Given this finding, it should be no surprise that the participants' identified their prior mentoring relationships as a safe, positive connection in which they felt secure to openly share their concerns, frustrations, and vulnerabilities.

As noted in Chapter IV, the participants in this study indicated that the training, support, and networking of these prior mentoring relationships were essential to their perceived current successes as doctoral students. Research has indicated that an effective mentor is one pathway around barriers, and mentoring contributes greatly to positive outcomes in educational or career aspirations (Kram, 1985; Murray, 2001).

Training

Essential to the socialization of graduate students is the concept that a graduate student must garner the "specialized knowledge, skills, attitudes, values, norms, and

interests of the profession" (Bragg, 1976, p. 1). Tinto (1993) linked socialization of students at both the undergraduate and graduate level to involve a similar process described as academic and social integration. The women in this study discussed in great depth the important academic training they received from their prior mentors. While some of the prior mentors supported the women during their undergraduate journey, others served as a mentor during a master's program. Regardless of when the mentoring took place, the women discussed the importance of learning how to conduct research, behave in a lab, and write for publication. All essential skills needed to be successful in a doctoral program. Zelma discussed this necessary training when talking about her undergraduate advisor.

> He taught me how to do a Western Blot and all of these lab, like the sheer, now looking back, the sheer volume of lab techniques he taught me is unprecedented in any undergraduate thing I've ever seen. Any technique he would show me. He would like leave me alone with microscopes then. It would make me very nervous with how much they cost but he was like you are a researcher, I trust you. (Zelma, IC629)

In addition to the training and skill foundation that students' received and currently used to navigate more complex research and tasks at the doctoral level, the women discussed the importance of the networking they were afforded and exposed to from their prior mentors.

Networking

Barnes & Austin (2008) conducted research on the role of the doctoral advisor. In their research findings, they outlined four advisor functions: collaborating, mentoring, advocating, and chastising. While all the women noted that they worked in tandem to some

degree with their doctoral advisors, most noted that the collaborative nature of their prior advising relationships were key to making connections in their chosen fields. Nancy spoke directly to her master's advisor taking her around professional conferences and facilitating introductions. Nancy also noted that her master's advisor was a key collaborator in her current research tying math and biology together. Some research suggests that networking is a distinctive function separate from mentoring (Schipani, Dworkin, Kwolek-Folland, Maurer, 2009); while socialization theory defines the function of networking as a component of the advisor-graduate student relationship linking it to mentoring and discipline integration (Austin, 2002; Austin et al., 2009; Baird, 1969). What the research connects for graduate education is that a student's ability to network and collaborate is essential. The women interviewed for this study noted this importance and indicated that their prior mentor provided a foundation for their current network of professionals within their discipline.

Support

Participants purported that one of the most important functions of their prior mentoring relationships was the support they received from their mentor. Of the women who discussed prior mentoring, all talked about reaching out to their prior mentor in times of struggle and frustration. The women indicated that when they felt like they could not go on anymore it was critical for them to make contact with their prior mentor. Ragins and Cotton (1999) and Schipani et al. (2009) found that mentoring research examined two pieces of the mentoring definition. The first being a career-oriented function of mentoring where the mentor helps position the protégé through training and development to enhance their positionality within an organization. The second function is a psychosocial function

in which the mentor provides counseling, friendship, acceptance, and confirmation to enhance the protégés sense of competence. This prior mentoring relationship produced a psychosocial connection the participants needed to feel competent and capable of completing the doctoral journey.

Managing Mentoring Wants versus Reality

Participants in this study were asked questions to prompt conversation about the way they defined their relationship with their doctoral advisor and what they hoped the relationship would be like compared to the actual experience. For 11 of the 12 participants there was disconnect from what they believed the faculty-graduate student relationship should be and what they actually experienced. All 12 women indicated that their desired faculty-graduate student relationship was that of a connection, feeling a sense of community, and maintaining a friendship with their advisor. Only one women indicated that her faculty advisor relationship met the description above.

For the other participants they described their actual relationship as structured, defined primarily by the department and institutional requirements for graduation. Levinson, Darrow, Klein, Levinson, and McKee (1978) discussed how mentoring relationships are often formal in nature, especially when they arise in a work or career setting. It could be asserted that the graduate student experience is situated as a career setting when principles of graduate socialization theory are applied. These principles assert the formal and informal nature of socialization of graduate student not only to the role do student but also to the discipline and department the student is situated in. With most mentoring research conducted within the management or education sectors, two types of

mentoring relationships have been defined and studied within the these two environments (Rosser, 2004).

Rosser indicated that formal and informal mentoring relationships emerge from two different environments. Formal mentoring is usually assigned by a third party, the mentoring is identified as a need by the organization with specific pre-determined goals and outcomes in mind, and typically there is focus on professional or career related outcomes (Kram, 1988; Ragins & Cotton, 1999; and Rosser & Egan, 2003). In contrast, informal mentoring is described as a spontaneous and voluntary relationship that evolves overtime with a loosely developed structure and limited agreed upon outcomes, if outcomes have been identified.

