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# The educational journeys of first-generation college women in STEM: A grounded theory study

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# THE EDUCATIONAL JOURNEYS OF FIRST-GENERATION COLLEGE WOMEN IN STEM: A GROUNDED THEORY STUDY

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by

Susan Geier

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For my husband, Ronald W. Geier, whose encouragement and unwavering faith in my abilities sustained me throughout this journey.

For my father, Kenneth L. Westerhausen, whose love and support has always been a comfort for me**.**

For my children, Reggie, Benjamin, and Rachael, you fill me with pride, joy, and laughter.

And in loving memory of my mother, Helen Westerhausen, who shared her love of learning and music and her belief that anything is possible. I miss her gentle and courageous spirit.

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# TABLE OF CONTENTS

Page

Page

Page

Page

# ABSTRACT

Geier, Susan Ph.D., Purdue University, August 2016. The Educational Journeys of First-Generation College Women in STEM: A Grounded Theory Study. Major Professors: Deborah E. Bennett and Patrice M. Buzzanell.

The purpose of this study was to ascertain the various factors that influenced these first-generation college women as they chose a college and selected a STEM major and subsequently persisted to upper level (junior/senior) status. Twenty-five first-generation college women in STEM majors who attended a research-intensive university in the Midwest were interviewed. Approaching this study using constructivist grounded theory provided the opportunity for deeper insights by examining data at a conceptual level while preserving the voices of the women in this study. The women faced numerous challenges on their journeys, yet they persisted. As the women in this study selected and persisted in STEM, they demonstrated thoughtful determination, experienced shifting identities, established purposeful relationships and applied forward thinking, as they practiced high-stakes decision-making during their journeys. The experiences of these women, namely first-generation women in STEM fields, may inform students, parents, educators, researchers, and policymakers concerned with (a) inspiring students to consider STEM majors, (b) fostering student success in STEM throughout their academic journeys, and (c) ultimately increasing the number of underrepresented minorities and women in the STEM fields.

# CHAPTER 1: INTRODUCTION

> If the United States is to function effectively in a technology-based economy, it cannot afford to underutilize its workforce so drastically. If the nation continues to rely on decreasing numbers of White and Asian males for scientific talent, the quantity--and quality--of the workforce will be substantially lower than it would be if all groups were included. In addition, as technology becomes increasingly central to work and national life, lack of attainment in science and mathematics will affect the ability of women and minorities to compete for employment, wages, and leadership in any professional field. In a society grounded in the long-standing policy of the fair distribution of economic and social opportunities, such a situation is untenable. (Oakes, 1990, p. vi)

Some might read the above argument introduced by researcher Jeannie Oakes (1990) in her publication *Lost Talent* and dismiss its relevance for today, almost 30 years later. In fact in a recent article in the *Chronicle of Higher Education*, "The STEM Crisis: Reality or Myth?," some researchers called into question the need to expand the number of students earning STEM degrees; citing lack of employment opportunities for graduates as a major factor in their argument. Yet, in 2009, President Obama declared his commitment to foster the economic growth of the United States through cutting-edge science and technology innovation and to prepare a 21st century workforce with the goal

of graduating one million additional well-prepared STEM (science, technology, engineering and mathematics) students over the next decade (OSTP, 2012). In keeping with his declaration, in May 2013, the President's Committee on STEM Education National Science and Technology Council revealed its 5-year strategic plan to Congress outlining the implementation of STEM education initiatives (Committee on STEM Education National Science and Technology Council, 2013). These objectives present considerable challenges for the policymakers, educators, and citizens of the nation.

Who are the students who will be the next generation of scientists and innovators? From where will they come and how will they be prepared to meet the ever growing need for educated workers in a 21st century global economy? Who represent the "lost talent" as coined by Oakes (1990) and discussed again by Hanson (1996) in her study of underrepresented women in the sciences? What have decades of research told researchers and educators about the challenges and facilitators for increasing the number STEM students, especially women and women from underrepresented minority groups (specifically African American, Hispanic, and Native American)? In order to fulfill the objective of President Obama and prepare a strong workforce with relevant skills educators and policymakers need to understand how best to assist the "lost talent" in the educational pathway.

**Rationale for the Study**

In this study, I identified the characteristics of a group of students, specifically prospective and first-generation college women in STEM (PFGCW and FGCW, respectively), who have the potential to be part of the 21st century workforce yet whose

members are often unsuccessful due to a complex blend of factors (Chen & Carroll, 2005; Crisp, Nora, & Taggert, 2009; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2007; Wilson & Kittleson, 2013). The educational journeys of the women in this study were complex with many interrelated challenges yet they persisted in their pursuit of STEM baccalaureate degrees. Learning about who they are and how they navigated their academic and career seeking experiences can inform educators, policymakers, community leaders and parents. Armed with this knowledge, students with similar backgrounds and talents can be recognized and encouraged to prepare for and pursue STEM- related occupations.

**Status of First-Generation College Students (including Prospective FGCS)**

Many definitions exist to describe college students in relationship to parental educational attainment. For the purposes of this study, first-generation college students are those students whose parents or guardians have not completed a baccalaureate degree (Davis, 2010). Large segments of the U. S. population have parents who have not attained a bachelor's degree. The children of these parents are considered prospective first-generation college students (PFGCS) prior to college; they are referred to as first-generation college students (FGCS) once enrolled in college. According to *The Condition of Education 2012* report (Aud et al., 2012), in 2011, 63% of children ages 5-17 would be considered PFGCS. As a group PFGCS are often from families in the lower socioeconomic quartiles and have a higher representation of underrepresented minorities compared to the population at large. In 2011, 42% of the PFGCS were from homes

categorized as poor or near poor. Black and Hispanic PFGCS were considerably overrepresented at 77% and 84%, respectively (Aud et al., 2012).

During the last twenty-five years, more U.S. students earning bachelor's degrees included FGCS. In 2005, FGCS comprised 15.9% of the incoming freshmen who were first-time enrollees and held full time status at both public and private institutions; the population of college students with first-generation status continues to grow. (Saenz, Hurtado, Barrera, Wolf, & Young, 2007). Although strides have been made to increase college access for PFGCS and FGCS over the past decades, many of these students remain underserved and underprepared (Ward, Siegel, & Davenport, 2012). For example, even as more students overall are enrolling and completing undergraduate degrees, FGCS continue to have higher attrition rates than their non-FGCS peers (Saenz et al., 2007). Moreover, 33% are undecided as to which major to pursue upon arrival, and most tend to major in fields other than science and technology (Chen & Carroll, 2005).

FGCS struggle with a variety of obstacles related to college enrollment, persistence, and completion such as inadequate academic preparation, lower educational aspirations, less practical assistance about the college enrollment process, limited financial resources, and less academic and social integration in college. These are the same obstacles that place students at risk for attrition in college (Saenz et al., 2007; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; Tinto, 1993). Moreover, just the fact that a college student has first-generation status decreases the likelihood that he or she will earn a college degree: "Students whose parents held a bachelor's degree or higher were five times more likely to earn a bachelor's degree than were similar first-generation students (50 percent versus 11 percent)" (Pascarella & Terenzini, 2005, p. 590).

Prospective FGCSs and FGCS are often the students with untapped potential and fit the "lost talent" descriptor. They could be encouraged to become part of the "one million additional well-prepared STEM students" to contribute the country's economic and workforce development. Moreover, these students would benefit from increased opportunities for employment and the upward economic mobility that holding a STEM degree affords (U. S. Department of Commerce, 2011).

**Status of Women and STEM Baccalaureate Degree Attainment**

As indicated, much research has been conducted associated with student success in college and in particular the experiences of students with first-generation status (Davis, 2010; Ward et al., 2012). Similarly, the research about the experiences of women in STEM spans decades (discussed in Chapter 2). Although strides have been made to increase the representation of women in STEM, women still lag behind their male counterparts in the pursuit of science, engineering, and technology education and careers (NSF NCSES, 2015). More recently, some researchers have focused on how the experiences of women in STEM vary across specific fields, particularly the physical sciences, engineering and computer sciences, all considered traditionally male-dominated fields where underrepresentation of women still exists (Holland, Major, & Orvis 2012; Major, Holland, & Oborn, 2012; Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008).

According to the National Center for Science and Engineering Statistics recent report (NSF NCSES, 2015), more women continue to earn bachelor's degrees at a higher rate than men (57.3% in 2011), while men still receive a higher percentage of degrees in

many of the science and engineering fields of study. All women have degree attainment much lower than the men in the physical science fields. Moreover, engineering and computer sciences are considered low participation fields for women, at 19.2% and 18.2% respectively (NSF NCSES, 2015).

**Status of First-Generation College Women in STEM**

Many researchers and policymakers have recognized that there are populations in our society that do not have the same academic and economic advantage as those who come from more privileged backgrounds and social statuses, such as White middle-class men. Many researchers, policymakers, educators, and our President are interested to find out why certain groups of U.S. citizens, specifically, women and FGCS, remain underrepresented in the fields that offer the best opportunities for stable and prosperous employment (STEM) (OSTP, 2012; Committee on STEM Education National Science and Technology Council, 2013). For FGCS, enrolling, persisting and graduating from college presents a myriad of challenges as previously described. These challenges are particularly salient for first-generation college women (FGCW) who are pursuing a bachelor's degree in STEM-related fields, as they are dealing with the additional burden of navigating unfamiliar and sometimes hostile territory on two fronts. (Chen & Carroll, 2005; Crisp et al., 2009; Kuh et al., 2006; Ward et al., 2012; Wilson & Kittleson, 2013).

The economic and social mobility of FGCW would be greatly enhanced if students from this group were attracted and well-prepared to have careers that are in demand in the U.S. workforce, namely STEM occupations. Couple first-generation status, the likelihood of lower socioeconomic status and/or underrepresented minority

group status (Poirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2005; Shapiro & Sax, 2011) with being a woman in STEM, and these FGCW face a daunting cumulative disadvantage. This disadvantage stems from a combination of structural and opportunity obstacles; for example, limited financial resources, time-to degree concerns, inadequate science and mathematics preparation, and the competitive STEM college culture. FGCW have to surmount these challenges that accumulate over time and are critical to academic success and advancement (Merton, 1968, 1988; Miller & Pearson, 2012).

Many studies conducted over the past decades asked several question about the 'what, who, where, and when of underrepresentation for women in STEM (Crisp et al., 2009; Hill, Corbett, & Rose, 2010; Wilson & Kittleson, 2013).

Fewer studies have used qualitative methods to ask the how and why of the many aspects associated with the STEM educational experience and the influences that facilitate STEM degree completion for women in STEM (Miller & Pearson, 2012; Packard, Gagnon, LaBelle, Jeffers & Lynn, 2011). Still fewer studies have specifically examined the academic trajectories of women STEM majors who were also first in their families on the path to attain a bachelor's degree (William & Kittleson, 2013). The narratives of these women, namely first-generation women in STEM fields, may inform students, parents, educators, researchers, and policymakers concerned with (a) inspiring students to consider STEM majors, (b) fostering student success in STEM throughout their academic journeys, and (c) ultimately increasing the number of underrepresented minorities and women in the STEM fields. Understanding the factors that explain the attraction, preparation, and persistence in STEM majors for these FGCW can provide the

impetus for action so that the nation as a whole and labor force in particular can develop potential talent in areas critical to national economic development.

**Purpose of the Study**

Given the college-going challenges for FGCW in a STEM major, I wondered, "How did these women decide to go to college, select a STEM major, and moreover how have they persisted to graduation? What aspects of these women's lives led them to where they are today? What can we learn from their journeys? In order to shed light on these issues, I conducted a study that was founded on the broader conversation of the experiences of women in STEM and more importantly brought the voices of first-generation college women in STEM to the table.

Therefore, this study was built on the decades of research about women in STEM disciplines and FGCS, and contributed insights gathered from the unique perspectives of first-generation college women in STEM majors who persisted at a large, Midwest, research intensive institution. Specifically, the purpose of this grounded theory study was to ascertain the various factors that led to these first-generation college women initially choosing college and selecting a STEM major and subsequently persisting to upper level (junior/senior) status. These factors included the individual attributes, influential relationships, and experiential opportunities that assisted these women as they traversed through critical access points that spanned their educational journeys from kindergarten through their current college status. Approaching this study using grounded theory provided the opportunity for deeper insights by examining data at a conceptual level. Key concepts derived from this study can inform educators and interested others about

developing interest and fostering success in STEM. Moreover, the population under study faced cumulative disadvantages in their pursuit of STEM degrees; examining their journeys provided numerous examples that will resonate with others facing complex obstacles in their own journeys.

The central research question (RQ) for the study is: *What factors influenced the educational journeys for these first-generation college women that led them to select and persist in a STEM major?*

The guiding sub-questions were:

1. What individual attributes contributed to the process of (a) preparing, choosing, and persisting in college and (b) selecting and persisting in a STEM major?
2. What relationships and experiences do these women perceive to be the *most influential* sources of (a) developing an interest in STEM, (b) choosing a STEM major and, (c) persisting in a STEM major?
3. What challenges did these women encounter along their educational journey and how did they deal with these challenges?

**My Personal Interest in the Study**

It was always my goal to get a college degree and although my journey had many detours, hills and bends I entered college, later than was typical, as a first-generation student. During those college years, I began mentoring a number of student athletes who were often from underrepresented groups. I also led study groups for students who were in my classes. It was while listening to those students and their struggles and successes that I decided to get my master's in college student affairs so I could work closely with

students; facilitating their success in college. As part of a course taken during my master's work, I was assigned a book to prepare for class, *Hope in the Unseen*. I read with interest how a bright African American student entered and succeeded at an elite institution. His poignant story has stayed with me over the years. During my master's program I became involved with programs seeking to broaden participation in STEM. I worked with a range of undergraduate students, graduate students, science teachers, and professors in STEM and learned about the issues surrounding women and underrepresented minorities accessing STEM majors and occupations. My current research combines these interests. I sought to gain insights about being first in the family to complete college as a woman in a STEM major and share those insights with interested others to help those in similar circumstances.

**Summary and Organization of the Chapters**

In this study, I was interested in learning about the educational journeys of first-generation college women who were majoring in STEM. By understanding their challenges and triumph I anticipated that their stories would resonate with other students and encourage them to consider STEM college majors. Additionally, key stakeholders involved in the quest to broaden participation in STEM may find these women's experiences relevant and meaningful to their own efforts.

Chapter 1 presents demographic information and general characteristics related to college students with first-generation status, a brief overview of the status of women attaining STEM-related bachelor degrees and a description of the study. Chapter 2 presents the Literature Review. In this chapter, I provide more details about being

prospective first-generation students (PFGS) and first-generation college students (FGCS) plus highlight the foundational and recent literature about the experiences of women navigating the STEM educational landscape.

Chapter 3 describes the methodology for this grounded theory study. Specifically, I purposefully selected and interviewed 25 college women who were STEM majors and first in their families to earn bachelor's degrees. I employed a constructivist, grounded theory approach analyzing the data using the constant comparison method.

Chapter 4 offers the results of the study. Section one presents the participants' pre-college experiences related to their interest in STEM, academic abilities, opportunities for practical experiences, influential relationships and transitions to college. Section two delves into their college experiences and highlights their challenges and triumphs. Findings suggested that the women demonstrated thoughtful determination, experienced shifting identities, applied forward thinking, and established purposeful relationships to guide them as they practiced high-stakes academic and career decision-making.

Chapter 5 presents the assertions and discussion, implications of the study for key stakeholders, the limitations of the study, and suggestions for future research. The chapter concludes with the researcher's reflection. The main contribution of this study was revealing the pragmatic, dynamic, and resilient decision making processes employed by the women in this study, as they encountered challenges associated with attending college, majoring in STEM and persisting to graduation.

# CHAPTER 2: LITERATURE REVIEW

Studying first-generation, college women (FGCW) in STEM (upper-level undergraduate) provided insights about the progress of students who historically face complex challenges for college success, moreover, success in STEM majors. Few studies directly focused on this particular population, FGCW in STEM. I reviewed the expansive body of work related to students with first-generation status, searched for information about women in the STEM education pathway, and selected the literature most relevant to my study. Since so few research studies disaggregated the data by gender, level of parental educational attainment, and type of major (STEM vs. non-STEM), I relied on the studies that included participants that closely resembled the characteristics of the FGCW in my research study. In the first section, I outline the characteristics of first-generation college students; in the second section I present an overview of best practices for (a) expanding the participation of students in STEM, and (b) college student success; and in the third section I offer a synthesis of literature related to the experiences of women along the STEM educational pathway.

## First-Generation College Students

**Pre-college characteristics.** All college students begin college with perspectives developed from influential others (parents, teachers, peers) and their educational experiences and opportunities during their primary and secondary school years.

First-generation college students (FGCS) also bring their unique vantage points; however, there are characteristics that FGCS have in common. FGCS typically are from families with lower socio-economic status (Terenzini, Springer, Yaeger, Pascarella, & Nora 1996). Choy (2001) and Bui (2002) also found FGCS were more likely to be from families in the lowest income quartiles, from Black or Hispanic racial/ethnic populations, and from groups that speak a second language.

According to (Bui 2002; Choy 2001; Terenzini et al. 1996), FGCS were less academically prepared upon entering college, had lower SAT scores; and they took fewer advanced mathematics courses. FGCS who completed advance mathematics courses were more likely to enroll in college (Choy, 2001). Additionally, FGCS were less likely than non-FGCS to complete the required steps to enroll in college even when they intended to enroll. Compared to non-FGCS, they received less assistance from parents with academic preparation and applications to college, two critical steps for successful enrollment (Bui, 2002; Choy, 2001; Terenzini et al., 1996).

Parental level of educational attainment and interest in science were also indicators for majoring in STEM (Huang, 2000; Turner, 2004). The researchers found as parental education level increased so did (a) the likelihood of their children developing an interest in science, (b) the likelihood of their children majoring in STEM, and (c) the likelihood that parents would expect their children to attend college. The impact of the transference of educational attainment from one generation to another cannot be dismissed as a major factor in the educational achievement of women in STEM. "Parental education is the most important predictor of women's and minority success and participation in mathematics and science and achievement for women in

particular," stated Oakes (1990, p. 58). Nevertheless, parents who did not attend college can still increase their daughters' interest and readiness for participating in STEM by teaching them to learn from their mistakes and encouraging them to consider activities related to STEM fields (Dweck, 2006; Hill, Corbett, & Rose, 2010; Messersmith et al., 2008; Turner, 2004).

**College experiences.** Many FGCS were limited financially and needed to work while attending college. Working often prevented involvement with campus life and campus programs and organizations (Bui, 2002; Choy, 2001). Consequently, the students have less exposure to the campus culture when compared to non first-generation students (Pascarella, Pierson, Wolniak, and Terenzini (2004). Cress and Sax (1998) highlighted the campus culture knowledge gap between first-generation and non first-generation students. The university can become a divided campus with "in the know" students (non-FGCS) who have an inclusive perception of campus life and the "out of the know" students (FGCS) experiencing college from the side lines. This is noteworthy given the importance of campus social integration for persistence in college (Astin, 1993; Tinto, 1993).