The women in this study expressed disappointment about the quality of the mentoring they received from their advisors. However, when asked to further explain this disappointment the incongruity with the nature of the faculty-graduate student relationship (a formal mentoring relationship) and that of an informal mentoring relationship became evident. It was not that the women were not receiving academic coaching and support; their dissatisfaction had to do with a misalignment in expectations. According to Shea (1994) informal mentoring relationships are probably the most common type of mentoring and are associated with mutual admiration and are usually very intimate and close in nature. It stands to reason that the women would assign these informal mentoring attributes to their expectations of what mentoring should look like, as the informal mentoring relationship is more common, and therefor express disappointment when these attributes were not experienced.

In the book *The Compleat Academic: A Career Guide,* Zane and Darley (2004) dedicated a chapter to the role of faculty in mentoring graduate students. The authors offered a model of advising graduate students that are conducting research as that of a modified apprenticeship. They asserted that a faculty member should be neither disengaged from what their graduate student is doing academically nor should they be too authoritarian in guiding the student through the academic research process. "Instead, we give our students an idea with, perhaps, some thoughts about how that idea might be turned into a [research] study. The student, then, does some background reading, develops some ideas of his or her own, and together we design the study" (Zane & Darley, 2004, pp. 117-118).

This concept of the modified apprenticeship reflects the structured nature of the faculty-graduate student relationship. Elle Nyx spoke directly to this model when she discussed the evolution of her advisor relationship. "[My advisor] started pretty hands on…I had no idea what I was doing so she started out with some small projects…and I have noticed that since I have been working with her now for five years she is sort of moving [her] hands away" (Elle Nyx, IC99). While Elle Nyx did not directly articulate an intentional nature of her advisor's role modeling and coaching as a master to an apprentice, she spoke to the progression of her own research ability and need, or lack thereof, for her advisor's guidance.

Zane and Darley (2004) emphasized the importance that faculty members maintain a professional distance from their graduate students. They indicated that "although it is appropriate to discuss professional ambitions and personal matters insofar as they affect the graduate student's training and job preferences, it is inappropriate to dwell on discussions of personal matters" (p. 126). While it is doubtful that most faculty adhere

rigorously to the guidance offered by Zane and Darley, the participants indicated a distance between their advisors that created a sense of disregard for them as students. This feeling of indifference from their advisors was further exasperated by the personally held assumption that they were supposed to be friends with their advisors and therefore connect on a more personal level.

The complex design of the faculty tenure process further reinforces the formal structured nature of the faculty-graduate student relationship. Faculty work, according to Tierney and Bensimon (1996) is comprised of teaching, research, and service. Based on the discussion of service as a component of faculty work in their research, service is about committee work to the department, university, or community, not in the advisement of students. It is important to understand that faculty do not receive tenure by being a great mentor. Faculty earn tenure by producing research, teaching courses, and to some minor percentage providing service to the institution. Rebecca summed this disconnect between graduate students' and their advisor relationships when she stated:

> Professors' purpose here is different. Their job is to write research, to do research, and they are really good at it. But as a result, your access to them is very limited. So you know you email them first. You only stop by during their office hours or you verbally make sure like hey if I come by at this time is that okay? (Rebecca, IC417)

No matter how the faculty-graduate student relationship was dissected, there was a gap for the participants in this study related to what they desired the faculty-graduate student relationship to be and what it actually was. The nature of the structured relationship is designed to move graduate students through academic course work, qualifying exams,

and the research and dissertation phases, ultimately graduating from their program. While every woman acknowledged this expected progression in their academic discipline, all communicated a yearning for something more when it came to connections with their advisors.

Personal Grit and Intrinsic-Motivation are a Component of Success

The third major finding of this study was the importance that personal grit and self-motivation played in the continued persistence of all 12 participants. Unlike any other theme that developed out of the data in Chapter IV, the idea of grit resonated with each and every woman. During the member-check process of the major and secondary themes, all participants felt it important to comment on the theme of self as mentor. While none of the women used words like grit, perseverance, persistence, courage, or resilience to describe their journey through their STEM doctoral program, each one spoke about an internal motivator that they used to create pressure on themselves to produce momentum forward.

Angela Duckworth was the first researcher to examine grit as a trait used to predict achievement. Duckworth, Peterson, Matthews, and Kelly (2007) defined grit as the tendency to sustain interest in and effort toward very long-term goals. According to Przystas (2016), “to have grit means you have courage and show the strength of character. A person with true grit has passion and perseverance. Goals are set and followed through. A person who works really hard to follow through on commitments has true grit. (MSU Extension website, 2016).

Synthia summarized this concept of grit best when she stated “Regardless of what I have to go through to get there, regardless of how long it takes, I can get a Ph.D. at the end of this. I have already started this process. I have put this much time into it, and how do

you quit at this point" (Synthia, IC625). While Synthia was in the middle of a significant academic transition, moving from one faculty advisor to another and referenced grit to carry on through this transition, Lauren, who indicated that, overall, her academic progress was in order but also spoke about her own internal dialog as a way to keep moving forward academically. "I know that at the end it will be worth it, but it just really sucks right now. So I think it's still more of an internal dialogue rather than an external like oh I want to do it because of xyz. Self-motivating I think, but like that motivation is a roller coaster" (Lauren, IC660).

Grit is considered to be unique from other psychological constructs such as resilience and self-efficacy (Kannangara, Allen, Waugh, Nahar, Khan, Rogerson, & Carson, 2018). While grit is about sticking to long term goals, resilience is the capacity to recover quickly from setbacks or difficulties. Separate from the two psychological constructs above, self-efficacy is defined as one's believe in one's ability to succeed in a specific situation or accomplish a task (Bandura, 1982). Finally, perseverance is defined as continued effort to do or achieve something despite difficulties, failure, or opposition (The Merriam-Webster, 2020).

While research on graduate student self-efficacy exists the research around grit as a construct to the contribution of success of graduate students is limited. A graduate student's self-efficacy has been studied in relationship to research self-efficacy and an individual's perceptions of the training environment (Phillips & Russell, 1994). Additionally, the same research has shown a correlation between research self-efficacy and research productivity. A larger body of research focuses on the self-efficacy of undergraduate students in a number of academic settings. Like the literature surrounding

undergraduate self-efficacy, a body of research exists that looks at grit as a predictor of academic success. In addition to the literature on undergraduate success related to grit, a few research articles discussed grit as a construct to determine academic achievement in science (Bazelais, Lemay, & Doleck, 2016).

The participants articulated an understanding of both their short term and long term goals. All women were able to expand on the requirements and connections of their short term goals related to the achievement of their long term goals. In addition to their own grit, participants acknowledged that the doctoral experience required perseverance. Stated differently, the women in this study understood they would face challenges, even failure at times, and maintained that when these difficulties happened they just got back up and kept going. Sometimes relying on prior mentors or other socialization communities to offer encouragement and support. The participants saw perseverance a key attribute to have in the doctoral process.

Women Role Models Matter

The third research question associated with this study, *does gender difference between mentor and mentee have a different effect on the experiences of domestic STEM doctoral studetns?,* was created to better understand how domestic female doctoral students view their relationships with male faculty similar to or differing from those with female faculty members. By study design, the participants self-selected to participate in the study, therefor the researcher did not control for advisor-to-graduate student gender match or difference. Given the current literature on the limited number of female faculty in STEM (particularly at full professor rank) it was surprising that eight of the 12 women indicated they had female faculty advisors.

Drury, Sly, and Cheryan (2011) looked at the relationship female role models had on the recruitment and retention of women in STEM. Their findings found that male and female faculty are both equally effective in providing role modeling for the recruitment of women into STEM disciplines. Differing from recruitment, their research found that in the retention of women in STEM disciplines, a higher retention rate was associated with same-gender role model matches.

While several of the participants indicated that they actively sought out a female advisor, a few participants indicated that regardless of their advisor's gender the most important aspect of their selection was the quality of the advisor's research. However, during the interviews Charlotte, Nancy, and Elle Nyx, indicated that they often dismissed any immediate importance to gender but upon further reflection they all acknowledged they were paying attention to gender in the faculty role. They articulated an awareness of rank, number, diversity, and skill set of the female faculty role models. Many of the female participants indicated that they used this observed knowledge help interpret and understand gender roles in their disciplines.

Research has shown that not all mentoring relationships are created equal and that protégé satisfaction with the mentoring relationship is a key indicator to the protégé's work attitude and even productivity (Ragins, Cotton, & Miller, 2000). While research shows that a high level of satisfaction with a mentor is based on greater investments made by the mentor in career development and psychosocial support, research suggests that women exhibit higher levels of satisfaction with a mentor who provides socio-emotional-based support (Ortiz-Walters, Eddleston, & Simione, 2010). Additionally, Ortiz-Walters et al. research suggested that the socio-emotional-based support provided by female mentors

was greater than that provided by male mentors. According to self-construal theory, as a result of sex-role socialization, male protégés maintain higher levels of individual self-significance, whereas, female protégés maintain a more interdependent sense of self and therefor prefer more intimate socio-emotional-based support and connection (Cross & Madson, 1997).

While the research on mentor-protégé gender match does indicate a more successful and satisfying experience for both the mentor and the protégé when same-sex matches are made, the participants in this study acknowledged that the limited number of female faculty in any given discipline made it difficult to always have a gender match. Furthermore, the participants indicated that they believed a male faculty member could be as helpful as a female faculty in degree attainment. What the participants acknowledged as vital to domestic female doctoral students persistence was the existence of female role models with their departments.

Bizzari's (1995) research on women as role models and mentors indicated that "the ability of women to achieve in college and in a career depends upon what has happened at home and what encouragement has been given them to succeed in academic and nontraditional career roles" (p. 152). Aligning with Bizzari's work, Epstein (1973), Hoffman (1977), and Young, Cady, and Foxon (2006) indicated that because bias and negative stereotyping about women in the work place exists, women's behaviors and self-confidence are strongly influenced by gender and gender composition of groups. In addition, research focused on gender modeling of women scientists indicated that female students were more likely to express interest in further science education and science careers when they were exposed to women scientists (Smith & Owen, 1986).

The women in this study expressed the importance of seeing female role models within their fields. Participants indicated that the ability to talk to, observe, and learn from other female faculty provided an enhanced sense of assurance that they too could be successful. Valerie, Tatum, and Donna indicated that the importance of female role models played into their own ability to move past their imposter syndrome and engage in their discipline with a renewed sense of purpose. In aligning the research data with the body of existing literature there appears to be valuable positive outcomes in the connection female doctoral students to female role models that may attribute to some component of persistence.