In 2007, Saenz, Hurtado, Barrera, Wolf, and Yeung published a profile of first-generation college students at four-year institutions using data spanning more than three decades. In their study, characteristics such as challenges with academic preparation and concerns about financial resources were highlighted. For example, a major reason cited for attaining a degree was to earn more money and to have a secure financial future, possibly connected to the fact that many were pursuing higher education to position themselves to help family members (Bui, 2002; Hicks, 2002; Saenz et al., 2007).

According to Saenz et al., integrating with campus life was not a priority for the FGCS. Furthermore, living in close proximity to their family home was a factor in college selection. Saenz et al. also noted that contrary to previous notions about parental support (see also Terenzini et al., 1997), parents were encouraging and motivated their children to attend college. Also unlike previous findings (Choy, 2001), FGCS received meaningful guidance from counselors and relatives for various college choices (Saenz et al., 2007).

Pascarella et al. (2004) concisely convey the experiences of FGCS:

> Compared to their peers, first-generation college students tend to be at a distinct disadvantage with respect to basic knowledge about postsecondary education (e.g. costs and application process), level of family income and support, educational degree expectations and plans, and academic preparation in high school. They have a more difficult transition and are less likely to persist. (p. 250)

**Student Success**

Student success can be narrowly defined as relating to academic achievement and degree attainment; however, the best practices described, view student success from a broader, longitudinal, holistic, and diverse perspective. These strategies take into account the students' early academic preparation needed to have satisfactory outcomes associated with postsecondary education, such as "engaging in educationally purposeful activities and acquiring knowledge, skills and competencies" (Kuh et al., 2007 p. 9). Also acknowledged is the varied characteristics of students that result in diverse experiences throughout their educational pathways, such as pre-college academic opportunity,

financial resources, family background, and academic self-efficacy (Kuh et al., 2007, National Research Council, 2011).

**Best practices for success in STEM.** Based on expansive research about broadening participation in STEM, a report by the National Research Council (NRC, 2011), outlined the six ingredients for success in the STEM educational pathway (K – 16): 1) acquisition of knowledge, skills and habits of the mind, 2) opportunities to put these into practice, 3) developing sense of competence, confidence and progress, 4) motivation to be part of the field (STEM) by way of sense of belonging and self-identification with the field, 5) information about stages, requirements, opportunities" (p. 240), and 6) a supportive institutional environment.

In other words, student success in STEM begins with the students' capabilities and builds on prior knowledge as they progress through the educational system, moving from acquiring basic knowledge and skills like arithmetic facts and laws of science in the primary grades to developing complex, abstract thinking and critical reasoning skills to solve problems at the university level. The knowledge acquisition phase is coupled with practice through inquiry-based learning and design activities that lead to deeper learning (Bransford, 2000). In turn, students develop an increased sense of competence, confidence and progress in their abilities, namely, self-efficacy. The development of academic and STEM self-efficacy is a powerful predictor of enrolling and persisting in a STEM major. Bandura (1994) defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 71). According to Bandura, there is a strong relationship

between students' perceptions of self-efficacy and mastery experience, vicarious experience, social persuasion, and physiological reactions.

Another best practice to increase STEM interest is motivation to be part of the field (STEM) by way of sense of belonging and self-identification with the field (NRC, 2011). Providing opportunities for students to work along-side accomplished representatives of the fields and facilitating mentoring relationships with future colleagues help students envision themselves as scientists and engineers. Students are more likely to consider and persist in these fields, in part, because they see themselves as "fitting in" with the work involved as well as identifying with their role models.

As students move through the educational pathway, it is critical that they have accurate and timely information and access to enriching opportunities. Parents, educators, and counselors play a key role in transmitting information and opportunities to their students. Students need qualified teachers with strong STEM backgrounds, access to educational resources, such as computers and laboratories, plus financial and social support (NRC, 2011). Therefore, an important role for the educational system in the quest to increase the number of STEM focused students is to foster student success by providing accessible and relevant learning opportunities. Ultimately, adopting these best practices may lead more students, especially young women with first-generation student status, to consider STEM occupations to be a viable option: "we must do much more to attract and retain underrepresented minorities, low-income students, and first-generation undergraduates who aspire to a major in STEM" (NCR, 2011 p. 6).

**Best practices for college student success.** The monograph, *Piecing Together the Student Success Puzzle*, was authored by George Kuh and his research team for the

National Postsecondary Education Cooperative. The monograph evolved after extensive review and synthesis of "high-quality inquiries and conceptual analyses, favoring national or multi-institutional studies over single-institution or state reports" (p.5) with the purpose of identifying best practices to enhance student performance in postsecondary education, in general, and in particular "students who may be at risk of premature departure or underperformance [relating to postsecondary education] such as historically underserved students (first-generation, racial and ethnic minorities, low income)" (Kuh et al., 2007, p. 5).

The emphasis for Kuh's treatise is the college student trajectory and begins with a list of precollege factors that contribute to the advancement or foreclosure in the educational arena. After reviewing numerous research studies spanning two decades, Kuh et al. (2007) proposed this guide for those interested in the processes that influence the persistence and degree attainment of college students. For Kuh et al. there are three major segments in the trajectory: precollege characteristics, student engagement during college and post college aspirations. Pre-college factors include: enrollment choices, academic preparation, aptitude and college readiness, family and peer support, motivation to learn and background characteristics such as gender, race, and socio-economic status. Kuh et al. unpack student engagement to include a combination of student behaviors, study habits, time on task, motivation, interaction with faculty, and peer involvement, and institutional conditions such as campus environment, academic and peer support, and teaching and learning approaches.

The literature presented described the multifaceted factors that influence whether students persist and advance in the STEM educational system, from kindergarten through

college. Numerous factors also contribute to the educational pathways that lead young women to attain STEM degrees. These factors are dynamic, interrelated, and have varying levels of direct and indirect influences on their experiences along the STEM education trajectory. For FGCW in STEM, background characteristics, such as first-generation student status and their underrepresented status as women in STEM fields, may work together amplifying challenges faced in their educational pursuits.

In the first section I present the pre-college characteristics and college experiences of first-generation college students. In the next section I discuss selected literature about the experiences of women in the STEM educational pathway. I categorized the studies in three broad topical areas: academic preparation for primary, secondary and post-secondary grades, STEM identity development and access to STEM opportunities. Overall, the discussion includes research findings associated with factors that impede or facilitate women's success in STEM: course-taking patterns, opportunities for practice, pedagogy and curriculum, self-efficacy, relevance, achievement, STEM-related activities, influential relationships, and access to educational resources.

## Women in STEM

**Academic preparation**. This section begins with the primary grades and continues through the post-secondary years. Academic preparation for math and science refers to the interaction of several student characteristics, for example: interest, motivation to learn, and prior knowledge, with elements of the educational arena such as quality teachers, accessible and relevant pedagogy, and exposure to science and math activities.

***Academic preparation in the primary grades.*** In the early years (K-8), it is especially important to prepare an educational environment that makes science and math accessible and relevant for the students (Hanson, 1996; Shapiro & Sax, 2011). Academic preparation and achievement in science and mathematics during elementary school predicts future academic ability for those areas. There is a connection between opportunities to learn math and science, student achievement, and the student's decision to pursue STEM studies. Therefore, for students in grades kindergarten through eighth increased achievement positively relates to increased interest (Hanson, 1996; Oakes, 1990). Increased achievement and interest enhance the likelihood of selecting advanced high school science and mathematics courses which in turn increases the likelihood of selecting STEM majors (Hanson, 1996; Oakes, 1990). It is at this early stage that young girls need to be exposed to engaging, relevant, and positive science experiences to encourage the possibility of studying STEM and begin to learn about the various STEM careers, and how those careers are relevant to their futures as women (Hanson, 1996; Shapiro & Sax, 2011; Thompson & Windschitl, 2005).

Maltese and Tai (2010) interviewed STEM graduate students and scientists to find out the timing of student interest in science, and what factors piqued interest in science for these future and current scientists. Using retrospective interviews, the researchers reviewed and analyzed the participants' science interest. They found that the majority of the women scientists began their interest *before starting middle school*. Specifically, this finding was true for 19 (63%) of the women scientists. Women indicated that interest in science was more often associated with external sources such as *school activities and teachers* (n = 15, 52%) and family (n=7, 24%). Whereas 57% of

men cited self-interest as their initial source of interest; then school (33%) and finally family was the least likely source of first science interest in science for the men (10%). Similar findings were found by Rowan-Kenyon, Swan, and Creager (2012) in terms of using interactive, collaborative instruction in the classroom. The researchers found that that class group activities increased interest in mathematics via increased extrinsic motivation for middle-school girls. Parents, teachers, and classmates also influenced interest in the subject. This study highlighted the need for early, interactive student engagement in science by teachers and their institutions, especially to attract young girls to the science fields.

***Academic preparation in the secondary grades.*** As the student continues; the foundation established in the primary grades impacts the choices and decisions as they enter high school (grades 9-12). Many of the same factors from the primary grades continue to contribute to the directions taken by the young women in high school specifically related to course taking patterns. As mentioned, performance in advanced science and mathematics courses strongly predict choices and opportunities for enrolling and persisting in college (Huang, 2000; Kuh et al., 2007; Oakes, 1990; Shaw & Barbuti, 2010). Research also shows that the transition from primary to secondary grades is a critical point of departure from STEM subjects for women. Those who choose not to take the advanced mathematics and science courses in high school narrow their opportunities to attend selective universities, in general, and STEM programs, specifically (Poirier et al., 2009). Students may not realize how these choices can limit their future academic and occupational aspirations. These students could be tracked out of the essential courses, with quality teachers and curricula, needed to enroll and persist in STEM majors at

college. Such tracking not only affects future opportunities but can decrease young women's self-concept about science abilities (Linver & Davis-Kean, 2005). The practice of tracking can be particularly inequitable as students with lower SES status are often placed in the lower tracks. Lower academic tracking leads to lower achievement performance (Oakes, 1990). This is a concern since college-going behavior and majoring in STEM are associated with achievement, academic confidence, and mathematics and science self-efficacy and sense of belonging. (Kuh et al., 2007; Oakes, 1990; Shaw & Barbuti, 2010; Thompson & Windschitl, 2005). Furthermore, the senior year of high school and the first year of college are critical decision points for choosing a STEM major (Oakes, 1990).

Brown (2002) interviewed 22 Hispanic college students majoring in science or engineering, 12 were female and 13 were FGCS although the FGCS were not disaggregated by gender. The participants shared their academic journeys and discussed their experiences in primary and secondary grades. Several important factors for their persistence were associated with academic preparation. For example, almost all participants were tracked in an honors program (even though this was not a criteria for selection), took advanced mathematics and science courses in high school, were drawn to STEM subjects by interactive and novel elements in the curriculum and by particularly engaging teachers, and took courses in classes that were small in size (10 – 20 students per class). In this case these students benefited from tracking into the honors programs; although research shows that tracking typically disadvantages students from lower SES and underrepresented groups. Moreover, challenging curriculum with engaging and supportive teachers lifts all students (Oakes, 1992). Shaw and Barbuti (2010)

quantitatively examined the switching patterns for third-year college students in STEM majors. Again, high school performance, especially taking advanced placement (AP) classes, contributed to persistence for all STEM majors except computer science.

Goode, Estrella, and Margolis (2006) used qualitative methods (interviews and observations) to discern factors that influenced girls' participation or lack thereof in their computer science courses in their high school. Four dominant themes emerged: (a) limited access to computer courses and equipment and weak curriculum where computer courses existed; (b) poor connections made between learning computer science and advancement academically or in future careers; (c) negative classroom experiences given the disparity of computer experiences between the boys and girls; for example, more boys in the class had integrated technology into their everyday lives through home and social experiences. As a result, some of the girls felt inferior to their male peers, and (d) classroom interactions did not favor varied learning styles. Classroom observations revealed a pattern of male-dominated classroom discussions and lack of engagement for the girls in the class.

Recently, in 2012, Riegle-Crumb, King, Grodsky, and Muller challenged the popular notion that the underrepresentation of women in STEM can be adequately explained by high school achievement gaps between men and women students. They posit that while parity of achievement is still of interest, researchers need to look elsewhere to explain the dearth of women in traditionally male–dominated STEM majors. They suggest that future research should focus on gender as a social structure and on the impetus behind the positive choices women make. For these researchers, the more

appropriate question might be *why **non**-STEM*? as opposed to using a deficit model to answer why **not** STEM?

***Academic preparation in the post-secondary years.*** Once at college, several factors influence women's decisions whether to continue ("persisters") or leave ("switchers") their declared STEM majors. In their landmark study, Seymour and Hewitt (1997) interviewed over 400 undergraduates on seven campuses, collecting 600 hours of ethnographic interviews and focus group discussions, spanning three years. They found that factors associated with academic preparation that contributed to attrition of women from STEM majors included: the competitive, 'weed out' culture of science courses, lack of cohesive and consistent instruction and materials and lack of encouragement, particularly from faculty. For "switchers" these factors led to the women feeling overwhelmed by the curriculum and pace, and they began to lose interest and doubt their abilities. However, the "persisters" reacted differently. "Persisters" employed personal coping strategies, accessed institutional programming and engaged with advisors at the departmental and university levels. Moreover, faculty intervened at critical decision points for these women who persisted in STEM majors (Seymour & Hewitt, 1997).

Other studies also highlighted that college pedagogy and curriculum still present obstacles for women in STEM (Crisp et al., 2009; Reyes 2011; Wilson & Kittleson, 2013). Wilson and Kittleson (2013) interviewed 10 FGCW at a research intensive university and used case study methodology to understand their experiences. A strong theme of "school as a competition" (p. 811) emerged as the women described how faculty and the course format encouraged competition among peers. In addition, success in lecture was considered more valuable by classmates as opposed to success in lab

segments of the course. The two women in the representative cases studies excelled in the lab section and struggled in the lecture portions of the course. The competitive environment did not create a welcoming environment for these women (more on their experience in the next section). Ong, Wright, Espinosa, and Orfield (2010) and Poirier et al. (2009) report on the significant impact academic preparation can have on women of color and success in the STEM educational pathway. Likewise women majoring in STEM who transferred from community college also faced negative course experiences (Packard et al., 2011). Wilson and Kittleson (2013) commented on the need for structural reform to pedagogy and curriculum to expand the number of women in STEM. As noted in Fox, Sonnert, and Nikiforova (2009), the focus on institutional/structural factors rather than individual/student factors lead to more persistence for women in STEM. According to the NRC (2011), it is counterproductive to invest in students only to have them leave frustrated and doubting their abilities due to an unwelcoming and exclusive learning environment such as the 'weed out' culture that exists in many introductory college science courses.

**STEM identity development.** As stated earlier, "developing a sense of competence, confidence and progress" (NRC, p. 240), namely self-efficacy, is a key factor for the success of students in STEM (Britner, 2008; Else-Quest, Mineo, & Higgins, 2013; Simpkins & Davis-Kean). Ong et al. (2010) also reported that science self-efficacy is an important factor in choice of major. Another critical factor is the identification with the field of interest (STEM identity) that develops, in part, as a result of a sense of belonging and self-concept (NRC, 2011).

Although the broad topics, academic preparation, STEM identity development and access to STEM opportunities, are often discussed in a linear fashion; in reality all the factors interrelate to inform and influence the decision-making processes of the women students. Academic preparation and achievement interrelate to self-efficacy, interest, motivation and relevance. The added ingredient for identity development is the recognition by others that one 'fits' in their community (Carlone & Johnson, 2007; Gee, 2001; Holland, Lachicotte, Skinner & Cain, 1998; Wenger, 1998; NRC, 2011). Understanding the complicated and nuanced aspects of STEM identity development offered a heightened awareness and a more holistic viewpoint about who these young women are, how they perceived their many worlds, including STEM, and how they made sense of their places in these worlds. Since student engagement is most effective in the context of the students' experiences, aspirations and knowledge (Kuh et al., 2007); being aware of how women's STEM identities influence their perspectives can inform best practices for attracting women students to become our future scientists and engineers.

The term identity has many interpretations which vary by discipline and are often used interchangeably. A full explication of the construct of identity is well beyond this work; instead, various models of how identities are constructed for women in the STEM educational pathway are presented plus studies that demonstrate how identity development can influence entry and persistence in STEM fields. Although Stets and Burke (2003, p. 131) use the term self-concept, their definition encompasses the construct of identity:

> The self-concept is the set of meanings we hold for ourselves when we look at ourselves. It is based on our observations of ourselves, our inferences about who we

> are, based on how others act toward us, our wishes and desires, and our evaluations' of ourselves. (p. 131)

In other words, identity is the combination of self-concept, self-perception, and our view of ourselves relative to others in various contexts (Markus & Wurf, 1987). As described in the following examples, identity is a multi-faceted concept. Identity is influenced by individual factors: sex, race, ethnicity; background: socio-economic status, parental occupations and family values (Holland et al., 1998; Tan & Barton, 2007). Identity is constructed by the individual in relationship to particular responses from society (Wenger, 1998). Identity is performed and recognized; and thus shaped through relationships and discourse (Brickhouse, Lowery, & Schultz, 2000; Carlone & Johnson, 2007; Gee, 2001; Tan & Barton, 2007). Identity is dynamic and situational. Identity can be imposed, often by those in power, and responded to by the individual as they navigate the landscape of a community (Brickhouse & Potter, 2001; Carlone, 2004). Various identities intersect and overlap often presenting challenges to the individual. These challenges can arise from structural barriers and preconceptions about who we think we are, and who others think we are (Brickhouse, Lowery, & Schultz, 2000; Capobianco, 2006; Tate & Linn, 2005). At the core of science identity formation is the interrelationship of self and other as part of a broader educational system (Carlone, 2004). Recent research relating to the underrepresentation of women in science has also focused on how young women form their science identities and how science identities influence entering and persisting in the field (Hazari, Sonnert, Sadler, & Shanahn, 2010; London, Rosenthal, Levy, & Lobel, 2011).

***STEM identity development in the primary grades.*** Tan and Barton (2007) build on the identity work of Holland, Lachicotte, Skinner, and Cain (1998). They use an identities-in-practice framework coupled with global feminism to understand the experience of two Latina middle school girls engaged in science. The researchers employed ethnographic case study methodology and categorized personal and social aspects of identities-in-practice as: (a) student reputation, (b) significant student characteristics, (c) social resources/dynamics, and (d) figured world(s) in which identity-in- practice is authored. Their perspective highlights connections between science, location, knowledge production and learning. Moreover, it serves as a guide for future research about student science engagement for girls.

Brickhouse et al. (2000) were interested in how students' identities were consistent with their school science identities. They conducted a study of twelve girls in middle school who met two criteria: (a) students needed to show some interest in science either in school or out of school, and (b) students were from low income or minority backgrounds. Interviews and focus groups were conducted with the girls, their teachers, and parents. Girls were also asked to write in journals and the researchers observed classroom interactions. This particular article focused on the case studies of four African American students who represented a varied portfolio of student identities and science performances. These girls represented distinct views about the ways students engage in science and how reactions by important others (parents, teachers, classmates) shaped their perceptions of who they are. This study highlights: (a) the variations within gender groups; (b) the intersection of student identity and teacher identity, such as whether a teacher uses inquiry based instruction; and (c) the disadvantageous practice of making

high school tracking decisions based on prescribed "good student" notions rather than the appropriate placement for student success.