Implications for Theory and Research

So what does all this mean? The literature review in Chapter II indicated that much of the research surrounding women in STEM and graduate students in STEM focused on departure from academic programs and often STEM disciplines in totality. While socialization theory helped to create a framework for the concepts that should support domestic female doctoral students persistence in their programs, little is known about what factors actually do contribute to graduate student persistence.

Tinto (1993) asserted that persistence for graduate students is longitudinal in nature, meaning that events and experiences are continually being shaped by passed events and the anticipation of future events. Unlike their undergraduate counterparts, graduate students persistence is directly influenced by several normative reference groups (local and external) for which the student identifies and integrates. Here, the effect of the community found in both the local and external groups plays a role in persistence. Within the themes developed in Chapter IV, this studies data indicated that the participants used a number of

communities to help them navigate their doctoral experience: the graduate student community within their department; other faculty, university staff, and administrators within their colleges and departments; and family members.

In addition to these normative groups or communities, Tinto aligned his work toward a theory of graduate student persistence by addressing the unique nature of the faculty-graduate student relationship and the socialization process experienced by the graduate student to their respective discipline. “The effect of community, however, is likely to change over time. Specifically, it is likely that the process of doctoral persistence, especially in later stages, will be much more a function of the behaviors of a specific group of faculty or a of a particular faculty member” (p. 232). Additionally, Tinto indicated that because department and discipline maintained their own unique norms, a graduate student’s persistence would be idiosyncratic, or unique to the individual in relation to the individual’s discipline and personal experiences. To assist with further discussion, presented below is the model from Tinto’s work on the longitudinal theory of graduate student persistence. Here, the complex nature of the graduate student experience is visualized to account for a breadth of attributes and experiences. There are two key concepts that should be noted. The first is that attribures, orientations, instituional factors, graduate integration experiences, and research do not necessarily progress in a linear fashion. Second, the model below accounts for a significant number of varaibles that can influences or alter a graduate students experience. All happening over an extended period of time. This model illustrates the difficulty for research to track and understand what factors do or do not contribute to graduate student persistence.

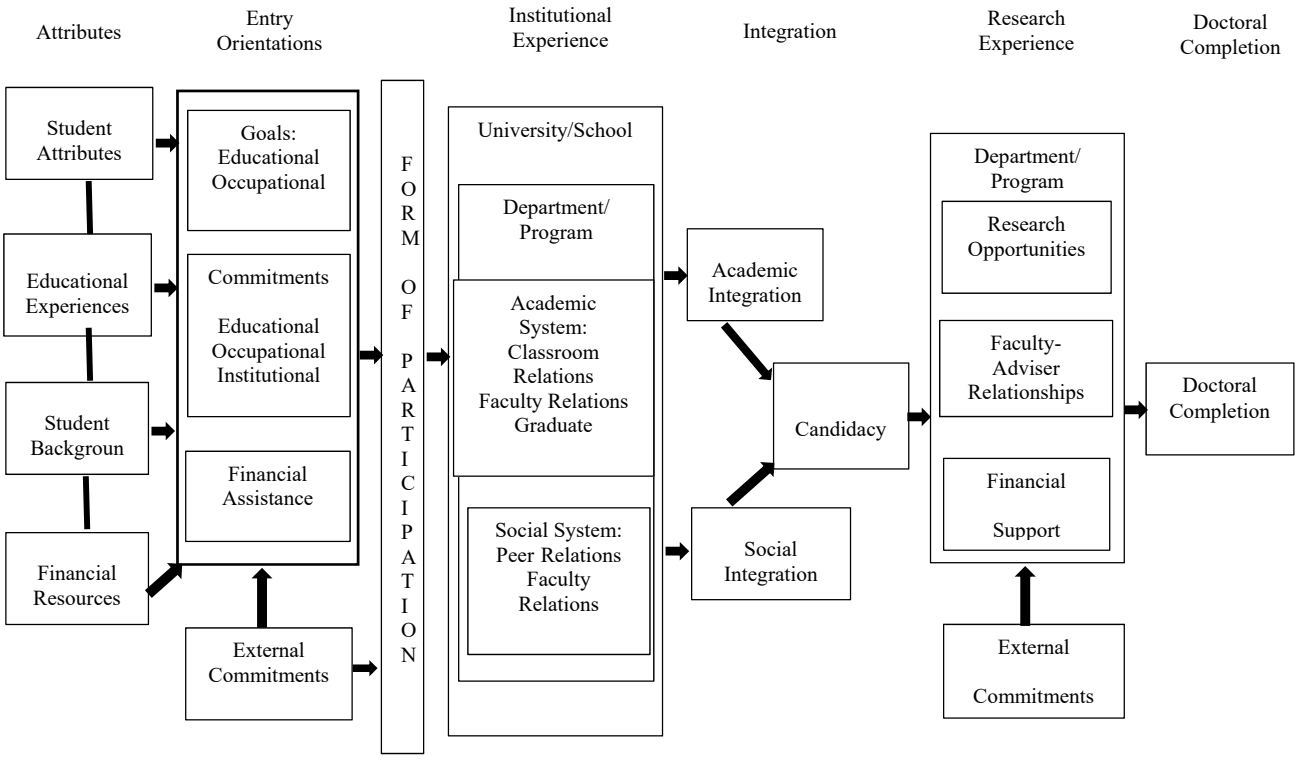

Figure 1 Tinto's Longitudinal Model of Doctoral Persistence (Tinto, 1993, p. 240)

Graduate Socialization Theory

Golde's (1998) theory on graduate student socialization stated that graduate students engage in four stages of socialization: a) intellectual mastery, b) understanding the realities of being a graduate student, c) learning about the chosen discipline and profession, and d) determining fit and community by integrating into the department. Golde's graduate socialization theory indicated that many of the stages overlapped and intersected, often informing the graduate student about segments of information and experiences within multiple stages simultaneously. The graduate socialization process described in the research literature indicated that it was a developmental process and occurred bi-level,

indicating that a student engaged in development as a graduate student and a member of the discipline in tandem (Gardner, 2010).

Support, self-direction, ambiguity, and transition were the four major findings from Gardner's work on contrasting the socialization experiences of doctoral students in high- and low-completing departments. Gardner indicated that these themes were present in both high-completing and low-completing departments but took dynamically different roles depending on the department. "Existing literature speaks to the types of environments that tend to foster students, those that provide social and academic integration for students, and those with supporting faculty-student mentoring relationships (Council on Graduate Schools, 2004; Golde, 2005; Lovitts, 2011)" (Gardner, 2010, p. 75). Central to Gardner's model of the graduation socialization experience is continued support. Gardner indicated that the support came from a number of connections including other graduate students in the program, departmental faculty and staff, or those outside the institution such as family or clergy. This key finding from the research aligns with the data provided in this study – which many individuals contribute to the mentoring relationship that had a positive impact on the academic persistence of domestic female STEM doctoral students.

Gardner's research also aligned with the assertions Tinto placed in his longitudinal model of doctoral persistence. Together the two researchers concluded that graduate socialization and connection to normative communities can mitigate some of the negative experiences associated with the transitions that occur throughout the doctoral journey.

In addition to the theme of support, Gardner's findings indicated that with each new transition, graduate students experienced ambiguity. This ambiguity caused rise for a sense of self-direction that graduate students used to help manage the uncertainty and

feeling of instability. Provided below is Garner's 2010 model of graduate student socialization experiences. The model emphasizes the centrality that support plays in the graduate student's socialization. Gardner stated that "the socialization process, by definition, is inherently social. As an individual learns to become a part of a larger organization or group of people he or she must also learn how to interact with others and to forge relationships within this organization to be successful" (Garner, 2010, p. 69).

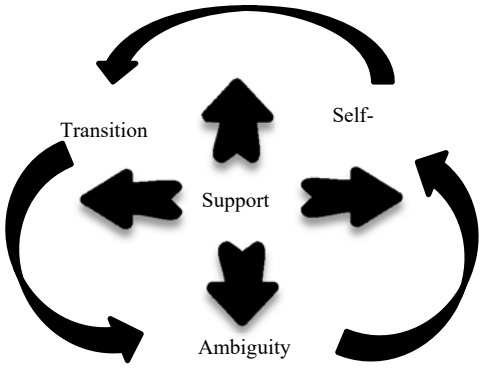

Figure 2 Gardner's graduate student socialization experience at work (Gardner, 2010, p. 75)

Mentoring Theory

In this current study, one of the primary places that domestic female STEM doctoral students looked to create support was in their mentoring relationships. When comparing this study's results with mentoring theory, similarities and differences exist. In Tinto's (1993) work on graduate student persistence, he noted the importance of normative communities that by nature would transition to an individual connection (e.g. a graduate student's advisor) as the student moved through the phases of the model. Much like

graduate socialization, mentoring is a non-linear process that occurs in a number of stages and the experiences of a graduate student's academic journey and will often overlap with several stages and mingle within the bi-level nature of the graduate socialization experience – focusing on both the development of the individual as a graduate student and also as member of the discipline and department.

There is not one consistent theory of mentoring used across the literature (Bozeman and Feeney, 2007). However, mentoring literature tends to cluster into subsets of research based on the underpinning environment and the nature of the mentoring. Bozeman and Feeney (2007) provided the following definition of mentoring for the advancement of mentoring research:

> A process for the informal transmission of knowledge, social capital, and psychosocial support perceived by the recipient as relevant to work, career, or professional development; mentoring entails informal communication, usually face-to-face and during a sustained period of time, between a person who is perceived to have greater relevant knowledge, wisdom, or experience (the mentor) and a person who is perceived to have less (the protégé). (pg. 731)

In addition to this working definition, Ragins and Cotton (1999) identified two functions of the mentoring relationship: formal and informal mentoring. As noted in several sections of this chapter, the participants in this study identified both functions of mentoring as having a positive impact on their graduate student experience. Two of the major findings associated with this research focus directly on key mentoring relationships the women experienced. While the researcher did not explore the original function of the

prior mentoring relationships, the data indicated that the prior mentoring relationships had developed into (whether from onset or over time) informal mentoring where the protégé, in this case the graduate student, expressed a deep relationship with her mentor and utilized this mentoring relationship as a key touch point for support as defined by Gardner's (2010) research.