***STEM identity development in the secondary grades.*** Hazari et al. (2010) extended Carlone and Johnson's model (2007) in their study of the relationship between high school physics experiences, physics identity, and physics career choice. Hazari et al. started with the three dimensions outlined by Carlone and Johnson: performance, competence, and recognition by others, and added a fourth dimension: interest given the characteristics of their participants. The data for the study were drawn from a national survey of college students in introductory English courses who had completed at least one physics course in high school. This provided a cross-section of students in STEM majors as well as non-STEM majors. Hazari et al. found that factors experienced in high school physics such as student engagement, collaboration with peers, and encouraging teachers were important predictors of developing a physics identity for women. Also, women found physics to be less relevant to real world applications as compared to the men. In addition, discussions about the underrepresentation of women in STEM strengthened physics identity for women, yet had no impact on the men. However, an unexpected finding for the researchers was the lack of impact on the women's physics identity associated with having female scientists as guest speakers and exploring women's scientific work. Ultimately, Hazari et al. found the physics identity model used predicted their intended choice of a physics career. London et al. (2011) also found identity a useful measure for persistence in STEM majors for women. Although limited in scope, their findings support the importance of social support and sense of belonging in STEM for women who persist in STEM majors.

***STEM identity development in the post-secondary years.*** Tate and Linn (2005) applied a multiple identities framework to their study about the experiences of women of color in undergraduate engineering. It was their contention that women, and especially women of color, draw from their academic, social and intellectual identities to be successful in their engineering programs. In this case, academic identity was related to accomplishing academic activities such as engineering coursework, in other words, identity as an engineering student. Social identity was about one's role in the community of engineers, as seen by self and others. Intellectual identity refers to becoming an engineer and determining one's contribution to the engineering field. In this particular study, using a multiple identity framework revealed the interconnectedness of the academic and social aspects of the women's experiences. For example, this study highlighted that academic success is central for the student identities of women of color. What is more, however, was the influence of one's social identity with her academic identity, that is, feeling socially comfortable in order to form needed study groups and academic relationships and therefore facilitating academic success. Tate and Lynn's multiple identity framework allows for a deeper understanding of events. Not unlike the other identity frameworks mentioned, the multiple identities framework goes beyond the concept of identity as an isolated view of "Who am I?" to acknowledge the contextual and relational complexities of identity, especially at the intersection of race and gender for these women engineering students.

Capobianco (2006) studied how a group of undergraduate women in engineering constructed their personal and professional identities. As part of this study, a model of identity was developed to capture how professional engineering identities are negotiated

by these women. The model consists of four dimensions: academic identity, institutional identity, gendered identity and role models. This model is consistent with the overarching themes of the construct of identity development as complex and interrelated. These women internalize multiple identities to "fit" in the various communities they encounter. Also, of particular interest, was the high value these women placed on other women role models. Findings from this study lead to the question: How might young women's identities be influenced if successful women role models in their fields were plentiful and accessible?

Carlone and Johnson (2007) developed a model of science identity to understand the experiences of successful women of color in sciences at the undergraduate and graduate levels. Their science identity model encompasses three overlapping dimensions: competence, performance, and recognition. The model incorporates the intersections of racial, ethnic and gender identities and acknowledges their additive effects. Two key aspects of Carlone and Johnson's model are its ability to: (a) attend to the individual's negotiations in multiple realms to gain science identity; and (b) highlight the role of recognition, especially for historically marginalized groups. Carlone and Johnson explain science identity:

> Identity arises out of the constraints and resources in a local setting…A science identity is accessible when, as a result of an individual's competence and performance, she is recognized by meaningful others, people whose acceptance of her matters to her, as a science person. (p. 1192)

**Access to STEM opportunities.** Many factors work together that contribute to science identity development (performance, recognition, role models and relevance).

Similar factors are associated with integration into the college culture and persistence in STEM majors. College students benefit from a positive academic environment and a sense of community. For FGCW in STEM this is particularly true (Kuh et al., 2006; Saenz et al., 2007; Tinto, 1993; Wilson & Kittleson, 2013). Students have expectations of college life that typically come from their families.

For FGCW, expectations can be ambivalent for they are at the beginning of a journey to an unfamiliar territory without a map (first-hand guidance) from their parents. Although their parents are often encouraging, they typically lack the knowledge about the college culture to offer their children substantial, practical advice. Additionally, FGCW in STEM must unpack the culture of the STEM undergraduate program while learning the nuances of the overall campus culture. This creates a daunting scenario requiring extra energy and care in their daily interactions on campus.

Having access to STEM opportunities in the form of programming, influential others, and resources are critical for success in college. Researchers have found that relevance of the science enterprise, building community, plus acceptance and recognition from others are all important factors for persistence in STEM for women. Peers and representatives of the university (faculty, advisors, and program directors) play a critical role in providing a supportive environment (Blickenstaff, 2005; Cohoon, 2006; Conrad, Canetto, MacPhee, & Farro, 2009; Espinosa, 2011; Jackson & Laanaan, 2011; Wilson & Kittleson, 2013).

Cohoon (2006) conducted interviews with computer science undergraduates. The following factors for persistence were similar for men and women: computing self efficacy, encouragement from others and career opportunities. Of special interest were

the factors mentioned by the women. They cited becoming part of the computing science field as (a) a means of communicating, (b) offering an outlet for creative expression, and (c) a path for helping occupations. These factors directly relate to a sense of relevance for these women and in turn increase identification with computing science. Also revealed was the value of same sex peers in the computing major and faculty encouragement through targeted mentoring. Relevance of STEM was also mentioned by the women in the Conrad et al. (2009) study. The women were undergraduates in either science or engineering. When asked what was the most attractive aspect of their current major, the top response was passion for scientific research (71%) followed by wanting to make a contribution to society (39%).

As seen in Seymour and Hewitt's (1997) study encouraging relationships can make the difference for persistence versus attrition. Building communities on campus and within the STEM environment diminishes the sense of isolation often felt by women in STEM and especially FGCW. It is through these relationships that women begin to learn the landscape of the institution and department through conversations and shared experiences with peers, faculty advisors and the like. Blickenstaff (2005) stated that women leave STEM in part due to unwelcoming climate in science courses, traditional gender role expectations by peers and institutional representatives, and a narrow perspective based on a masculine worldview of science education. Blickenstaff also concludes that having same sex role models was part of the solution.

Stout, Dasgupta, Hunsinger, and McManus (2011) research with undergraduates taking calculus found expert role models of the same gender increased self-concept in STEM. The women in Espinosa's (2011) study who persisted in STEM were more likely

to discuss coursework with peers, and had intentions to use science in service. They also flourished at institutions that had a strong community of STEM students.

For the women in STEM majors transferring from community college, having a sense of belonging at the new institution takes effort. The culture is often different from their community college campus and faculty and peers can seem unapproachable. Many FGCS and underrepresented minority students begin in community college due to the proximity to home and the reduced financial burden (Saenz et al., 2007). Persistence for these students is often impacted by encouraging relationships with peers, advisors, and faculty. In cases where the college atmosphere was less than welcoming, women who sought out their own support system and established their own communities on campus were the most successful in terms of persistence in STEM majors (Jackson & Laanan, 2011; Packard, 2004-05; Packard et al., 2011; Reyes, 2011).

In addition to challenges with academic preparation, the two women (representative case studies) in Wilson and Kittleson's (2013) study felt 'out of place' in their positions as college students in STEM. Both women felt they had to choose their new STEM student identity to be considered a 'competitor" and give up their home identity. They received mixed encouragement from family members, with some faculty not realizing the heavy work load and sacrifices being experienced by these students. Lack of resources (discussed in next section) added to their difficulties.

As discussed, representatives of the university (faculty, advisors, and program directors) play an important role in providing a welcoming atmosphere. They also are a vital link to access for FGCW in STEM as they have knowledge of opportunities that may not be explicit for those new to campus culture (Blickenstaff, 2005; Cohoon, 2006;

Conrad et al., 2009; Espinosa, 2011; Jackson & Laanaan, 2011; Wilson & Kittleson, 2013). Topics related to access include programming, relationships, and resources.

Taking part in various programs on campus offers a variety of benefits for women in STEM. For example, participating in undergraduate research programs increases one's sense of belonging and confidence in the field (Hunter, Laursen, & Seymour, 2007; Seymour, Hunter, Laursen, & DeAntoni, 2004) and is a factor for women's persistence in STEM majors (Espinosa, 2011; Reyes, 2011). Given the importance of having an undergraduate research experience, Reyes (2011) expressed concern that criteria such as GPA might limit access for women transferring from community colleges. Inkelas (2011) studied women's participation in living–learning programs and did not find a direct connection between persistence in STEM and program participation, although she found an indirect connection since women participating in the program gained academic peer networks. "Faculty interactions and mentoring, and socially supportive resident-hall climates" (p. 33) were factors found to increase persistence, in general.

Fox et al. (2009) found that undergraduate women in STEM were more successful when programs they participated in were focused on improving structural/ institutional issues such as culture of STEM coursework, offering bridge and hand-on undergraduate research programs, have faculty engagement and are based on institutional recognition of the importance of increasing women in STEM. Holland et al. (2012) surveyed undergrad STEM engineering and computer science majors (40% women). They found that involvement in peer mentoring and extra curricula activities leads to positive professional identity outcomes for these students, which in turn, lead to increased satisfaction, increased commitment to STEM majors, and increased willingness to mentor others.

Getting involved in organizations, particularly with a STEM focus, also increases opportunities for (a) developing relationships with peers, resulting in decreased isolation, and increased confidence about campus processes; (b) meeting future faculty mentors, and (c) making important connections for career development. Building strong communities on campus was often mentioned as a factor for the persistence of women in STEM and especially important for specific groups of students including FGCS (Conrad et al., 2009; Espinosa, 2011; Holland et al., 2012**;** Jackson & Laanan 2011, Saenz et al., 2007). Packard et al. (2011) studied women in STEM majors who transferred from community college to four-year institutions (67% FGCW). Facilitating relationships with faculty and advisors at their community college were factors for their continuation in STEM majors; however, upon transfer several obstacles were experienced: negative classroom experiences, poor advising, and unwelcoming campus. Three specific factors contributed to the persistence in STEM majors for the 22 women who transferred: (a) they received assistance from professors and advisors; (b) they maintained contact with the co-transfer group from the community college and (c) a few shifted to other fields within the STEM majors. In addition, women in STEM majors, who also transferred from

community colleges, were more likely to persist if they sought academic mentors (Packard, 2004-05). Those who switched out of STEM or dropped out of college mentioned receiving poor advising as a significant factor (Packard et al., 2011).

The importance of women's presence in STEM and therefore increased access to same gender relationships and role models was also highlighted in the studies. Cohoon (2006) found that faculty who encouraged the women computing science students to stay in the major and were concerned with the lack of women in their departments had higher retention rates. Moreover, having enough women represented in the department that same-sex peer support was available "had the strongest relationship with gendered attrition rates than any factors identified in this study" (p. 216). Stout et al. (2011) found that expert role models of same gender increased self-concept in STEM for undergraduate women taking college calculus. The literature described indicates the importance of the programming and community opportunities for the persistence of women in STEM and other research demonstrates the importance of academic and social integration for college student success (Kuh et al., 2007; Saenz et al, 2007; Tinto, 1993). Taking full advantage of the many opportunities offered on campus, relating to academic, social, and career development does require time and financial resources; these resources are often limited for FGCW (Kuh et al., 2007; Saenz et al., 2007).

Financial concerns are common among FGCS and particularly those in STEM majors (Jackson & Laanan, 2011). Many FGCW do not have parents with the financial resources to pay for college expenses so they typically incur student loans and need to work while attending classes (Saenz et al., 2007). Also, the heavy and competitive course load often leads to a longer time-to degree than for non-STEM majors (Gayles & Ampaw, 2011). The FGCW in Wilson and Kittleson's (2013) study struggled to balance

work, study and family responsibilities especially deciding the priority of staying in the STEM major or giving priority to personal and family issues given the probability of a longer time-to- degree. Other women in STEM have expressed similar concerns (Ong et al., 2010; Packard et al., 2011). In Seymour and Hewitt's (1997) landmark study, concerns about time-to-degree and the financial consequences led 'switchers' to decide that succeeding in a STEM major was no longer a realistic objective. Another deciding factor for undergraduate women 'persisters' in computer science was economic mobility. Cohoon (2006) found that institutions offering a computer science program that was applicable to the job market led to higher retention rates.

**Summary and Statement of Research Question**

As described throughout this literature review chapter many characteristics, experiences, and perceptions influence the choices and progress made by FGCS and women in STEM. Academic preparation, identity development, and access to STEM opportunities are critical elements that define one's journey. These important factors dynamically interact and either hinder or help the student realize her educational objective of attaining STEM degree. In other words, college success in STEM is an extension of the educational process and outcomes from the primary and secondary grades combined with the student's ability to seek out assistance and cope with the challenges faced. In 1996, Hanson stated, "Although the alarm has been rung on the shortage of women in science, we have not come very far in our understanding of the complexities of women's experiences in science nor the complexities of the explanations

for these experiences" (p. 8). "We must do much more to attract and retain underrepresented minorities, low-income students, and first-generation undergraduates who aspire to a major in STEM," urges the National Academy of Sciences (2011). Lessons learned from these women can inform those interested in increasing the number of women in STEM, in general, and historically disadvantaged groups, in particular, given that "policies or programs that increase access for FGCS may also do the same for low-income and minority students" (Choy, 2001, p. 6).

This research study continues the quest of other researchers to understand and reveal the challenges and successes faced by women in the STEM disciplines. Specifically, this study sought to understand the experiences of first-generation college women in STEM; a group of women, who traditionally face cumulative disadvantages, yet have successfully traversed the STEM college culture in their pursuit of a postsecondary degree. The central research question (RQ) for the study was: *What factors influenced the educational journeys for these first-generation college women that led them to select and persist in a STEM major?*

The guiding sub-questions were:

1. What individual attributes contributed to the process of (a) preparing, choosing and persisting in college and (b) selecting and persisting in a STEM major?
2. What relationships and experiences do these women perceive to be the *most influential* sources of (a) developing an interest in STEM, (b) choosing a STEM major and, (c) persisting in a STEM major?
3. What challenges did these women encounter along their educational journey and how did they deal with these challenges?

# CHAPTER 3: METHOD

In this chapter, I describe the methodology for this constructivist grounded theory study. These sections include the following: a brief introduction to qualitative research methods, a description of grounded theory methodology, characteristics of the study participants, data gathering and analysis procedures, strategies to enhance the trustworthiness of the data, and the role of the researcher in this study.

## Qualitative Research Approach

Qualitative research is often described as "an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2014, p. 4). Qualitative researchers employ emergent research designs and use multiple data sources, such as interviews and observations of participants in their own environment. The focus of qualitative research is on the participants' construction of their experiences. The researcher acts as instrument and presents a holistic depiction of the issues at hand, as shared by the participants. For these reasons, a qualitative design is conducive to understanding the nuances of participants' complex lives, in addition to various social processes. A key feature of qualitative research is to "render the complexity of a situation" (Creswell, p.4). I employed a qualitative research design for this study because it aligns with my constructivist research paradigm. Constructivist researchers seek to understand the multiple perspectives of participants in the context of

their lives (Creswell, 2014). I wanted to understand the multiple meanings these women ascribed to their experiences in the context of being a woman in STEM and being first in their family to earn a bachelor's degree.

**Grounded theory.** Grounded theory is one of the many qualitative research traditions well-suited to address multifaceted issues (Creswell, 2014). Grounded theory (GT) is notably the most widely used qualitative research method. GT research is systematic, inductive, comparative, and recursive; simultaneously collecting and analyzing data until the conceptual categories (theories) are robust and closely reflect the participants' perceptions of the processes and issues under study (Bryant & Charmaz, 2007). The origins of grounded theory can be traced to Barney Glaser and Anslem Strauss. Developed in 1967, during a period of quantitative research primacy, Glaser and Strauss sought to create a research methodology to study social processes that was systematic, rigorous, and led to building theories. While existing qualitative methods could describe a phenomenon, grounded theory could explain. The key features of grounded theory are the recursive processes of data collection and data analyses (known as constant comparison), the inductive formation of suppositions, and the continuous search for ways data explain the experience of interest (Glaser, 1998). Thus the versatility of a grounded theory approach is appealing for addressing complex problems as it encourages purposeful and ongoing methods of data collection (Charmaz, 2006).

Although most of the traditional qualitative inquiry methods incorporate interviews and observations, and while some may use constant comparison to analyze the data, grounded theory procedures were specifically designed to build theories grounded in data (Johnson & Christensen, 2008). Grounded theory provides its own

"methodological package" (Glaser, 1999, p. 836) that can offer strategies to examine complex social issues that escape understanding using other means. Later, Strauss, in collaboration with Corbin, would modify the tenets of the original grounded theory shifting some of the procedures and moving away from earlier processes (Bryant & Charmaz, 2007). Although Glaser's approach and the Strauss and Corbin revision remain powerful tools in social science research today (Glaser, 1998), recent scholars have tailored grounded theory to fit their own paradigmatic views.

**Constructivist grounded theory.** In her book, *Constucting Grounded Theory*, Charmaz (2006) combines grounded theory processes and procedures with "21st century methodological assumptions and approaches" (p. 9). Through the lens of symbolic interactionism, Charmaz extends the pragmatic roots of grounded theory and assumes that generated theories are interpretive constructions of participants' realities influenced by their social environments. The tenets of constructivist grounded theory: assume multiple realities exist; assume mutual construction of the data through interaction; assume the researcher constructs categories; view representation of data as problematic, relativistic, situational and partial. Constructivist grounded theorists acknowledge subjectivity throughout the data analysis, recognize co-construction of data shape analysis, engage in reflexivity, and seek and represent participants' views and voices as integral to the analysis (Charmez, 2009, p141).

The participants in this study are especially influenced by their social environments, at home and at college. Additionally, constructivist grounded theory practice places the women's voices at the forefront of the research study. Therefore, like Charmaz, I also subscribe to a pragmatic, constructivist research stance. For the reasons

described above, Charmaz's constructivist, grounded theory approach is the most appropriate method for studying first-generation college women in STEM degree programs.

**Recruitment for Individual Interviews**

This study included first-generation college women in STEM majors (upper division). The STEM majors included for this study were from the colleges of Agriculture, Engineering, Science and Technology. For this study "first-generation" college student referred to those first in their family, including parents, guardians and/or siblings, to complete a baccalaureate degree. The participants attended a large, research intensive university in the Midwest.