The second major finding of this study, managing mentoring wants versus reality, compares the formal nature of the faculty-graduate student relationship with the self-identified desired informal faculty-graduate student relationship. One of the primary reasons the advisor as mentor theme relied on a more structured mentoring function is the nature of the outcome. Kram's (1983) research on the phases of the mentoring relationship indicated two broad categories of mentoring: career development and psychosocial functions. The career development function involves coaching, sponsorship, providing challenging assignments, protecting protégés from adverse forces, and fostering positive visibility in the field (Ragins, 1997). These career development functions align with the role of graduate socialization and the key stages Tinto (1993) outlines as components/stages of the graduate academic journey.

In considering the relationship of the female participants to informal and formal mentors the women articulated in their interviews, it is important to frame the mentoring lens through a female perspective. Mentoring is intertwined with the cultural expectations of women as nurturers and caregivers (Bizzari, 1995). The 1983 work of Gilligan and Lyons focused on gender-related identity development. Their work, as cited by Belenky, Clinchy, Goldberger & Tarule (1997), has shown that the responsibility orientation, found in morality theory, "is more central to those whose conceptions of self are rooted in a sense of

connection and relatedness to others. This finding easily connects to the work of Ortiz-Walters, Eddleston, & Simione, (2010) whose research suggested that women exhibit higher levels of satisfaction with a mentor who provided socio-emotional-based mentoring. These key mentoring indicators along with research focused on female role modeling indicates that the participants stated desire to connect with female faculty aligns and suggests that such connections would enhance domestic female doctoral students' persistence.

Implications for Practice

This study is one of few (Austin, 2002; Gardner, 2010; Golde, 1998, & Tinto, 1993) that has explored the experiences of domestic female doctoral students in STEM related to factors of persistence. As noted earlier, the primary body of literature on graduate students addresses factors of departure. Additionally, mentoring research has focused predominately on the career development function of mentoring (Kram, 1993) and by nature of mentoring design has been researched mostly through the formal mentoring relationship experience (Ragins & Cotton, 1999). The findings from graduate attrition research provided insight into the experiences of women who are at greater risk for departure from STEM education based on both the declining enrollment of women in STEM fields (Council of Graduate Schools & Educational Testing Service, 2010) and attrition rates of women at several critical juncture points including the transition into STEM doctoral programs and STEM faculty positions (Gaston-Gayles, & Ampaw, 2014; Lott, Gardner, & Powers, 2009; Sax, 1994). This section discusses areas in which university administrators, graduate support staff, and faculty may contribute toward

enhancing domestic female graduate students' in STEM positive mentoring relationships and by extension may aide in the persistence of these women.

The complex nature of the graduate student experience (Tinto, 1993), the typically longer stay within the graduate program (Tinto, 1993), the bi-layered socialization (Golde, 1998), and the inherent individualized community and support created with the interplay of student, department, and discipline (Tinto 1993; & Gardner, 2010) afford many opportunities to enhance the graduate student experience. Based on the major findings of this research three implications for practice have been identified: creating opportunities to develop informal mentoring relationships with others outside of the faculty advisor; creating tangible documentation of the expectations and role responsibilities of the faculty-graduate student relationship; and cross departmental connections to help create a community for female graduate students in STEM.

The first recommendation for practice is to consider possible opportunities to develop programs or outlets for women to engage in informal mentoring relationships with others. The purpose of this recommendation is two-fold. First, for women entering doctoral programs that have not had prior mentoring or strong prior mentoring relationships a connection outside of the faculty-graduate student relationship would provide women a semi-structured path to help build their networks and create support systems for the doctoral journey. Additionally, these relationships could benefit those who had a strong prior mentoring relationship but due to transition and distance may have limited access to that mentor.

Secondly, in considering the incongruent alignment of wants versus reality related to faculty-graduate student relationships, a formal outline of the process as defined by the

respective discipline and/or department could create a common understanding about the nature of the structure mentoring relationship. Documents of this nature can be handed out during departmental orientations, lab meetings, or one-on-ones, and provide an outlet to prompt an open discuss about expectations, availability, and other onboarding pieces associated with the faculty-graduate student relationship.

Finally, with the growing diversity in higher education and yet the pockets of isolation many of the women in this study experienced, practitioners should consider outlets in which female STEM doctoral students could connect with other women. It is noted that the current research indicates that the strongest role model and mentor matches would align as many common attributes as possible – gender and discipline be two of the primary attributes. However, as reported by several of the participants in this study, many female faculty are over taxed and cannot realistically connect with every female doctoral student. Initial research suggests that cross discipline communities may elevate some of the struggles expressed by participants in looking for female role models within STEM. Additional benefits might include cross discipline research, development of a supportive normative community to aide with persistence, and helping graduate students, post docs, and faculty bridge community supports.

Recommendations for Future Research

This study focused on the role that mentoring plays in the persistence of domestic female STEM doctoral students. With the use of a case study methodology grounded in a qualitative research approach, the methodology afforded the collection of rich descriptive data that looked at the individual experiences of the female participants and was bounded by the case of domestic female doctoral students in STEM. The methodology inherently

limited the generalizability of the findings to a large population (Merriam, 1998; & Stake, 2000). This limitation can be viewed as presenting opportunities for additional research.