I contacted the registrar to get the number of upper level women students on the main campus in the colleges of Agriculture, Engineering, Science and Technology who were first in their family to complete a bachelor's degree. I drew a sample of 25 women from a population of 554 FGCW in STEM: Agriculture 8/248, Engineering 7/103, Science 7/113, and Technology 3/90.

I crafted a recruitment email (Appendix D) inviting the women students who fit the participant criteria in my study. I then sent the email text with the request form to the registrar's office asking that the email be sent to all who qualified for my study. Students who received an email were instructed to contact me if they were interested in finding out more about my study. As I received the emails, I replied with another email that outlined the study criteria and gave instructions for next steps. The students who wanted to participate confirmed that they met the criteria. Twenty-five women were enrolled in the

study. Their majors are included in Appendix A. An email was sent to schedule the individual interview. I also sent a confirmation/reminder email one day prior to the interview meeting.

**Individual Interview Procedures**

A semi-structured interview protocol (Appendix F) was developed as a guide for the individual interviews; however, flexibility and attention to the participant's responses focused the interview. Topics included childhood career aspirations, family education and career history, formal and informal education experiences, educational and career path turning points, identifying and dealing with obstacles, programmatic support and role models. Examples of questions included the following: (a) What is your earliest recollection that you wanted to be [in a particular STEM field]? Tell me about that time in your life. (b) Describe the important people in your life who influenced your academic/career decisions either in a positive or negative way. (c) Describe your experience as a first-generation college woman in [STEM field].

Individual interviews were conducted from November 2014 to December 2014. All interviews were conducted in a small office in a centrally located building on campus. Upon arrival each participant was welcomed, we introduced ourselves and I offered her a seat facing me, there was an open space between us. I gave the participant a bottle of water and I shared information about myself, my interest in the study and thanked her for participating. Next I handed her the IRB approval information sheet (Appendix C) with the study details and I sat next to the participant as we reviewed the entire sheet together. I explained that her interview would be referenced with a code number and pseudonym

and her name will not be associated with her interview responses. I stated that the code key, audio recordings, and transcribed data would be stored in secure locations. I emphasized her participation was voluntary. I asked if there were any questions and reiterated that she could stop the interview at any time to ask questions or make comments. I then showed the participant the audio recorders and asked permission to record our conversation.

I used the introduction time to put the participant at ease. After receiving permission to record the conversation we completed the background questionnaire (Appendix E) together. I asked each question and recorded the answer on the form. Once completed, I began the interview with a brief explanation of the interview process. I used an interview guide; however, the interview was conversational in nature. I asked the participant about her educational trajectory from kindergarten through her current educational status. I made it clear that although my questions would be asked in chronological order, I wanted the interviewee to discuss the important events, people and memories as they came to mind rather than waiting until we were discussing a particular segment in time. The interview continued and as the student shared her story, I probed about meaning of events, expanded on responses given, and paused at times to allow for reflection. If the participant became emotional or needed a break, I paused the recording and waited until she was ready to continue. I asked if she still wanted to continue and assured her there was no fault if she decided to discontinue the interview. In all cases, the participant chose to continue with the interview. The individual interview was typically 60 - 75 minutes long. I let the participant know when we were approaching the end of the designated time. In some cases the interview was completed shortly after the notice.

Other participants wanted to continue to share their stories. At the end of the interview, I gave the participant her choice of gift cards valued at $20.00. I reminded the participant that she would be contacted about the discussion group in a few months and thanked her for her interest and wished her well. Immediately following the interview session, I wrote summary memos about first impressions, the interview content, participant demeanor, and relevant observations made during the interview. I also reflected on my interview process, thinking about how my questions were interpreted and making adjustments to questions and delivery as warranted.

**Recruitment for Discussion Groups**

I analyzed the data from the individual interviews and developed discussion points and guide for the group interviews (Appendix G). I sent emails to all the participants and scheduled the sessions accordingly. Four group sessions were established. Five participants attended group one; two participants attended group two; three participants attended group three and eight participants attended group four. Eighteen of the twenty-five women in this study attended a discussion group. The discussion groups were held in conference rooms centrally located on campus during the month of January 2015. A small meal and refreshments were served at all group meetings. As participants arrived, I welcomed them, invited them to get refreshments and introduced the women to each other. The group spent several minutes getting to know each other while sharing the meal. Once everyone was settled, I began the group discussion by reiterating the importance of confidentiality for what was shared in the room during the discussion. I emphasized that in a group setting I could not guarantee

confidentiality of what was shared. I reminded the group that their names would be replaced with their assigned codes and pseudonyms. I then pointed out that I gave each participant a pad of paper and pen and encouraged them to jot down questions, and talking points during the discussion. I also suggested they write down any thoughts they preferred not to share with the group and I would collect the papers at the end of the discussion. The group discussions were a participatory process, giving participants an opportunity to confirm, disconfirm and expand on my interpretation and development of emerging core categories, to date. I also encouraged participants to share personal reflections and relevant experiences in relationship to proposed categories.

**Data Analysis**

In constructivist grounded theory research, data gathering and data analyses are on-going and concurrent processes. Data collection needs are dynamic, and were determined throughout the study, as coding of the data began and the conceptual categories unfolded. A distinctive feature of constructivist grounded theory is its focus on developing theoretical categories by constantly comparing new data to existing data categories (Hood, 2007). At the point when "gathering fresh data no longer sparks new theoretical insights, nor reveals new properties of these core theoretical categories" theoretical saturation has been reached and data collection will be complete for that conceptual category (Charmaz, 2006, p. 113). In constructivist grounded theory, coding helps the researcher look closely at the data to understand what is happening and what the data means. "Coding is the pivotal link between collecting data and developing an emergent theory to explain these data" (Charmaz, 2006, p. 46). Three phases of coding

were used: initial coding, focused coding and theoretical coding. Charmaz recommends the following process for initial coding: keep an open mind, stay focused on the data, keep codes short, straight forward, and clear, pay close attention to action words and move freely as data are compared (Charmaz, 2006). This initial coding process established fit and relevance for the study. At this stage, the codes and categories began to reflect the real world experiences of the respondents; and thus provided direction for the next analysis stage, focused coding.

Memo writing was a central technique to analyze and interpret the data in this study. The memos served to lend familiarity and attention to the data in the early stages and brought to light relationships and theoretical concepts in the advanced stages. Memos are about process; they can be messy and unclear especially at the beginning of data collection: “Memos serve as a fundamental link between data and emergent theory” (Lempert, 2007, p. 249). Memo writing is an organizing process of describing, interpreting, and theorizing data. Memos are narratives about how data fit together and the meaning of the story behind the words and lines. Memos are pictures of words and concepts and the connections that are forming. Memos can be ambiguous at the beginning of the research and gain clarity as additional data fill in gaps and lead to concepts. Quality memos provide a history of the research process and a way for the researcher to view the data from other angles. Ultimately, memos are analytical stories related to the data that lead to elevating categories to constructs.

Memo writing is a personal enterprise; each researcher decides what techniques work best (Charmaz, 2006; Lempert, 2007). Two memo writing strategies were used in this study: freewriting and clustering. Freewriting, as the name implies, is unstructured writing. It is especially useful when dealing with writer's block. Since there are few rules with this method, it helps document your thoughts, especially unformed ones, so you have a record to refer to later. Clustering is a visual aid that begins by writing a central idea and mapping related data categories to it. This technique is also used to prompt creative thinking about the codes and their relationships (Charmaz, 2006; Lempert, 2007). Hence, memos are particularly useful when moving to the theoretical sampling phase.

Theoretical sampling is the process of collecting additional data, informed by your theoretical categories and codes, specifically to help clarify and build existing categories. Participants are revisited at this stage and new participants are recruited if necessary to enhance theoretical category building. At this stage, memos become a product of the data collection and inform theoretical sampling.

Reviewing memos using an abductive method will guide the theoretical sampling. Abduction is the process of combining inductive and deductive reasoning. It is thinking about the totality of the data and forming suppositions and explanations. Abduction provides an emergent map of where you have been and where to go to advance theoretical development. Theoretical sampling adds meaning, fills gaps, refines and deepens your understanding of the events under study. This sampling continues until 'saturation' is reached. Saturation is an often misunderstood and misapplied term in qualitative research. As mentioned, theoretical saturation is reached when "gathering

fresh data no longer sparks new theoretical insights, nor reveals new properties of these core theoretical categories" (Charmaz, 2006, p. 113).

**Analytic procedures employed.** I transcribed the individual interviews and group discussions using a transcription program. First, I replaced the participants' names and identifying information with numeric codes and pseudonyms to protect confidentiality. Interview files were stored on a secure computer and associated documents were stored in a secure location. Transcripts were also backed up on a flash drive also stored in a secure location. While transcribing, I made notes about participants' inflections, laughter, etc. I also reflected about the interview during and after the transcription process, making notes (memos) in my research journal. After I transcribed an interview, I read and reread the document, brainstormed, asking myself questions such as "What's going on here?" "Were any responses unexpected?" "What similarities and differences emerged across the individuals' experiences and within the subgroups? I made notes and wrote memos as I reflected on these questions. I returned to this kind of reflection often as I interviewed each participant and processed the data.

I used varying methods to code the data. During the initial coding phase, I began by making hand-written margin notes on the paper transcripts. I ultimately created an Excel file with participants' information and text from the transcripts for each college. I developed worksheets organized and labeled chronologically: kindergarten through 8$^{th}$ grade (K-8), high school, and college. Data were then parsed and assigned to initial, broad categories. Organizing the data in this manner was useful if I wanted to look at one participant's responses, the responses from a sub-grouping or all responses to a particular question. Then, codes were selected, based on frequency of use and/or importance to

form the analytical categories. Although decisions are made about which codes fit best at this point, the recursive process allowed me to return to the data and reexamine the coding categories, as needed. As I continued to analyze the data, I developed codes and descriptor categories and created memos in table form arranged by emerging topics, themes, and patterns.

This process continued, resulting in various categories and subcategories and more memos. Finally I reviewed the memos and categories to discover various relationships which became my assertions for my study.

**Strategies for validating data.** There are a number of techniques that can be applied to a qualitative study to address the credibility the research findings. Credibility refers to the accuracy of the factual reporting of what took place by the researcher, and is concerned with capturing the participants' perspectives as if "walking in their shoes" (Creswell, 2014). I addressed the credibility standard by using four of the techniques suggested by Creswell: triangulation, peer debriefing, presenting discrepant cases, and member checking. Triangulation refers to using multiple data sources and comparing individual, sub-group, and group participants' perspectives to establish substantive categories (Creswell, 2014; Lincoln and Guba, 1985). Data from individual interviews and group interviews were reviewed and compared during data analyses. Peer debriefing provides an opportunity for the researcher to discuss research processes, expected and unexpected findings, and potential biases with someone outside the research. Peer debriefing lends a fresh eye to the data and interpretations and gives the researcher an opportunity to receive feedback about the study interpretations (Creswell, 2014; Lincoln and Guba, 1985). I enlisted three women for these discussions. My dissertation

committee co-chairs and a first-generation college graduate with a degree in psychology who was originally in a STEM major. We had several discussions throughout the data collection, data analyses, and data interpretation phases.

In order to reveal cases that were counter to emerging categories, I used constant comparison techniques to analyze the data, form codes, develop categories, and render assertions. Data were specifically examined for alternate categories and rival explanations. As suggested by Creswell (2014), I included discrepant cases in the narrative as warranted. Member checking refers to giving the participants an opportunity to clarify, extend, confirm and disconfirm findings and interpretations of the collected data (Creswell, 2014; Lincoln & Guba, 1985). Eighteen participants attended one of four small discussion groups after the initial interviews. I presented preliminary findings and facilitated a group discussion about my interpretations of their responses and associated experiences. Participants commented on the findings and interpretations of this study; they confirmed and extended their responses given during the individual interviews.

I addressed consistency by maintaining complete records of methodological strategies employed, including the reasons for choosing specific strategies, and lessons learned from a methodological standpoint. (Creswell, 2014; Lincoln & Guba, 1985). For example, I used memos to trace definitions of codes and categories as I compared new data to existing data throughout the analyses.

I also used rich, thick description of the participants' experiences in the narrative to provide context for the data and allow the reader to get a more intimate picture of participants' perceptions of the issues being addressed (Creswell, 2014; Lincoln and Guba, 1985). In addition, I wrote copious memos about the individual and group

incidents. I maintained a research journal where I documented the development and refinement of codes, categories, and assertions. This documentation assisted me as I wrote a robust, detailed research narrative (Creswell, 2014; Lincoln & Guba, 1985).

**Role of Researcher**

Constructivist grounded theory research is about people and their stories. Establishing rapport, mutual respect, and reciprocity at the beginning of the research is necessary and ethical. Given this is a qualitative study, potential biases exist from the researcher's preconceived suppositions and personal experiences. Reflexivity allows the researcher to understand how their background characteristics and experiences may influence all aspects of qualitative research (Creswell, 2014; Lincoln and Guba, 1985).

I was a first-generation college student. I initially studied computer science and decided to change my major to psychology. Therefore, unlike the women in this study, I am a "switcher" rather than a "persister" in STEM. While earning my master's degree in college student affairs, I met women who were first-generation and in STEM majors who switched to non-STEM or left college; one of the women left because her poor college grades caused her to lose her scholarship. This was shocking to her since she had been a high-achiever in high school. I also studied the college experiences of first-generation college students, in general, and millennial college students, specifically, within the context of being college student affairs professional. While seeking my doctorate, I became a research assistant for projects seeking to broaden participation in STEM. These experiences coalesced, and I became intrigued about the various factors related to

persistence for first-generation college women in STEM. I wanted to learn from FGCW in STEM who were "persisters" and share their knowledge and experiences with others.

Given my interest and personal experiences with the focus of this study, I needed to employ techniques that would address any biases that may exist. Patten (2002) describes two such techniques: epoche and bracketing. Epoche means to withhold judgment. In qualitative research it means to look beyond your predispositions and become aware of one's preconceived notions regarding the research topic of interest. I recognized that I have an advocacy stance for first-generation college women and women in STEM through my personal and work experience. I intentionally set out to increase my awareness of these biases and set them aside using reflexive memo writing during the research process.

Bracketing is a technique that sets aside any assumptions and biases of the researcher so the data can stay true to the participants' voices and meanings. As I wrote reflexive and analytic memos, I focused closely on the participants' words and meanings from the interview narrative. I used "in vivo" codes often so the participants' voices were explicit. I incorporated numerous participants' quotations throughout the narrative. I discussed my interpretations with the participants and incorporated their feedback.

**Protection of Human Participants**

Prior to recruiting participants for this study, approval was granted by the university's Institutional Review Board (IRB) under Protocol #1404014775 (exempt status). The copies of the approved recruitment email, participant information sheet, and approval notice are in appendices B-D.

At the beginning of the interview meeting, I described the research study to the participant, reviewed the information sheet with the participant, and answered any questions the participant might have about the research and her participation. All interviews were conducted with respect and consideration for the participant's rights with oversight from Dr. Deborah E. Bennett who served as Principal Investigator for the study.

# CHAPTER 4: RESULTS AND INTRODUCTIONS OF PARTICIPANTS

I interviewed 25 first-generation college women (FGCW) in STEM majors for this study. Eight women attended the College of Agriculture, seven women attended the College of Science, seven women attended the College of Engineering and three women attended the College of Technology. In addition, 18 of the 25 women attended one of four discussion groups. During the discussion groups the participants reiterated what was shared in the individual interviews and discussed their plans for after graduation. In Chapter 4, I present portions of these women's narratives to lend a deeper understanding of their experiences as FGCW in STEM majors. The pre-college topics include: Interests and Varied Paths to STEM Careers which is a brief overview of the participants' career journeys grouped by colleges, STEM Student Identity which presents the individual attributes that contributed to preparing and choosing a college and STEM major (RQ1), Influential Relationships for developing a STEM interest and choosing a STEM major (RQ2) and Transition to College which highlighted some of the experiences that influenced their college and major selections (RQ2) and also presented challenges faced while participants were choosing, applying, and getting accepted into colleges and their responses those challenges (RQ3).

The college topics presented generally referred to research question 3 (RQ3). These included Being First which highlighted some of the issues related to being FGCW

in STEM, Academic Integration which presented some of the academic challenges faced, Social Integration which presented several aspects of the participants getting acclimated to campus life, Influential Relationships which highlighted how the people in their college lives helped them persist toward their graduation goals, and Financial Responsibilities which presented the role that financial stability or lack thereof shadowed their college and career related decision-making. I chose quotations that best represented the various perspectives related to each topic. For example, one quotation might have represented several women who had similar thoughts or experiences. I also indicated if a quotation was specifically one participant's experience. Additionally, all quotations were derived from the individual interviews conducted from November 2014 through December 2014 unless otherwise specified. Throughout Chapter 4 I refer to the interviewees as either "participants" or "women in this study."

## Participants' Background Characteristics

The participants represented women who were first in their family to complete a bachelor's degree in a STEM-related career field. They also all attended grades 4-12 in the United States. Tables 1 and 2 present the participants' college affiliation, race/ethnicity, high school setting, and favorite subject in high school. Then the women are described individually within their major areas of study.

Table 1

Agriculture and Science Women's Background Characteristics

| Name | College | Race/ Ethnicity | High School Setting | Favorite High-School Subject |
|---|---|---|---|---|
| Alexis | Agriculture | Caucasian | Rural (Public) | Language Arts |
| Amber | Agriculture | Caucasian | Rural (Public) | Calculus |
| Amanda | Agriculture | Caucasian | Suburban (Public) | Science |
| Anna | Agriculture | Caucasian | Rural (Public) | Science |
| Andrea | Agriculture | Caucasian | Suburban (Public) | Biology |
| Angela | Agriculture | Caucasian | Suburban (Public) | Biology |
| Amy | Agriculture | Caucasian | Rural (Public) | Writing |
| Alexandra | Agriculture | Caucasian | Rural (Public) | Science |
| Suzanne | Science | Caucasian | Rural (Public) | Science |
| Sydney | Science | Caucasian | Rural (Public) | Biology |
| Shannon | Science | Person of Color | Urban (Magnet) | Biology/Chemistry |
| Samantha | Science | Caucasian | Rural (Public) | Calculus |
| Stephanie | Science | Caucasian | Suburban (Public) | Calculus |
| Selena | Science | Person of Color | Suburban (Public) | Foreign Language |
| Sophia | Science | Person of Color | Suburban (Public) | Biology |

Table 2

Engineering and Technology Women's Background Characteristics

| Name | College | Race/ Ethnicity | High School Setting | Favorite High-School Subject |
|---|---|---|---|---|
| Erica | Engineering | Caucasian | Suburban (Public) | Calculus |
| Emma | Engineering | Caucasian | Rural (Public) | Journalism |
| Emily | Engineering | Caucasian | Suburban (Public) | Language Arts |
| Erin | Engineering | Person of Color | Suburban (Public) | Mathematics |
| Elena | Engineering | Caucasian | Suburban (Public) | Photography /Arts |
| Ellie | Engineering | Caucasian | Suburban (CP) | Math/Chemistry |
| Eliza | Engineering | Person of Color | Suburban (Charter) | Science |
| Tara | Technology | Caucasian | Rural (Public) | Calculus |
| Taylor | Technology | Person of Color | Suburban (Public) | Government |
| Tiffany | Technology | Caucasian | Rural (Public) | Math/Science |

**FGCW in Agriculture and Science Majors**

The following represents brief profiles of each participant who majored in agriculture, science, engineering, or technology. Pseudonyms are used to protect the anonymity of each participant. In addition to the participant's name, I provide a brief overview of her interest or motivation for entering her respective field of study.