The data collection focused on the experience of 12 domestic female doctoral students, all enrolled at one institution in the south of the United States. Future research should include more domestic women in STEM graduate programs and at other institutions located throughout the country in order to gain additional insights. The women who participated in this study were diverse in terms of tenure within their doctoral programs (while none had less than three years of enrollment with their program of study), were a crosscut of college, department, and discipline with regard to NSF defined STEM fields, and presented a number of unique personal attributes such as partnered or married, having children, identifying as a person of color, or as a first generation college student. Further exploration of these unique characteristics could provide additional evidence to enrich the understanding of domestic female doctoral students' experiences. Additionally, the diverse nature of the department enrollment made it difficult to explore the role that program enrollment and departmental culture had on the influence of mentoring experiences for these women.

Secondly, this study focused on the role that mentoring plays in the persistence of domestic female students. By no means did delamination of international women or men imply that these populations of graduate students do not experience mentoring and positive outcomes from socialization and connection to others. It is encouraged that research be considered to help explain the unique challenges and opportunities of international female doctoral students as well as their male counterparts. Additionally, as Tinto (1993) purports in his examination of a model for graduate student persistence, only a handful of research

studies have considered the longitudinal nature of the graduate student experience. A longitudinal study would thereby provide an opportunity to look not only at subsets of the graduate population but to look across doctoral fields at men and women, domestic and international, and research the experiences over the duration of a student's doctoral journey.

Third, the major finding that personal grit and self-motivation qualify as a component to doctoral graduate student success should be further explored. As a fairly new body of research, connecting the trait of grit as a predictor of academic achievement in graduate education should be explored. Duckworth and Yeager's (2015) research assessing the personal qualities other than cognitive ability for educational purposes along with Lee and Duckworth's (2018) research on organizational grit warrants the exploration of such research topics at the doctoral student level.

Finally, future research should be conducted to discover further indicators of the mentoring relationship between the faculty and graduate student. Role definition, types of relationships, and anticipated experiences should be considered as topics to building on the work of Austin (2002), Gardner (2010a), and Golde (1998) as a way to further understand this construct of support as a component of the graduate student socialization process.

Conclusions

The domestic female doctoral students in STEM who participated in this study shared information about their personal lives, their academic journeys, personal challenges, and key relationships. The women's candor and desire to find ways to positively change the experiences of women in STEM is to be commended. Noteworthy from this study are the four major findings as they relate to domestic female doctoral students in STEM: prior

mentoring matters, managing mentoring wants versus reality, personal grit and self-motivation as a component to doctoral graduate student success, and the importance of women role models in STEM matter.

The literature framing graduate student persistence, graduation socialization, and mentoring theory indicate that there is an interconnection between the normative communities developed during the graduate journey that supports both career and psychosocial mentoring functions as a component of the graduate socialization process. The role and use of prior mentoring relationships as outlets to navigate program and research barriers indicates that the participants in this study had developed a since of personal assessment and resourcefulness in order to overcome obstacles and persist on their academic journeys. The disconnect between the structured nature of the faculty-graduate student relationship and the self-reported desire for more informal mentoring relationships also indicates that the participants looked to connect with individuals on a deeper level than surface requirements of degree completion and may explain why the women relied on their prior mentoring relationships. Additionally, the participants expressed value in connecting and observing women role models within their field as a way to interpret and navigate their own experiences. While the declining enrollment of women in STEM is an indication that parity in the faculty role may be further off then once hoped, post docs, lecturers, and faculty play a vital role and female persistence in STEM even when they do not serve as a primary mentor. Finally, the notion that grit and perseverance may provide insight into traits that promote or at least enhance one's ability to persist in thought-provoking. The lessons to be learned from this research and future research focused on graduate student persistence have the potential to change the way

universities and academic disciplines provide support and socialization as key contributors to graduate student persistence.

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APPENDIX A

OPERATIONAL DEFINITIONS

Attrition identifies the decrease in the size of a cohort. This can be the incoming cohort of a specific program, the admission cohort of a graduate school, etc. Attrition is the diminution in numbers of students resulting from lower student retention (Hagedorn, 2005).

Mentorship is a process for the informal transmission of knowledge, social capital, and psychosocial support perceived by the recipient as relevant to work, career, or professional development; mentoring entails informal communication, usually face-to-face and during a sustained period of time, between a person who is perceived to have greater relevant knowledge, wisdom, or experience (the mentor) and a person who is perceived to have less (the protégé).

Persistence is the act of continuing towards an education goal. It may include continual enrollment by semester until attainment is achieved. Hagedorn (2005) indicated that the words persistence and retention are often used interchangeably. Hagedorn asserted that persistence is a student measure. The National Center for Education Statistics uses retention as a way to measure institutional success of factors that contribute to student completion. Persistence then is the student measure used to access factors created or internalized by the student towards their educational degree.

Graduate Student Socialization is defined by Campbell and Tierney (2001, pp. 1) as “the process through which individuals gain the knowledge, skills, and values necessary

for successful entry into a professional career requiring an advanced level of specialized knowledge and skills."

STEM refers to the physical, biological, and agricultural sciences; computer and information sciences; engineering and engineering technologies; and mathematics.

APPENDIX B

IRB FORM

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

EXEMPTION DETERMINATION

September 20, 2018

Type of Review:	Submission Response for Initial Review Submission Form
Title:	Women in Science, Technology, Engineering, and Mathematics (STEM) Fields: Mentoring Pathways during the Ph.D.
Investigator:	Vicente M Lechuga
IRB ID:	IRB2018-1003
Reference Number:	080863
Funding:	Internal
Documents Reviewed:	• STEM Mentor Informed consent (English) - (Version 1.2) • Recruitment Email - (Version 1.0) • STEM Mentor Interview Guide - (Version 1.0)

Dear Vicente M Lechuga:

The HRPP determined on 09/20/2018 that this research meets the criteria for Exemption in accordance with 45 CFR 46.101(b) under Category 2: Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless, the information is obtained in an identifiable manner and any disclosure of the subjects responses outside of research could reasonably place the subject at risk.

Your exemption is good for five (5) years from the Approval Start Date. At that time, you must contact the IRB with your intent to close the study or request a new determination.

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186

Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

APPENDIX C

RECRUITMENT EMAIL

Howdy!

My name is Stefanie Baker, and I am a doctoral student in the Department of Educational Administration & Human Resource Development here at Texas A&M University. I am currently conducting my dissertation research study and would like to invite you to consider participating in the study.

The research study is focused on the role mentoring plays in the persistence of domestic female STEM doctoral students. The goal of this project is to contribute to the overall body of knowledge regarding women in STEM as it pertains to pathways initiatives that support persistence and hopefully graduation of students. Specifically, this study will look at the role that mentoring (formal and informal) plays in supporting more female doctoral students in completing their degrees. Ideally this study's data will provide additional direction for research, as well as, practical interventions colleges and departments can implement to further efforts on growing the population of women engaged in STEM work/research.

Participation in this study is completely voluntary. The study will involve a one hour interview where participants will be asked to answer questions and discuss their relationship with a mentor(s) they have developed while in their doctoral program. The interviews will be audio recorded. Any information shared during the interview will be held in confidence. No specific comments will be attributed to individual participants and all responses will be coded to ensure confidentiality. Participants will also be asked to

review the researcher's themes for reliability, indicating that those interviewed can relate to broad themes generated from the research study.

No particular expertise is required to participate. To qualify for participation in this study you must identify as a domestic (Unites States citizen or permanent resident) female doctoral student enrolled in a STEM program. Additionally you must be in at least your third year of your program.

This study and its design has been approved by the Texas A&M University Institutional Review Board (IRB).

IRB number: IRB2018-1003

Approval Date: September 20, 2018

If you meet the criteria and are interested in participating in this study, please reply to this email indicating your interest. Upon receipt of your reply I will work with you to schedule a time to review the informed consent document and schedule an interview time.

Maybe you don't meet the criteria for my study but know someone who does. Please feel free to share this email with other graduate students on campus. I'm looking for approximately 10-15 women who would be willing to share their graduate student experience with me.

Thank you for considering participation and/or sharing this recruitment email with others.

Stefanie Baker
Graduate Student
Department of Educational Administration and Human Resource Development

APPENDIX D

INTERVIEW GUIDE

Women in Science, Technology, Engineering, and Mathematics (STEM) Fields:

Mentoring Pathways during the Ph.D.

Interviewee (Pseudonym Only):

_____

Date: _____ Time:_____

Welcome & Introductions

- Introductions
- I will be audio recording this interview and taking hand-written notes while we talk.
- Following each interview I will transcribe the conversation. A copy of the transcription will be sent to you for review and revisions (if needed).

Overview of the Interview Purpose & Consent Form

- The purpose of this interview is to learn about your experiences as a doctoral student and to better understand the support networks you've created to persist through your doctoral program.
- Review the consent form and obtain signatures. Make sure to provide a copy of the consent form to the participant.
- After the interview, I may contact you later for clarification purposes.

Interview Questions -the following questions will be used to guide, not limit, the conversation.

1. What made you decide to go to grad school?
    a. Can you identify one or two individuals that helped inspire you to continue your education?
    b. What was it about this person(s) that resonated with you?
2. What types of barriers did you encounter while entering your doctoral program?
3. What types of barriers have you encountered since you started?
    a. Who have you turned to for help with these barriers?
    b. What tools, resources, or individuals helped you to overcome them?
4. What does a typical day look like for you?
5. What process did you use in selecting your advisor?

    a. Is your advisor male or female?
6. How would you describe your relationship with your advisor?
7. Do you think having an advisor of the same sex/opposite sex benefits you? Why?
8. Do you think having an advisor of the same sex/opposite sex hinders you? Why?
9. What type of support, guidance, and/or advice do you seek from your advisor?
10. Other than your advisor, is there anyone else that you turn to for support, guidance, advice?
11. For non-academic needs, who do you look to for support?
    a. How would you describe your relationship with this person?
    b. How long have you known this person?
12. Are there any female faculty in your program (beyond your advisor if they are female)?
    a. Have you ever reached out to them? Why or why not?
13. Do you worry about having no connection to a female academic in your program? For students who do not have a female advisor/mentor in their program.
14. What do you believe are the most powerful reasons you have stayed in your program?

Following the Interview

- Briefly summarize the major conversation points identified during the time together.
- As a reminder-following the transcription of our interview, I will send it to you for review and revisions.