**Alexandra** is a natural explorer and scientist; she tried several career fields and, through trial and error and persistence, found her real passion: research.

**Amy** liked to be challenged and developed a strong interest in science in high school and competed in 4-H. She liked the career options that majoring in animal sciences offered. College reputation was an important factor as she was making college decisions.

**Angela's** interest in animals, nature, and the environment led to her current major. She wanted to bring people closer to nature and was interested in pursuing outreach and habitat management in graduate school.

**Andrea** chose veterinary medicine at an early age because she wanted to work with animals. Her middle school science teacher fostered her science interest. She continued to work with animals and attended veterinarian camp. Although still interested in veterinarian school, her coursework in animal sciences has exposed her to other viable options related to her interests.

**Anna** discovered entomology through 4-H in 3rd grade and continued on this path through high school, being involved with 4-H for 10 years. She also attended entomology camp where her career decision was confirmed. Now nearing completion of her bachelor's degree, she intends to go to graduate school.

**Amanda's** love for animals in the early years initially led her to consider becoming a veterinarian. However, after shifting to pre-dentistry and learning more about the field, she decided it was not for hers and she explored other areas in science. During her freshman year of college she went snorkeling and loved it so much it prompted her find a college major that would incorporate her new passion.

**Alexis's** personal experience with animals led her to consider veterinary medicine in elementary and middle school. After careful consideration and a first semester detour (speech pathology), she entered the college of Agriculture which afforded her multiple career options and high employability.

**Amber** participated in 4-H wanted to be a veterinarian her entire life until she came to college. When she came to college she discovered various careers related to working with animals. She also decided not get an advanced degree and was specifically concerned about acquiring student loan debt.

**Stephanie's** favorite subjects were mathematics and science. She continued to be interested in biology and genetics but did not want to be a doctor. She planned to focus on research in graduate school.

**Selena** initially wanted to be a veterinarian; however her vet internship decreased her interest. Recent opportunities to work at the zoo piqued her interest in ecology and exotics. She is entertaining both options for graduate school.

**Sophia** wanted to be a doctor so she can help while applying her talents. A science teacher in high school introduced her to environmental sciences which inspired her interest so she added ecology, earth, and environmental sciences to her program of study.

**Samantha** decided to become a doctor in high school. She planned to attend medical school and at her father's suggestion majored in biochemistry rather than biology to prepare for an alternative career path.

**Shannon** attended a medical magnet high school. She worked at a medical school in the pathology department. This was her turning point for her career-decision; she could see herself doing the work. She planned to get a master's degree in public health before going to medical school.

**Sydney** was fascinated with how the brain and the body worked. She remembers taking family trips to science centers and learning about the brain from her father at various exhibits. She planned to start her career after graduation.

**Suzanne** has a long history working with animals; she joined 4-H in 2nd grade and continued moving into a leadership position during high school. She particularly liked AP biology and attributed her choice of biology major to her teacher. She planned to attend veterinarian school.

### Engineering and Technology Majors

**Eliza** knew she wanted to be an engineer after attending a special STEM awareness program during middle school. She had an affinity for mathematics and science and was influenced by her high school guidance counselor. She planned to go into industry after graduation.

**Ellie** wanted a challenging career. After considering many career paths in and outside of STEM, she learned more about engineering at high school graduation party. She explored

engineering as a career potion and that is what led her to Midwest University. She plans to go to graduate school to prepare for an academic career.

**Elena** came to engineering in a sideways route. Her high school physics teacher was encouraging her to major in physics; her own research and conversations through social media with current engineering students convinced her to try engineering. Engineering allows her to express her creativity and also make a difference, both important aspects for her chosen occupation.

**Erin** heard about Robotics in her freshman year of high school and it changed her life. She was involved in all engineering aspects of the program. She identified with the project engineers and loved the building and design. She found a home in the robotics club. Her interest in engineering was reinforced through the women in engineering program. Still interested in business, she ultimately decided on engineering.

**Emily** had heard about engineering growing up near Midwest University but really did not know what it entailed until she attended college. She wanted to secure a stable job after graduating and work in public service. She applied for a scholarship for graduate school and was weighing all her career options.

**Emma** wanted to be a lawyer or a journalist until her senior year of high school. At that time, her environmental science teacher asked her to consider engineering and attend a pre-college engineering program. She chose environmental engineering as a major because she wanted to make a difference in the world. She loves research and planned to go to graduate school.

**Erica** wanted to be a surgeon until she participated in robotics in middle school; that drew her into engineering. She attended Project Lead the Way, taking concentrations in

engineering and medicine. One reason she chose engineering was for financial stability. She planned to start her career after graduation.

**Tiffany** wanted to be a doctor in the early years. In high school she attended a pre-engineering program and a pre-medicine and decided engineering was a better fit. Found her home in the engineering technology department and was considering enrolling in a master's program

**Taylor** loved the virtual world from an early age. In elementary school she enjoyed coding on various forums and was drawn to computer design. However she first came to college majoring in history. After taking a few classes she decided history was an avocation rather than a vocation. A friend, who was majoring in computer technology, invited her to take a class. She felt lucky to have found a career field that she enjoyed. Moreover, a career in computer technology provided financial security, an important consideration.

**Tara** wanted to be a veterinarian and participated in 4-H for 10 years. Unsure of her career path, she tried allied health in high school. Still searching, she learned about the engineering program at Midwest University through her neighbors. When she did not get into the engineering program, a friend convinced her to give technology a try. She did and now could not imagine another career for herself.

## Pre-College Characteristics

What follows is a description of each participant's (a) pre-college interest in STEM and their varied paths to STEM careers; (b) characteristics of her STEM student identities; (c) influential relationships; and (d) transitions to college.

**Interests and Varied Paths to STEM Careers**

Participants' early career aspirations, for example being a teacher, doctor, or veterinarian broadened as they were exposed to new ways to express their curiosity, solve problems, and make a difference in their communities. Although their paths to STEM varied, the participants held in common many underlying motivations to select and persist in STEM majors. These included: following their passions, improving their economic positions, sharing knowledge and resources with family members, and contributing to society.

**Agriculture women's interests.** The women in agriculture majors tended to develop their initial science interest early through personal experience with animals and nature. Several of the agriculture participants were involved in 4-H for several years, reinforcing their early interest and expanding their practical knowledge. What follows is how the women described how participating in 4-H influenced their career choices:

> **Anna**: I started 4-H in 3rd grade and my dad and my step-mom had both come from 4-H families... I don't think I would have taken it to that next level to actually studying [insects] and researching [entomology] and becoming a career without 4-H.
>
> **Amy**: I had never been challenged in anything science wise until I finally went to my first year of high school. So that's when the interest in sciences kind of started. Never was really solid on that [career choice] until probably junior or senior year and it started with the livestock. I was really lucky to get in... Six 4-Hers in the county get selected for this competition and they ask you…about the

markets…about anatomy and diseases…Those 4-H competitions that even changed my preconceived ideas.

As their knowledge and understanding of the field grew, their career choices also shifted. While their interests relating to animals remained their underlying motivation, the kind of work shifted often for personal reasons. For example, several women in Agriculture, who originally wanted to be veterinarians, questioned that choice after learning more about the time, costs, and competitiveness of veterinarian school. Specifically, it was difficult for them to envision having to euthanize animals. As they grew older and were exposed to additional occupations related to animals, some women shifted from veterinary medicine to animal sciences, agribusiness, wildlife biology, and animal science research.

**Andrea:** Throughout life it built up but I think the main thing that drove me to be interested in sciences is probably my interest in animals…I knew if I pursued science I could have a career that involved research or vet med that works with animals… I was looking at other options like scientist and zoo keeper; I realized you don't need to go to college to be a zoo keeper (laughs) and it's not high paying. So the reason I chose animal science was because I wanted to go to vet school but that's questionable now.

**Alexis:** I wanted to be a vet; then, as I grew older, I still wanted to be a vet throughout freshman year in high school [when] I lived on a hobby farm…if you're going to be a vet, you're going to have to do all this stuff. I decided I can't put an animal down. So vet school went out the door, that, and 8 years of college at least and I told mom I'm not racking up that much debt. After that I wasn't sure

what I wanted to do I thought something in Agriculture cause I've always known Agriculture.

Several participants talked about their lack of knowledge about career choices related to working with animals. **Angela** and **Amber** explained that because she wanted to work with animals she initially wanted to be a veterinarian since she was only aware of that path to her passion:

**Angela:**… something to do with animals stayed consistent. I wanted to be a veterinarian because that was the only position that really anybody could tell me that fit, because nobody knew about…natural resource careers. Everybody at my grade school [who] wanted…to go to college it was doctor, dentist, business accounting, and veterinarian it was very generic. Nobody knew what else was out there.

**Amber:** I've always had animals my whole life. So I've been taking them to the vet with my mom and I was in 4-H in 3rd grade…I was exposed very young. I would say and I wanted to be a vet my entire life until I came here and then I decided there are other options still wanting to be with animals.

Still other women moved away from early interests and participated in different occupations and due to specific events in their lives decided to enter the college of Agriculture. Amanda and Alexandra transferred to Midwest University to pursue specific programs aligned with newly discovered passions.

**Amanda:** I originally entered college in pre-dentistry…That's where I planned to stay, got in started and was there for two years. Then decided that I didn't want to do it… The reason that I chose fisheries was that I went snorkeling. [Freshman

year] I was like, I want to do something like this, but before that I was searching other related topics like genetics, micro-biology. I was looking into all those, but then I really started looking into something to do with the ocean or fish and I found fisheries at Midwest University… so I started looking into it more. Fisheries and aquatic science…I looked at the curriculum and I saw the marine biology and all of these fish classes so....that's what sparked my interest.

**Alexandra:** I finally started to look at some of the programs in agriculture and finally thought- cause it really didn't occur to me at first- I mean I always would like garden, my dad always had a garden we always grew flowers, we always- we'd go out in the woods and hunt mushrooms he would look for ginseng sometimes, we were digging up roots and it just never occurred to me that you could do that as a career you know or things related to that, so the more I started looking at it the more I was like oh I really do like these things, I really am already into some of these things.

**Science women's interests.** While the women in agriculture majors were influenced more by home life and out-of-school time programs, five of the seven women in science were influenced by classroom experiences. They were inspired by their science teachers, had an affinity for mathematics and science, and felt they could succeed academically. They also expressed a desired to help others either by becoming researchers or doctors. Stephanie, Samantha, and Sophia described part of their early thought processes related to career choices:

**Stephanie:** [In elementary school] I wanted to be a teacher. I felt like it was a way to help people and get them going and create a new generation of leaders.

[Later] I switched to doctor… I need to get into a good college so I need to do this here and now. I was already prepping myself for that kind of mindset. I think if you are going to shoot for the stars you might as well go all the way. That was my perspective… I picked biology because I thought that would be the easiest transition going to med school.

**Samantha**: I think I wanted to be a vet. Um we always had animals in my house and I always um loved them. I think that's a very common little kid answer… Then probably made a transition I wanted to be a doctor pretty young that's still what I want to do... I knew I could get there I knew I was smart.

**Sophia**: So I was just trying to figure out: what I liked to do first and then what can I do with what I like to do. So elementary school more science, middle school was biology, 8th grade more cell biology and what I could do with that. Still [wanted] biology in HS. I knew plants didn't really interest me. I knew it was more like animals or research within cells itself but other than that I didn't really know. I started to know that as a senior in HS when I started to ask around. Do I want to do medical stuff? Did I want to become a doctor? I knew I didn't want to be a doctor. I knew I kind of wanted to do research because I like the lab. What can I do with that to get a job to work in a lab? So I guess my goal now I want to do a lot of research. I want to work for the NIH at a lab there. That's just like...and maybe with cancer or certain type of disease.

**Engineering and technology women's interests.** The engineering and technology majors entered the field later. Three of the women who were exposed to engineering before high school were identified as gifted and were given access to special

programming. Avenues to engineering included robotics, high school college prep programs such as Project Lead the Way, pre-college programs offered by universities, and more informally, conversations with engineers (parents of friends and neighbors), and interactions with college students already in the major. Two of the technology majors started in engineering and eventually found their niche in the College of Technology. These women discuss what drew them to engineering:

> **Eliza:** That's when I went straight into engineering. I knew, I think I googled it. What is a good career for math and science people like that I was in middle school 7th or 8th grade. Then I was in … a program for students who were academically succeeding…that's when I found out about [East Coast University] because they were an engineering and STEM school…we would just do different projects: build bridges with toothpicks or different activities like that so that's the kind of things that engineers do they build things. Use their ideas to build and make the world better. They were just trying to expose us to that kind of thing at a young age.
>
> **Ellie**: I had an interest in physics when I was in HS and along with the math and science side of things. Engineering it was a career that I'd known about because a lot of my friends were thinking about going into it at the academy…I knew that it was something that made sense with my interests. But the basic ideas, concepts, learning to think like an engineer type of thing and then we had a lot of colleges come to talk to the students at the academy so I went to a couple where they talked a lot about engineering.

**Elena**: So I was ok I guess I'll do engineering if I still want to be a pilot after that I mean civil engineering earns good money and I can do my piloting on the side or something. It's something I still look forward to in my future hopefully. Um so I think I was going to do physics once I went off of being a pilot because I had applied to some in state schools and one of them didn't have an engineering program but they had physics. I think I'm going to major in physics because that's what my physics teacher said I should do and I think that's a good idea... I talked to the people [Midwest University students] I met online some more and I did more research on it. I think I'm going to like engineering better… just they need lots of engineers and it's got good pay whereas being a physics…I guess just being an engineer sounded cooler based on my research. I mean it's all about designing things. For a while I didn't know what in engineering I wanted to do…

**Erin:** I didn't know anything about engineering up until HS. It's all about HS Robotics. It meant everything. And then all the mentors were engineers… And that just became a little community and I just loved spending time there. So I would go to robotics all the time and that became my second home.

**Taylor** described her early exposure to computer coding:

Exposure came early for me. I spent a lot of my childhood playing with neopets. You made an account and have virtual adopted pets. It drew you into the virtual world. First time I coded it was on the neopets forum; I was about 7.

The women in this study had access to knowledge about various careers, the opportunity to practice aspects of the field, and positive relationships with formal and informal

mentors who invited them to be part of the community. In other words, they personally identified with the work and the people who were in their fields of interest.

**STEM Student Identity**

For the purpose of this study, STEM student identity includes the participants' reported perceptions of her: (a) overall academic achievements, (b) mathematics and science interests and abilities, (c) attitudes about learning, (d) involvement with extracurricular activities, (e) roles in the family, and (g) expectations to attend college. These are the individual factors. Parents and teachers also played a significant role in the development of their STEM student identities. Although parents and teachers are mentioned in various narratives in this section, I discuss their roles in more detail in the section about influential relationships.

**Overall academic achievements.** Typically these women characterized themselves as good students who enjoyed participating in class and excelled in their academic subjects, especially those related to their chosen interests. While getting good grades was a constant for these women; defining 'good grades' varied within the group. Four women recalled their academic personas during the early school years:

> **Stephanie:** I was the very quiet perfect teacher's pet I did everything I was told to do. I kept to myself and did everything very orderly so I was perfect back then (Laughing).
>
> **Elena:** I liked school and got good grades but I wasn't someone who would do everything they could to get an A. If I got a B and I worked hard I was happy with my grade. I didn't feel I needed to sacrifice certain parts of my life for my grades.

**Angela**: I was I guess as involved as I could be for an elementary school student. It was a lot easier obviously all the teachers were…knew I was ready to help and grade papers and stuff like that. I still had friends outside of school. It wasn't like I was super nerdy. (laugh)… All A's maybe 1 or 2 B's in social studies. Ambitious, academic, hopeful, that would be it. I knew I was to do something but I didn't know what it was.

**Amanda:** I thought that I was a good student. Always wanting to help the teacher with whatever they needed help with like passing out papers. Always getting my homework done. Just being involved. I always got good grades, mostly As and some Bs. Yea, when I got my first B I was a little upset, but I was ok with it after a while. [I was involved] in elementary school [in] pretty much everything. Softball, volleyball, basketball, swimming...

**Mathematics and science abilities.** Mathematics and science came easy to 84% of the women through high school. When they reached college all the women except two (92%) stated they struggled with college level mathematics courses. Those who struggled with higher level mathematics and science courses often improved after they gave extra attention to their studies by spending more time on the work and getting help from teachers and students. Several women described their relationships with mathematics and science:

**Sophia:** Um there wasn't anything challenging about math. I knew I understood math it wasn't ooh I really like math. It was it comes easy I would always help other people with math because I understood it; but it was never that I wanted to pursue something else in math.

**Amanda:** A good student, I was a good student all of the time. I was on the academic honors diploma. I started working in HS. School just came easy to me. I think I studied a little bit for college prep chemistry, because it was a little more advanced.

**Alexis**: Math: I had to work harder in 5th and 6th grade but when I was younger not really if I ever slacked off I would have to kick my butt in gear and work a little harder to catch back up.

**Selena**: I was obsessed with grades that all I remember. I think because it was harder course loads. Higher levels accelerated Algebra, trig, Geometry, stats. Junior and Senior year.

**Erica**: Freshman year was awful. I had an epiphany so stepped up my game and started taking AP classes. It gives you extra GPA credit which seems amazing right now that you can do that. I think it hit sophomore year to hit 4.0 and after that I was above 4.0 from taking the AP classes. I ended with a 4.0 In order to get there I had to have a 4.2. My grades were fine [for college].

**Alexandra** describes her lost opportunities due to the math challenges she faced and her initial perspective as a non-college goer:

The science courses you were allowed to take were directly related to your math scores. So my math scores were not fantastic so I couldn't take like I got to take like earth science and I don't remember what else, but I couldn't take biology or chemistry or anything like that because my math scores weren't good enough. But I found later on in life that I can somewhat manage the math as long as it's related to chemistry because then it makes sense. I can't do arbitrary math problems

because it just doesn't make a connection like if it's not for a purpose why does it matter? But once it's related to something then it's easier for me to kind of be like oh now I understand where these numbers go so… [Since I'm not going to college] I'm not going to need any complex math so I never really looked for help.

**Attitudes about learning.** With few exceptions, the women in this study expressed a love for learning. They described themselves as curious, self-starters, and enjoyed solving problems. They often shared their love of learning with family members and other students. They described opportunities to expand their knowledge and experiences. They explain:

**Angela**: [In high school] I got 3rd in my class--first in junior high. So I did well but I didn't feel as connected to my academics as exploring my career options. I went to school and did the work and I'm going to go to this club I'm going to learn about this career - I'm going to make some money put gas in my car go to the museums and zoos and learn from people. I feel like in high school the world opened up a little bit more and I still enjoyed school. I liked to learn but I realized it [the world] is bigger than it is in high school. I don't know why anybody would just want to stop there (laughs).

**Eliza:** I was always driven for my future; so that was something that identified me differently from other people for my age. So I think that was the difference for me. I love learning things that I'm interested in.

**Stephanie:** I've always been very curious. If we're researching something in class doing a project I'd always go on line and learn more and more and more. You find yourself on a page and you click the see more button and I'd spend hours looking

up something way more in depth than I would need to - this is so cool so interesting… What drives the curiosity? That's just who I am. (laughs)

**Involvement with extracurricular activities.** These women were busy and goal-oriented. Most identified themselves as competitive in school and out-of-school. In addition to their academic pursuits, they were involved in sports, clubs, student councils, volunteer work and special programs. In the later grades, they typically held leadership positions. Of note was their solid commitment to their respective groups. Additionally, participating in these activities often led to significant relationships that fostered self-confidence and a sense of belonging. These women's experiences were typical for the majority of the group. They shared their insights about their participation:

**Elena:** I played soccer since I was 4. And when I was 10 I joined travel soccer; traveling around got more competitive. I was in girl scouts between 3rd and 5th and something that was fun but laugh didn't really something I stuck with. I was really involved there was like a study hall thing after school between 5th and 6th grade. [I played the] flute. I think that was mostly it. I was really involved with the sports. My dad's always encourage that.

**Samantha:** [Played] 4 sports; national honors society; student council, science club, campus life-youth group on campus, German club, choir... I like the feeling of succeeding my goals. And like even if I'm not aware of it being something that I personally want. In middle school when someone would put something on me if I finished the task, it was I liked that feeling even if it was something I didn't need to finish.

**Erin:** [I was in robotics] all 4 years. My first year I had one leadership position, my second year I had 2. By my third year I had 4 and then my last year I had 4 different positions as well. I was heavily involved and I loved every second of it.... My thing is you don't know until you try. I have problems with saying no. Oh can you do this…Yeah that's why my work would pile up but I was always busy, always very busy.

**Tara:** I played 3 sports in HS: I tried volleyball, swimming, and softball. I stress fractured my back and foot senior year. Made things I think I did better academically injuries didn't affect school. I was in 4-H for 10 years. I did photography showed pigs, goats, chickens, and rabbits. I had an opportunity to take electrical things but I didn't do it. HS I was the captain of the swimming dive team, captain of softball.

**Expectations for college attendance.** Having a college education was considered important and expected by these women's parents for various reasons. The participants reported that parents wanted occupational prospects for their daughters that would offer financial stability. Parents wanted to offer opportunities afforded to those who went to college and for which they could not have. Parents recognized talent in their daughters and believed college provided the best use of these talents. In some cases, the expectation for college attendance was initiated by the student's desire to attain a particular career field that required college. In many cases college-going expectations were initiated by the parents, participants explained they had no choice because their parents insisted they go to college. Several women shared the sources of their college-going expectations:

**Amy:** My parents had always told me that I would go to college. They didn't really specific or care where. They preferred it to be in-state, but that was their only preference.

**Anna:** No matter what she [mom] had to do; no matter what we had to do; we were going to college. There was never an option of not going to college for me.

**Alexis:** My parents were really gun hoe about going to college even my grandmother was like you're going to Midwest University, right; even in elementary school always go to Midwest University. I've always known I wanted to go.

**Sophia:** They [parents] wanted me to get a good education and go to college. I was supposed to get good grades on track to go to college….My mom was always pushing me to go to college but after that it was more myself pushing myself because I thought that was a good path to go to.

**Tara:** I always knew I was going to college; it was a big thing. Both my parents didn't go; so they were like really pushing for my sister and I, both, to go.

**Eliza**: It was somewhat of an expectation because they never went and finished so they wanted us to do better than what they were doing you know don't be like us don't live pay check to paycheck. You want to be better. It was still our decision but for me I always knew yes I do want to go to college and make a better life for myself.

**Stephanie:** I was always pushed toward--you need to go to college especially with this day and age my parents knew to get anywhere you need a college education so that was always the goal they set up in my mind at a very early age;

> so I was always aiming toward college. I knew that to get into a good college I had to do really well in high school. so I always kept myself-in HS we had an academic top 20- so I always kept myself on that list by always doing really well in my schoolwork and I also wanted to very involved I knew when you applied to college it wasn't just academic you needed to also do everything else. I got involved in leadership whenever I had free time.

For one of the participants college was not a family or community expectation. Alexandra shared, with some frustration, how challenging it was to push ahead. She talked about a future that she did not want to accept.

> **Alexandra:** [College] That was probably something that wasn't going to happen. If it was going to happen it would be some miraculous thing that caused it. It pretty much was not even laid out as an option. [It was not going to happen due to financial issues] and then probably just because it was never really emphasized in either of their [parents'] families. It just wasn't something that we did. Everybody graduating high school [that] was expected but after that you got a job and you worked *forever*.

**Roles in the family.** The participants played an important role in their families. They advocated for their siblings, modeled successful student behavior, offered assistance with studies, gave advice, and envisioned a more comfortable life for themselves. The women were committed to being positive influences in their families. When faced with challenges, their family role expectation was a factor in their persistence. They considered how their decisions would affect siblings, parents, and extended family.

**Erica:** For a long time it was internal [motivation]…but then at that point from middle school forward [due to sibling struggles] I have to do it for my mom; so I have to do it for them [my family].

**Selena**: If my siblings need help I'm the one they (parents) refer to… A lot of expectations… Sometimes it's a burden, sometimes not.

**Stephanie:** When people can look at you and see how successful you are and see what you did to become successful - your path- that's something that really means a lot to me… I wanted a better future for myself. I wanted essentially a better future for my future family too.

**Suzanne:** My motivation is my family…. I felt if I didn't achieve [a degree] it's like failing them too because that's what they want for me. First year was so bad; my motivation was I couldn't accept failure…. So I just kept pressing on and made myself keep trying harder (Group discussion, January 29, 2015)

## Influential Relationships

Research participants noted several relationships that were influential to their major decision making in different ways. These relationships included those with parents, teachers, and school advisors, and program leaders.

**Parents.** Parents played a significant role in the women's education. Parents served as the first ambassadors of STEM. They nurtured the women's early STEM-related interests. The women reported sharing home activities with parents, such as watching educational television shows, reading enriching books, and playing with science–related toys and equipment. Parents provided opportunities for exploration on vacations or at local museums; families participated in community programs together. Parents encouraged and advised the women; often recognizing and fostering their academic abilities. Parents helped when they were able; however, most of the women did not need help with their studies through high school. Parents served as motivators for the women to strive for excellence. The parents wanted their children to reach their potential and gain opportunities the parents often did not have. Moreover, the women frequently recognized their parents' wishes and they worked hard to make their parents proud. Extended family also played a supporting role for some as role models and cheerleaders.

> **Tiffany:** Actually I was still under the impression that an engineer was the person who drove the train. I don't know why it was probably because I was so strong in math and science and really not anywhere else and my mom realized more that I would have a really hard time in medicine. Even if I could make it, it would be something I wouldn't enjoy in the end. That it just wasn't for me.

**Elena:** I always did my work. I didn't think it was an option not to get the work done. I think it comes from my parents-go do it…. Yeah I didn't want to disappoint--[that] was a big thing because I really loved them [parents]. I always tried to be the best.

**Emma:** They [Parents] always kind of encouraged me to do what I wanted. It was go to school. My parents instilled in me to always do well I got in trouble for Bs when I was younger I feel bad if I do worse than an A. Tech026 My grandma would talk about different cousins who graduated- this is a good major --it made money that was her thing…. My parents were I kind of thought I would do engineering so they ok go with this it will work out so many broad opportunities with engineering and then I don't really know who influenced me--everybody kind of talked about it senior year. But it was not like you must choose this or you will not be successful.

**Teachers**. In the early grades the women enjoyed their teachers and had helpful relationships for the most part. In contrast, a few women had decidedly negative experiences with a few teachers; the women took the interactions with the 'problematic' teachers in stride often with support of family. Favored teachers in middle school typically taught science and provided opportunities for hands-on learning in the classroom. In many cases, it was the high school teachers who directly influenced these women to pursue STEM majors. Teachers recognized the women's talents and encouraged them to reach their potential. In most cases the teachers fostered learning and positive outlooks for education.

**Sophia:** I knew I liked science in elementary school but in middle school I went to biology. There was a professor that really made it appealing to me when we were learning about cell biology and ever since I was talking to him about it; what you could do, the possibilities, the pathways you can take. That's when I actually got sucked in to biology.

**Amy:** There were countless teachers that were really passionate about what they were doing, their school system, they're really supportive. I was the [yearbook] editor and then our advisor … he looked over all my applications, all my essays, I got pretty good at the end … but I could not have gotten there without him. And it's funny because he was a chemistry teacher and I went into chemistry thinking that I would hate it and that it would be the hardest class and he really challenged me, he was still--he still believed in everybody at the same time. He was a really good teacher, really great.

**Andrea:** [In HS I wanted to apply for a camp for veterinary medicine.] One of my teachers in HS, helped me with it--she's still a mentor to me--when she found out I got [accepted] she gave me a monetary donation to pay for it. She's been my number one cheerleader. We still email…. I was a shy kid. There was this one teacher who I really didn't like because she was kind of mean. But she said this one thing that resonates with me. She said she used to be a shy kid. And she forced herself to talk to people and engage in different opportunities and that made her more outgoing and extraverted. At the time I was whatever. But in HS I started thinking about that. I should start putting myself in opportunities--I don't

want to be shy for the rest of my life. And now I'm not shy but I used to be a really shy kid.

**Stephanie:** I have two. I had my freshman year biology teacher--he really got me into biology and I had my environmental science teacher in junior and senior year. He really got me [saying] 'yes I really want to do science. It's interesting to me.' That's what got me into the career path that I am on now. They would always challenge me and made me realize that there's always more to science and that what I really enjoy. It's not a stagnant field to go into. It's always changing. There's always more to find. That's something that I really took to heart and that really stuck with me that there's always more to know…. I would come in and we would talk and just having that personal bond with him was nice because it made science more real. So it made me think that ok I can do this. He just really sparked my interest in the study of biology. [My] environmental science [teacher] again we had the same bond, junior and senior year.

**Elena:** My physics teacher was really influential for my college decisions. I remember I wasn't very good in that class either. I did about as well as my math classes because [physics] is so math based…. and so if I did poorly--I would stay after either catch up somehow- one day I was talking to him [and another teacher]…they asked me what I was going to do in school and I said maybe I'll go to art school--maybe I'll do something in science and math and he's like I think you can do it…. At first I thought it was crazy. But then I started to think about it over the next couple of days and I was taking it as a challenge because I knew I was bad at math and I wasn't great at physics. I should do this. I'm going to prove

everyone wrong--I can do this. But as far as picking engineering um nothing in particular except my physics teacher to be honest. He planted that seed and so then after that I found more reasons for myself to do it.

**Emma:** I've always been a good student so I usually get close with my teachers and that helped a lot with where I should go. [I] always have a strong mentor. I always ask a lot of people what they think because I feel that helps me make my final decisions. My precalc [pre-calculus] teacher [said] 'I think you should try it (environmental engineering) because there aren't enough women in it and there's a really cool program for you to at least see if you like it.' I was open to her advice. She encouraged me to go to engineering *and I would not have gone if someone didn't [ask me]*.

**School Advisors and Program Leaders.** These influential others: parents of other students, coaches, teachers in their roles as club leaders, and counselors informed the women about opportunities for campus visits and pre-college STEM-related initiatives. They offered information about college admissions, scholarships, and details about specific majors. These advisors and program leaders encouraged and guided the women; they were available to lend an ear while the women made countless decisions affecting their futures.

**Angela:** One of the biggest influences in me heading toward here [college] was a sponsor. She wasn't my teacher; she was another chemistry teacher…and also the sponsor for the chemistry/environmental awareness club and so we would do projects with community outreach and teach kids about science experiments.

**Eliza:** I was definitely challenged [by my counselor]. She was assigned to me. She came from the same background as me so she knew that I was driven. She wanted to help me more and I felt like she was actually just very there for me; always checking to see if I was meeting these deadlines and doing this. So she stayed on top of what I was doing. She was telling me 'yes, I think you should be in engineering because your scores are strong and this and that.' And then she pointed out that this was a good school….

**Samantha:** I had a really good mentor in 8th grade. He was my national honors society, cross country coach, science teacher. He again expected a lot out of us…. He was in every aspect of my life and in science too. He pushed me in science; he pushed me in honors society.

**Erin:** [In] first robotics--[I talked] to some of the engineers on the team who were parents and mentors. A lot of them would invite me over for dinner and we'd talk for hours and then he [my mentor] sat me down; alright what do you want to do? I want to be a leader at one point but I'm also interested in engineering because I want to do something along those fields…. He explained to me… how you can work your way up. And people who want to remain engineers they can remain. That was definitely one of talks that made me realize...oh yeah engineers can be leaders too. Laugh

While all of the women had positive experiences and generally were encouraged by the educational community, there were times when they had to overcome the negative attitudes of some educators. Due to the positive support from parents and influential

others coupled with their own determination, these women did not allow naysayers to stall their ambitions.

> **Alexandra:** [This counselor's attitude was] if you're grades are bad you must either come from a bad family or you're stupid… that was just the attitude, like, surely you couldn't do better if we gave you more resources, that wasn't even like a thought to them.

The women frequently mentioned how grateful they were for the praise and guidance they received from all their supporters. These relationships and future relationships would continue to help them along their academic journeys.

**Transitions to College**

The participants in this study described that their families began serious conversations about college attendance at two junctures: nine of the women (36%) had conversations during eighth grade when the schools presented information about state-funded scholarships and all had conversations during high school, typically during junior/senior years when preparing for college was focused on at school. Additionally, some of the programs the women attended, such as 4-H and university sponsored summer camps, disseminated college information and offered college visits. These conversations typically included criteria for choosing a college, for example in-state vs. out-of state, and deciding college majors related to employment expectations. Family discussions about applying to colleges often took place after the women did preliminary research; in many cases the students initiated and followed through with the college application process on their own. Moreover, discussions focused on finances and the family and student

contributions needed for college attendance. These women applied to several colleges and declared their majors, mindful of their interests and options. While immersed in this selection process, they also applied for numerous scholarships and played a significant role in securing financial aid.

**Choosing college and major.** Ten of the women in this study came to Midwest University and chose their major based on prior experience on campus gained through pre-college programming, such as Women in Engineering. The women attended sessions on campus and were exposed to science and engineering majors and career fields. Due to strong organization affiliations with the institution, women involved in 4-H heard about Midwest University often and participated in community events sponsored by the College of Agriculture. Thus for many, Midwest University was familiar territory. Additionally, Midwest University was selected for its reputation and rankings in the STEM areas being studied.

A few women began with one major in mind and switched to another. Although uncertain about their decisions at the time, they now felt they found the field that best reflected their talents and career objectives. Another consideration was proximity to family. For many, maintaining family ties was important; especially those women with younger siblings. It was important to experience the independence of living away from home without venturing too far away so frequent visits were possible. On the other hand, being so accessible to family can also detract from studies and college activities. One more issue for these women to consider.

The women discussed their decision-making processes related to college and major selection:

**Amy:** And so I came [here] knowing there were a lot of options…. It's kind of funny because I didn't really like Midwest University, and I didn't really want to go but I knew they had the most admirable agriculture programs….

**Erin:** It was really hard to decide between business and engineering. Business because I'm a people person and really outgoing and I wanted to be a leader. At the same time I really liked math and science so I thought I could combine my leadership skills and outgoing skills and be a super social engineer…. My senior year I went to [a] Women in Engineering program here and they talked about the different types of engineering.

**Ellie:** I had no clue [where I wanted to go]. I applied to different colleges and my major was going to be decided by whatever college I went to- honestly. Looking at what the school was best for….But the basic ideas, concepts, learning to think like an engineer type of thing and then we had a lot of colleges come to talk to the students at the academy so I went to a couple where they talked a lot about engineering.

**Emma:** Definitely the session [here was influential.] I didn't have the money [for out-of-state tuition] and I wanted to take advantage of the [in-state] scholarship and I wanted to do engineering and I was pretty confident that I would get in…. [My parents] were ecstatic my dad was a little worried about me going into journalism so [going] into engineering [he was pleased.] He worried about the [lack of] money in journalism…. Probably equally important was the program. Important aspects --the person presenting explained how [engineering] helped so many people. I felt like I could really make a difference that was important to me.

**Erica:** My issue is robotics. I love the building but I love the programming… But the building, we had a machine shop at our career center it was amazing and I loved it cause it was hands on. So I figured if I got it [degree] I could build and program and do maybe a little bio with mechanical. They had girl days introducing girls to engineering… So being in robotics I heard the name Midwest University a billion times. Junior year robotics loved it, breathed it, and lived it in my veins. I just couldn't imagine doing anything else after what I had been through with robotics. I had been here. I loved the campus. I had talked to people seemed to fit me and it gave me the most money to come here. It all fell into place.

**Stephanie:** So we come to here [for a campus visit]; it felt great. It felt like home. I felt like I could be here, I belonged here…

**Eliza:** Talking to the people in Minority Engineering Program that was kind of like the solidification for me to go into…engineering….I received the letter that I got accepted… and all the financial things that their giving me… On to Midwest University...

**Sophia:** There was other family situations that happened that required me to go home almost every weekend [from other college]. So then after that I lost--I couldn't juggle everything anymore so I ended up having to drop out of Other University and then move back home. After that I knew I still wanted to do biology, I knew I still wanted to go to school and I wasn't just not going to go to school so I went to the community college near my house. And at that point I got a job; I was living with my mom; I was going to school and helping them out. So

I did all that. [She left home and transferred to Midwest University her junior year].

**Tiffany:** It just made sense for me to start thinking about Midwest University because that's where I discovered engineering and [it] is such a good school in it and there also is the highest women majority so I wouldn't feel like an outsider. A month shy of graduation I got the second letter saying that I was denied in engineering but was accepted to the university and offered a spot in either undecided or the college of technology…. So when I first got the news my mom was the only reason I ended up in engineering technology. I was dead set on going undecided and declaring engineering after and I wouldn't have made it. I would have ended up dropping out of college and so I was so upset and now I could not imagine (doing something else).

**Amanda:** I originally entered [a different college] in pre-dentistry. That's where I planned to stay, got in, started and was there for two years. Then I decided that I didn't want to do it… I really started looking into something to do with the ocean or fish and I found [the program here] I just started researching marine...anything close to marine biology and I wanted to stay in-state because I knew going to the coast for marine biology was way too expensive… I looked at the curriculum….that's what sparked my interest.

One participant's suggestion for streamlining the transfer process:

**Alexandra:** I feel like there should've been …a kind of be a go-between between the two colleges to kind of say here's what makes it easier to transition from one

to the other, or things you might consider if you're thinking about transitioning from one to the other.

**Application processes for college entry.** As these women were applying for colleges, two factors were commonplace: considering the financial requirements of the application process and searching and completing the process independently. Applying to college costs money. The cost associated with college applications was a factor in their college choices. Some were strategic and took advantage of college week initiatives when fees were waived although not all colleges of interest were included in the promotion. Others qualified for financial waivers. Most carefully considered their chances of getting into a particular college, in-state status, and potential scholarship monies awarded before digging into their college application budgets. In addition to applying to multiple universities, they also were responsible for scholarship applications and going through the financial aid process. The women had varied levels of support for applying to college. Some guidance was offered through the college prep programs in their high schools, a few teachers assisted with the process, parents were encouraging yet mostly without the practical knowledge to lead the process. A couple of parents worked together with their daughters; learning the process together.

**Anna:** Just my mom and I sitting in I would go to her work and we would have 3 or 4 nights where we just marathoner as many applications as we could and as many scholarship application.., .and I've been fortunate enough that I've gotten at least one scholarship every semester I've been here

The women were strategic as they applied to colleges:

> **Amy:** I knew what days to apply; I knew that there about 80 to 100 bucks. And then as far as applications go, I had all my--I remember there being one week free that you could apply to all these colleges, and those were the main colleges that I applied to. [There were] a couple of others that I applied to; they just had a free application fee so I just threw my application in there. Accepted into all schools applied] Yeah, I did. Which was nice.
>
> **Stephanie:** I applied to 10 other schools. I would beg my parents [for application fees] because they're 50-75 dollars. Any ones that were [$] 100 I would not apply; if they were $50.00 I was cleared for the 50s. The $75.00 [ones], I'd be 'please I really want to go I think I'd have a good chance of going.'
>
> **Samantha:** My parents said that they were going to--they were only going to let me apply to two places. I had to stay in state because they knew, [I] guess they did research but they didn't tell me. They said 'Indiana has good college[s] so you don't need to leave' and 'she was only going to let me apply to two.' That was fine. I wasn't scared about getting denied so that was fine with me.

The women talked about applying for financial aid and scholarships:

> **Stephanie:** Another pressure I had with that was scholarships. My mom said 'if you don't get any scholarships you're not going to college.' I was always in the guidance office every week pulling all the new scholarships they put up. They'd get about 10-20 new ones each week and I would pull the ones I would be qualified for and pull them out.

**Angela:** The financial aid process was probably was most difficult….I think just the process of getting into college is the hardest part (laughs) making sure that you get everything turned in on time. And you're ready to go and then once you get there it's like now what.

**Erin:** I took the initiative. My parents expected me to do it they knew that I would. I applied to over 75 scholarships. So at first 20 I got turned down. Then I won [a large scholarship] but then 2 weeks later [an even larger award. All expenses included.]

**Ellie:** I was definitely already looking into what scholarships I could try to get…. My parents tried their best to help. It was definitely something that's a foreign language to people who never went to college. I submitted my applications really early in comparison to my friends...For some reason I was really excited about it. So I was super excited about having a brand new lifestyle. I love changes in my life and having new environments and stuff so I guess that's probably why.

**Getting accepted and financial considerations.** Twenty of the women in this study received their college acceptance letters as expected. Three women were not accepted into their preferred major but offered a place in the university as undecided or with other options. Two women started in non-STEM majors. Three women transferred from other institutions. Parents were supportive and proud of their daughters' initiative and acceptance into college. However financial concerns, for parents and students, loomed large. Even though parents encouraged and in most cases expected the women to attend college, these expectations did not always come with needed financial support.

Although students' financial concerns as they were choosing and applying to colleges varied; the lack of funds was a significant factor in their decision-making. Students' financial concerns included:

(a) watching parents struggle financially and not wanting to add to their burden;

(b) considering their siblings' college future –"so I need to take care of myself;"

(c) applying only to colleges that had a free application process;

(d) needing scholarship money and loans to attend college;

(e) knowing that in some cases the parents would be able to help; however, the student debt that accrued during college would be their responsibility.

These concerns often led to these students spending countless hours researching scholarships, filling out applications, writing essays, and doing volunteer work to bolster their scholarship chances. Eight women worked for pay in high school to put aside money for college. Many of the participants worked an average of 15 hours per week during the school year and worked full time during the summer. While most of the women worked with college expenses in mind, a few worked for spending money, while others were not permitted to work during high school due to family philosophies and time constraints related to extra-curricular activities. Financial considerations were paramount when choosing which college to attend. The cost of tuition (in-state vs. out-of state), financial aid packages, specialty funding (state and university sponsored funding), and scholarships awarded influenced final college decisions. Financial constraints did limit college options for these women and would continue to be a source of stress and concern once on campus. Due to the efforts and diligence of these women several were awarded scholarships. Where scholarships were non-existent or insufficient loans were required.

Although students worried about student loan debt, the consensus was that the cost of attending college was worth the future benefit of the degree conferred and the personal growth attained during the college experience. The women discussed the family stresses associated with college expenses and how they moved forward to be able to attend college via grants, scholarships, loans, and personal and family contributions:

> **Amy:** But the big thing that they really- that my parents and my family really stressed was funding because it was going to be all independent- I would also be responsible for that. It was really hard, honestly. I was angry for a little while, but I got over it really quick.
>
> **Angela:** Everyone was stressed about putting down their tax information and stuff. They were like why can't you just go to a junior college and then go from there…. They (Parents) were very concerned so it took me researching on my own how much money can I get from this university and my freshman year actually almost completely paid for in grants and the rest was in federal loans--so I didn't have to take any outside bank loans or anything. [The debt] …does [bother me] a little bit until I talk to other people and they say oh I have way more loans than that. Cause I actually checked how many loans do I have and then I look at even if like the job I'm heading towards doesn't really have a big income expectancy and that's fine with me. It's enough that I will be able to pay it off within 20 years hopefully…
>
> **Stephanie:** You need to do something…so our financial burden is lessened…It was a lot of stress with scholarships; a lot of them are nationwide. Can I compete at a nationwide level? Am I good enough to win these scholarships? …that's a

scary thing to think about when you are just turning in an application. So that was a lot of pressure on me because this is my dream but there is a chance that I won't get it…because if you didn't go to college in [my community] you stayed and worked at McDonald's - you were poor. It's a scary reality that I could see and I didn't want that. I got a full ride with all mine. I got a presidential scholarship a few governmental grants and then the scholarships I applied for. I came within 2 dollars of having a full ride. (sigh of relief). [The scholarships] were merit and need based…

**Alexis:** Basically my parents told me 'our name is on the student loan' but I'm paying for everything; I'm paying them back. I'm fine with it. My mom had to pay for hers so I didn't expect them to pay for all of my education. I'm getting old enough now I can start helping out so I never had a problem with that. My mind was thinking scholarships!

**Erin:** So I worked at the internship but my senior year -my parents can't help me pay for college they just don't have the money so at one point I had 3 part time jobs

**Sophia:** ... I had grants and scholarships…so my school was covered. What the issue was rent and everything else….I ended up working and managed my money really well.

**Eliza:** [Going in-state] It was a large factor because I didn't want to take out a lot of student loans and I prided myself on being debt free; so going here I could save some money. [My parents] …had to pay just $1000.00 a semester. We could do that but having to pay back $40,000 I didn't want to do it. I'm very organized I

wrote everything down, for example, costs for my books, and I saved some of the money. I haven't had any loans yet. I had an internship so I've been saving money; moved off campus to save money.

**Amanda:** I think my parents had always planned to help as much as they could and then get student loans.

**Elena:** …We haven't taken out any loans. I used my savings and my brother's savings so then when I graduate I'm going to help him pay for his college if my brother even goes to college. My grandmas…help pay for my groceries and daily things. Everyone's helping out a little bit.

**Erica:** .... If I did not have the scholarships, I would not be going to college. Through high school I did not know about the [scholarships] so I was working. I started 15 1/2 hours a week and I saved everything to make sure I could go to college. I have a job. I was afraid I was going to be working full time in college so I was working in HS--I worked [seasonal jobs for a few weeks] 40 hours a week, it was awful. [I] had to step up my game [grade wise].

Nevertheless, given all these complications, the prospect of attending college was exhilarating, albeit intimidating for these women. Moreover attending college was the beginning of new challenges and triumphs.

## College Experience

In this section I describe participants' college experiences including their: (a) perspectives about being first in their family to attend college (b) academic integration, (c) social integration, (d) influential relationships, (e) financial considerations, and (f) after graduation plans.

### Being First

Being first in the family to go to college was seen as an honor for these women. Attending college was an opportunity to contribute to the family and be a role model for siblings and sometimes extended family. For these students the process of earning their degrees was layered with doubts and feelings of inadequacy; however their concerns that they would let their families down and disappoint them often outweighed any thoughts of not completing college. Since attending college would not be possible without financial support (scholarships, loans, parents' contribution) participants were appreciative and considered attending college a privilege they could not squander. These women faced a myriad of obstacles intrinsic with a college landscape that was unfamiliar to them. Preparing and applying for college in high school, navigating course rigor, and trying to settle in to the campus community was challenging. Moreover, more than half of the participants were still concerned and involved with family members and responsibilities at home. These women drew on past experiences, strategic social support, and a can do attitude to persist and progress toward their goals.

Although a couple of women did not think being first in their family to go to college was a factor in their struggles, most of the women acknowledged that being

FGCW contributed to their unsettledness and the sense that they were "drowning" in all that was expected, yet unanticipated. The women's perceptions were that compared to non-FGCS they were: more unfamiliar with academic expectations, clueless regarding the social landscape of campus, disadvantaged financially, and tasked with educating their parents about college grading systems. These challenges were in addition to their personal upheavals as they acclimated to living on their own for the first time. Even so, these women persisted with optimism. The women discussed the advantages of having parents who attended college:

> **Samantha:** I don't know how to explain it. I wasn't raised as a college student because my parents didn't have that experience and they weren't able to give me insights. A lot of kids whose parents went to college they were raised like a college student. Just having it in the back of your head; this is where you will be eventually. I didn't have that.
>
> **Eliza:** [People whose parents had already been to college] they knew what to expect and what to do. [For example] I thought an internship would just be given to you. I didn't know you had to go thru these interviews, this competition just to get internships and I realized that my first year and that was very intimidating... *I felt like maybe I wasn't as prepared as other students and that pushed me to try to get it even though I didn't get one that year.*
>
> **Sydney:** My parents are super supportive but I feel they don't understand.... Being first generation comes with a lot of pressure. My family is super proud of me...but they don't understand my struggles through college and whether or not their expectations are realistic.

**Tiffany:** I feel like I'm learning how to do college. I feel like by the time I graduate I'll probably have a better idea but also a better idea of how to do life.

Many parents did not understand the college grading systems and were expecting their daughters to get grades that were similar to their high school academic performance. The women had to deal with their parents' concerns and help them redefine 'acceptable' grades.

**Tara:** When I got my first D, I was like guys-I studied my butt off for this but I just couldn't get it. So it's kind of hard for them to grasp- you did so well in HS how come you're not doing so well in college. *They really don't understand.*

**Erica:** I feel accomplished. I know it's not just for me because my family was always poor so more like they couldn't afford to go to college so I feel like I'm changing the status of our family, our whole family…. I do feel pressured because now it's not about like in elementary school; my parents if I got a B they [would] laugh it off. Now it's like OMG Erica- what are you doing?

**Alexis:** It's hard sometimes because you have to explain to your parents all this stuff: why aren't you doing better… It's hard at times because you are the first one; so you feel nobody understands what you're going thru at home. *[Felt] overwhelmed a lot freshman year: school, work, time management and everything in life.*

**Shannon:** For me, I have a big family 14 children...I am still the only one going toward a degree. I want my career to help my family. I can't let them know that I'm struggling. Usually I don't show my mom my grades.

Financial concerns were salient for these women. The majority of the women came from families who struggled economically.

> **Ellie:** I feel like I struggle with being a FGCS with not being able to go to my parents directly for input on a certain situation…. and *being a low income college student having to worry about how much is in my bank account [is a struggle]*.
>
> **Anna*:*** One of the most glaring, obvious things is that [non-FGCS] parents have a higher income. So a lot of people that I have surrounded myself with their parents all gone to college and all of them have everything paid for… one of the things that has been really difficult: having to be more financially responsible because school…by itself is hard enough but having to worry about school and financial issues has been really hard for me-but I've done it-I've been ok….
>
> **Angela:** Around the college community I feel people [non-FGCS] are usually a little bit better off financially before they come into college. So it's a lot more common for people to have their apartments paid for their college sometimes completely paid for…. That is unimaginable like nobody in my community back home would ever be able to do that. *So I feel like they have the advantage at least financially and then knowing about different college opportunities.* I definitely there is an advantage for people who come from second generations or further that went to college over first-generation because you don't know about it and it's scary to think that it's so expensive.

The women had the added responsibility of being a role model for siblings. Sophia sums up how many of the women felt when they first came to college.

> **Sophia:** I am a role model--I expect [siblings] to go to college. Well they always saw that I was trying my hardest to go to school and get good grades but they also saw that I cared about them because I would take care of them after school…. It's like you have a burden but not really it's hard- you feel like there is not really a guide, someone there to guide you. *I feel like you're in a dark room and your having to guide yourself.*

Although Amy felt clueless, she did not attribute her lack of knowledge about campus life to her first-generation status.

> **Amy:** I think if anything I just felt more clueless coming into it, but I don't think it's really impacted how I gauge my ability or how I think of- I don't think I compare myself with my peers based on whether my parents went there or their parents did or didn't. Clueless about just what to expect…,

**Academic Integration**

In high school, the participants' excelled in classes, adapted to class rigor, and maintained high standards. They were leaders and had close relationships with teachers and adult leaders. Who they were as students was challenged once they entered college. They were not prepared for the academic rigor of college STEM courses, competitive grading schemes, and large class sizes—what worked in high school was now insufficient. Maintaining good grades and graduating on time was college life or death for these women. Their scholarships required maintaining minimum GPAs and provided funding for four years. This timeline does not allow much flexibility in terms of changing majors, retaking classes, or taking a reduced course load. After the initial shock and once

these women realized they were slipping grade-wise they began making changes, some reacted more quickly than others but in the end they rose to the occasion. They became strategic; prioritizing course importance relative to their degree, reassessing what was acceptable for their goals, and adjusting or retaking courses. They also took action. They made modifications in their study habits: spending more time studying, trying different techniques, getting extra help: reaching out to students and faculty, attending help sessions and enlisting tutors. Their adjustments paid off; grades and GPAs improved. Yet, these adjustments came with a price- less time for family and friends, work, and sleep.

The difficulty of the college courses was unexpected given these women's top academic status in high school:

> **Stephanie:** I went in with the same study habits that I had in HS and it kicked me… Back then in HS it was just rote memorization and you were fine. *First semester was a slap in the face.* I was highly ranked in high school so you get that mindset I'm pretty smart... You get to college and everyone's on the same page because you weeded out everyone else already and this is a top ranked school....Second semester I retook my chemistry class because I got a C first semester and I didn't want that on my transcript.
>
> **Tiffany:** I'm not doing as well as I would like. I came to college with a dream of making honor role and being AB student nonstop. I wouldn't characterize myself as doing poorly but I'm not living up to my dream for myself. I'm more falling just a little bit short.

> **Eliza:** …When I failed my first exam and that was very surprising; actually an eye-opener for me coming from not having to put in all that extra work and hours of studying. It was very eye-opening 'you can't keep doing that Eliza because you're not going to go anywhere with those types of grades.' So that was a good shocker for me. Pushed me to be better; got more resources, tutors, put in extra hours to study... My friends that I took the class with, we always compared scores and they did better than me. I was kind of embarrassed-'what did I do wrong?'

The women experienced stress and doubt during those early semesters:

> **Alexis:** [I'm] tired of being stressed out about my classes and grades I understand I'm, I don't mind being at college; I really feel when I do my best it's not good enough here. It's like a confidence debooster. In HS I didn't have this much problem. Here I'm struggling, I'm trying my best; I'm trying to get help. It doesn't seem enough; so it's really frustrating when the best I'm giving isn't good enough.
>
> **Samantha:** Especially in college, [I had no] studying habits. I had to really dig deep and figure out how to [study]. I wasn't in the learning community, I wasn't in anything. Maybe I wasn't aware. But I feel like [the university] didn't really… maybe they said learning community and I didn't know what that was so I didn't even know what they were talking about.

Amanda's reappraisal of what constituted acceptable grades in college coursework was a common practice among the women.

**Amanda:** I feel like I was that way [wanting best grades] in elementary school, but once I started to get lower grades it was ok. Some things you're not going to be perfect at, some things you are and I think it's more important to excel at what's going toward your goal, like calculus - I knew that I wasn't going to do that great so I focused more on my other classes. I still was focused on calculus because I still had to pass.

**Erica:** I barely did anything I felt so drowned in work…. Still so hard to get an A; so there goes my bubble that I had built up all of HS…. It's still a goal to get an A even though it feels impossible. I took 18 ½. I didn't learn my lesson not until this year. I took 16 credits this year. I don't have a choice to have anything lower than 16 because of my major… It seems better now that I know I had to do better time management.

**Emily:** Very challenging math department grading. Everything here is on a bell curve. So you're never tested relative to some absolute standard; you're always tested relative to the rest of the students in your class….especially as a first generation college student it was hard for me to figure out how to succeed in math because you only beat the [person] next to you… so that was really challenging. I never really did well in math here but I do like math.

For the most part, once parents understood that college coursework was more difficult than high school, they were accepting and encouraging of their daughters academic struggles.

**Samantha:** I took physics, the engineering physics here and that's when I got the C. It was miserable. The class was miserable like I think if I took it now it would

> be a different story because I know I can do things but I have to come at it the right way. Freshman year, after the first exam I got a 40%. 'I can't do this.' …that wasn't me…my parents accepted it and so I accepted it. They [said], 'We all have like rough parts of our life. Maybe physics is just the rough part of your life- get done with it and move on. I went to the help room three times a week probably. I tried. I passed both of the classes. Not how I wanted but I got over it….I just went forward and did it.

Many students would not have survived the disappointment and frustration experienced by Anna. On a positive note, all of the women found people, faculty and staff who advocated and mentored them. However, too many interacted with faculty and advisors who were dismissive.

> **Anna:** We walked in and I was sitting there; naive little me sitting in the front row. "Half of you won't be here by the last time you can withdraw from the class...half of the people who stay are going to fail." I had never been told anything like that before…. I had taken the first exam and I just bombed it. I studied I got a tutor and had these pneumonic devices. I really felt confident going into the exam and when I got it back, "this is a horrible result." [Talked to professor] "This is how long I studied and this is what I did. Do you have any advice about what I need to focus on to study?" Professor replied, "You're just not smart enough and you need to leave my class."

This was a required class for Anna's major. Although completely shocked by the professor's response, she persevered and continued in the course.

**Social Integration**

Researchers have touted the importance of college social integration for increased student retention. For example, joining organizations and being part of a learning community increases the students' sense of belonging and aids in college student development (Tinto, 1993). It took these women longer to integrate into the social fabric of the university mainly due to heightened focus on their grades. FGCS, who often are unaware of the benefits of 'joining', are reluctant to lose study time to social activities. Additionally, they may have to work or live off campus for financial reasons, making it more difficult to establish valuable relationships and connections.

It took a while for many of the women to adjust:

> **Anna:** There's not a single other time in your life, until you get dropped off at the college campus, where you have this much ground to cover in a week.
>
> **Alexis:** First year in general was rough - I'm used to being home; I'm very much a homebody. I came home a lot. First semester was definitely really rough I didn't like it all.
>
> **Amy:** I was just- I was kind of shy, really sheltered, didn't know, like these kids came in with all this knowledge about what people in my generation were doing and I had no idea so that was kind of a culture shock.
>
> **Selena:** You spend most of your time studying – [more] than you would expect because people are saying 'I have time to party; college is about partying' -I don't really see that.

A few women embraced college life early:

**Eliza**: I was kind of scared to get out of the car when my parents were dropping me off. Very intimidating lot of people lot of cars people that I didn't know. Once I was able to get into my group [at orientation] I was able to be comfortable and have fun. I felt like the learning community [helped academically and socially]. Since we were all living on that same hall, if I needed help I could just talk two doors down and say can you help me with this homework problem? And at the same time you build friendships so you're able to have people to sit with in your classes and that helped me out.

**Emma:** It felt really good I remember being excited to leave [for college] … I always liked the idea of being independent I guess.

**Angela:** [Excited] The more I learned the more I researched the more I networked with people the more classes I took like when I got into the higher level courses and I was able to experience these professors and their research and different possible fields. There are so many different things out there for me that I didn't know existed.

**Getting involved in college life.** For the most part by mid-sophomore year, these women had a sense that "things were beginning to fall into place" academically. At this point, many had established a work life that was manageable; eighteen of the women worked 10 to 20 hours per week during the semester. The women not working were involved with internships and volunteer opportunities. It was at this juncture that most participated in the more social aspects of college life. Many found that reaching out to others helped them with their studies because they could consult students who were in the

classes and those who already had taken the class. Students from learning communities and professional organizations became peer mentors. Faculty members became champions and advisors; moreover, they provided direct access to undergraduate research experiences and connections for internships. The good news is that these women began to interact during their second and third years- once they were satisfied their grades would not suffer and their time management skills were honed. The decision to integrate with the university culture has been a positive experience for most.

> **Tara:** I didn't join any organizations until my second semester sophomore year…. I got more involved in my major and reassured that I liked my major and it was the right choice; [Getting more involved] helped me meet more people and made this year a lot easier too.
>
> **Amanda:** After coming to Purdue and being more involved I have done a lot better academically.
>
> **Sophia:** When I came here I also decided I was going to get out of my comfort zone. I wanted to get involved with campus before I started to do research because I needed to get a feel for the campus…. Get involved. I think… it's really good to get good grades but I feel getting involved and being around different cultures is better.
>
> **Stephanie:** I always have a rule you do an organization related to your major, one for fun, and something that can get you ahead in the future.
>
> **Ellie:** [Sophomore year]I'm also really involved with my sorority's philanthropy aspect of things which I think brought back my service; that's one of the things I'm passionate about it is really important for me

**Tiffany:** I belong to Female Recruitment and Retention Initiative…we help post events and high school girls come in and learn about engineering and technology… I'm involved with the electric racing team so I'm helping build a car from the ground up which I think is just awesome.

**Research and internships.** Seven of the 15 women in the Agriculture/Sciences group participated in undergraduate research. All who expected to go to graduate school after graduation participated in a research experience.

**Alexandra:** I love research…I want to do this forever. I did … the agriculture center experience program in the summer…I'm doing research, I still work in the labs that I worked with this summer but as a research assistant for pay.

The women from the engineering/technology group focused more on obtaining internships which is standard practice in their fields.

**Tara:** I had never been to a career fair I didn't know if I wanted to go. It helped push you out of your comfort zone; it was really helpful--it was really intimidating [at first].

Last summer had an internship in Phoenix and worked…as operations asst, more of a project management.

**Unexpected opportunities.** Eight of the women found unexpected opportunities at college. By participating in study abroad programs they traveled to places that would be out of reach otherwise. Similar opportunities were offered through internships and volunteer programs.

**Andrea:** Last summer I had an internship with a wedding planner laughed unrelated but it was in the Virgin Islands so it was an opportunity I couldn't pass up.

**Tara:** I joined [a society]; I guess that's been the most unexpected…. Now I'm one of the competition leaders. We went to Chicago. We're going to Reno next semester. I have the chance to go to Nicaragua for the spring competition.

**Gender roles.** The women in Agriculture and Science did not perceive there to be gender role issues related to their courses. Not surprisingly, the women in engineering and technology majors, fields typically dominated by men, observed and experienced stereotypical attitudes from some of their male classmates. Their responses to these attitudes varied.

One of the women initially did not consider her current major an option. She was uncomfortable with the thought of being "surrounded by guys" and not having girl friends in her classes. She was encouraged by a close male friend to give it a try and she courageously put aside her concerns and took the plunge. She is glad she did not let the lack of women deter her because her current major "is the perfect fit for my personality". She is doing well academically and socially and has worthwhile prospects for employment upon graduation. Another woman took the gender issues as a challenge to "prove the boys wrong". She is now treated "as one of the guys" and happily succeeding in her coursework and research experience.

The women discussed their observations and experiences with male classmates:

**Tiffany:** In engineering technology there are… a lot less women; more often than not I'm the only girl in my class and it can be a lecture with 150 people. I took a class this summer and my professor literally called me the token girl… I'm not offended by it -it's just like it is very different and not exactly what I was expecting when I came to Midwest University but I've gotten over it. I've gotten used to it by now. My first semester here, my first class here, I was the only girl in my lab and all the boys sat away from me cause they didn't want to be my lab partner. Now my lab partner from that class is one of my closest guy friends… There was a guy that was sitting closest to me; we were filling out a worksheet and as he was copying my answers off my page. [Then] he asked me if I understood what was going on or if I needed him to explain it and I just looked at him like really? The gender stereotype is real!

**Emma:** My major is pretty unique because there are 50% woman which is amazing because it's so small… When I was a freshman it was really intimidating to be in a room full of almost all men and the girls tended to [sit] together… It felt like…we always ended up doing most of the work if there were all guys… I felt I wasn't doing as well as the guys in my groups; it just seemed so easy to them and I felt maybe I shouldn't be doing this [major]. Some of my friends were guys and I started to see with some of them… [They like] to brag [more than their abilities warranted.]

**Erin:** I personally don't feel [out of place]. I know some classmates [do]… At first I thought it would be kind of weird to be a girl in engineering but after a while, after you take more classes, you find a group of girls….I know for my computer science lab, [guys would say] you don't want the girl on your team because she won't know how to code. One of my [guy] friends said, "When I saw you on my team [I thought] oh crap a

girl.” Overall you do your work so it's fine. He admitted that he had a stereotype of me that I wasn't good.

Alternatively, **Ellie** shared: “I really haven’t experienced difficulty with [gender stereotypes]. I definitely experience more problems with being a FGCS or being a low income college student rather than being a female in engineering.” Although women students were plentiful in their classes, these women noticed many more professors were men.

**Andrea:** In animal science there are a lot of women. I wouldn’t say it's an issue. I feel like life sciences tend to have a lot of females in it. It is kind of limiting when there are a [small] number of female professors in animal sciences. So there's a ton of [female] students but not a lot of female professors.

**Anna:** At Midwest University we have more women in entomology than males. When you get to the upper level [courses]…in the role of professors there are definitely more men. I've seen that in chemistry and biology labs and just that people will trade lab partners to not get the girls.

**Diversity on campus.** I asked the women what was surprising or unexpected related to their college experiences. In particular the women of color expressed their perceptions of diversity around campus. These women commented: [names have been altered]

**Debbie:** There isn’t that much diversity and a lot of people just look at me differently. I also learned I am really proud to be who I am and a lot of people at Midwest University call me Mexican. I get really offended and I never thought I

actually felt that strongly about [it]. Why don't they just say where are you from? Or where is your family from? [Where I'm from] is so diverse when someone tries to talk to you they don't categorize you; they don't say that. It's different.

**Diane:** I think [what's surprising is] diversity. Because at my high school we had basically a blue collar white city so you don't really see many minorities so that really stood out. It's interesting I don't affiliate with minorities because I feel out of place. It's so weird. I think my freshman year in [class], the big lecture hall, the teacher's [said] just talk to random people around you and this girl she started talking Chinese; I don't understand and she felt bad.

**Dana:** In my classes there could be more variety of people. I do see Midwest University is trying to make it better.

**Denise:** The diversity was enormous back East. In my high school year book they put that I was a foreign exchange student (laughing). It was really un-diverse. So that was really shocking and it wasn't fun in that aspect. I love it at Midwest University. I really like it here. I like how there are a lot of international students and kids from all over the country. I felt way more out of place in high school…. But here overall it's still pretty diverse and I like it.

### Influential Relationships

All the relationships developed by the women were central to establishing their sense of campus community. Having the support of their parents and families provided a safety net for these women so it was easier for them to venture out and establish a

campus ‘family’. These relationships fostered the women’s academic success and overall development as college students.

**Parents.** The women acclimated to campus life within varying timeframes. In the same way their parents adjusted to their daughters’ new lives on campus at their own pace. Parents became sources of counsel and encouragement. Parents were cheerleaders, advisors, and initiators. While the women were at college their parents, particularly their mothers, were their emotional anchors. Parents were welcome shelters when storms were rising as the women faced unexpected negativity from others or new and seemingly insurmountable obstacles along their college journeys. When the women were overwhelmed, experiencing shock, doubt, or disappointment, a phone call or a quick trip home infused a sense of calm and motivation as these women took on another day, wading through the seemingly, endless challenges of being a first-generation college woman in STEM.

> **Amy:** My grandma helped me step by step throughout all of it [getting to college]. I still talk to her very frequently and she still asks me about classes and stuff. Oh yeah, she's definitely my cheerleader on this; *definitely*.
>
> **Anna:** It's been hard but there has never been a time when I haven't been able to… come out alive. That's what I need my mom for: 'you did it with physics you can do it with this.' All that information is in the back of my head already and she's just the one who has to reach in and pull it out for me.

**Amber:** Sophomore year I was having a bad day…called mom crying a lot that I couldn't be a grown up and I couldn't live by myself. But she talked me through it...

**Tiffany:** My mom. My mom has always been a get it done kind of person. So I want to make my mom proud and I want to make my dad and my brother proud and all my family 'look you did good'…. My mom literally dragged me through the darkest days and put me on a pedestal when I was at my best. So I don't know who else to credit. I really do think I could not have a better mom…

**Faculty.** Once the women were more comfortable with campus life, they were more apt to go to professors' office hours and seek out opportunities to enhance their career prospects. Professors opened doors for the women; facilitating study abroad programs, summer research experiences and internships. Specifically, the women who planned to attend graduate school were guided and encouraged by their professors. Emma's professor is also her mentor and facilitated her acceptance into an elite summer program. Another professor helped her study abroad. These professors were important role models and advocates for Emma. Many of the women mentioned similar experiences. Alternatively a few of the women commented about the apathy of the faculty toward undergraduates. These few had a general sense that the faculty members were more interested in their research than teaching undergraduates.

**Alexandra:** My professor [at Community College] I don't know what he said to my financial aid advisor because the guy wasn't very helpful and then I told my professor the problems I was having, he went and talked to him, and them my

financial aid advisor fixed it right now. I mean he loved science; he was all about everyone else loving science. He thought that I should do whatever it took to get my degree and do what I wanted.

**Sophia:** My chemistry professor from community college was helpful. I met with her a lot after class and during office hours. I was interested in what she did. She has a PhD in chemistry. We had a good connection; I still talk to her now. She knew I wanted to do research in biology "oh have you looked into Midwest University?" I was like no never really thought… I don't really see my chances getting [in] and she was just apply you never know

**Knowledgeable others.** The women appreciated the accessibility and helpfulness of advisors, club sponsors, and staff.

**Anna:** She's a fantastic woman and I call her my ento mama (entomology mom). She's like a liaison between the students and the professors. I met her at STAR and I've used her as a resource the entire time I've been here.

**Sophia:** [Midwest University] My advisor, I talk to her a lot. I also noticed that the advisors here are a lot more helpful than all the other advisors that I've ever had laugh so I think that makes it a lot easier…

**Ellie:** The summer before college I went to one of my friend's graduation parties and both of her parents were engineers. So I talked to them- what I would be doing? (One of them actually went to Midwest University for engineering) what am I majoring in? She explained to me what I would be doing my first year of college to some extent. 'It's definitely helpful to have a mentor; whether it's

somebody that went to college a year or two ahead of you or for something you are thinking about doing. Talk to those people and see if that's something you see yourself doing'.

**Peers.** Peer relationships were important for academic and social support. The women made various connections and participated in: sororities, clubs, learning communities, volunteer programs, and societies associated with their majors.

**Erin:** I talked to my RA a lot when I was feeling stressed out.

**Emma:** I went to Elite University for the summer. That was my first time out of Indiana. It was awesome. [There were] all these people my age, all these nerds too, (laugh) lots of women there too. [I'm] still friends with a lot of them.

**Financial Responsibilities**

All the women mentioned varied financial concerns associated with college and post college possibilities. Working while in college, maintaining scholarships, dealing with unexpected expenses and mounting student loan debt were existing salient concerns. Furthermore, the women grappled with weighing the merits of continuing their education given the financial costs. In addition to future costs of the advanced degree, finding funds for testing fees, application fees and travel costs was not easy. Balancing work and student life was especially taxing for these women as they were adjusting to the time demands of college.

**Amy:** I didn't work at all freshman year; I just focused on school freshman year. And then starting after, starting the summer between freshman and sophomore I started working during college. I did that for-probably 25 hours a week- easy. I

was on probation, and that was really hard because if I don't work I can't pay for school, and if I can't do school then what's the point of working so it's just this constant battle.

**Anna:** Actually my sophomore year was the first year I ever had an apartment by myself and my mom was really scared because she said I can't help you. If you have a month where you aren't going to make rent-I can't help. Well I'm going to get a good job. So I put in 40 applications for jobs in one day in the greater Lafayette area and I got a job. I'd say the hardest time of my entire life was the first semester of my sophomore year.

**Eliza:** I'm working 20 hours a week during college. It doesn't impact academics; usually work on the weekend and still have time to study and do what I need to do.

For some of the women, accruing student loan debt added additional strain to their already stressful first semesters. For the most part, the women adjusted their thinking and gained a more healthy perspective about college costs. Generally they found value in their college educations.

**Ellie:** It was definitely stressful clicking that button to say I have…debt. Every now and then I wish my parents could contribute a little bit more but it's never been an expectation --it's my education not theirs. I mostly have loans. I am going to have to get a job this semester but that's the first time I've had a job outside of a summer job. I didn't feel like I had the time management skills to do that up until this point in time but by managing your money by not spending as much and that's really harder to do when everybody around you does it. I know that I'm

going to have to be a lot stricter about the way I manage my time over the next couple of months after I get a job.

**Tara:** As long as I get a job when I graduate, that I'm already in debt it is what it is as of right now. I already have a couple of full time job offers. I'm ok- every time I take out another loan its very stressful but in the long run I should have a job; fingers crossed, it's what helps me, this is worth it if you can get it paid off.

**Emma:** This semester I saved enough money so I'm not because I have a heavy course load and I'm applying to grad school but previous semesters my sophomore year it was 20 hours a week. [If money was not an issue, I would live on campus,] definitely. And I would have retaken my GRE…and I would have applied to more grad schools if money wasn't an issue.

**Tiffany:** I definitely was more decisive than some of my friends, I guess, who went to college knowing their parents would pay like my best friend her family taken her through college so she hasn't taken a full course load yet and she's been in college for 3 years…. And I'm not going to have the bulk of loans that I was expecting and I think that's almost why I'm not nervous about it because I was expecting to come out with huge loans anyway that coming out with less than I expected is almost a relief.

**Taylor:** Money was definitely a major factor [for career choice]. I'm pretty lucky that I found a major that is fun and I enjoy, and there's financial security; so I lucked out (group discussion, January 27, 2015).

**After Graduation**

The women in this study discussed their plans for after graduation. Nine of the women planned to attend graduate or professional school and were actively preparing for their objectives by preparing for graduate entrance exams (GRE), completing application processes, inquiring about loans and assistantships, and visiting universities. Five of the women planned to start their careers and were actively job searching. The women who participated in internships hoped to leverage that connection for future employment. One woman wanted to do volunteer work after college and then would decide future plans based on opportunities presented. Ten of the women were also starting their careers; however, they wanted to earn an advanced degree in the future. Financial considerations, current student debt and cost of continued education, were the reasons given for not continuing their education. Six of the ten women wanted future employers to contribute to earning an advanced degree. Table 3 presents the women's after graduation plans per college.

Table 3

| Plans After Graduation | Agriculture | Science | Engineering | Technology |
|---|---|---|---|---|
| Attend Graduate or Professional School | 2 | 4 | 2 | 1 |
| Start Career / currently Job Searching | 1 | 0 | 4 | 0 |
| Start Career but would like to continue education in the future | 4 | 3 | 1 | 2 |
| Volunteer then keeping options open | 1 | 0 | 0 | 0 |

# CHAPTER 5: DISCUSSION

The purpose of this study was to explore the various factors associated with the first-generation college women choosing to attend college, selecting a STEM major, and subsequently persisting to upper level (junior/senior) status. The educational journeys of the women in this study were complex with many interrelated challenges, yet they persisted in their pursuit of STEM baccalaureate degrees. Learning about who they are (e.g., their identities and goals) and how they navigated their academic and career seeking experiences (e.g., building relationships that enable them to accomplish specific aims) can inform educators, policymakers, community leaders, and parents. Armed with this knowledge, these stakeholders as well as other students with similar backgrounds and talents can be recognized and encouraged to prepare for and pursue STEM-related occupations.

In this chapter, I discuss the research findings in the context of the related literature for recruitment and retention of women into STEM, focusing on the experiences of first-generation college students (FGCS).

I discuss the influential factors associated with preparing and choosing STEM majors (i.e., pre-college experiences) and persisting in STEM majors as first-generation college women (FGCW) (i.e., college experiences) as the following research questions were addressed:

1. What individual attributes contributed to the process of (a) preparing, choosing and persisting in college and (b) selecting and persisting in a STEM major?
2. What relationships and experiences do these women perceive to be the *most influential* sources of (a) developing an interest in STEM, (b) choosing a STEM major and, (c) persisting in a STEM major?
3. What challenges did these women encounter along their educational journey and how did they deal with these challenges?

I then discuss five interrelated assertions that respond to my central research question: *What factors influenced the educational journeys for these first-generation college women that resulted in the selection and persistence in a STEM major?*

## Preparing and Choosing STEM Majors as FGCW (RQ 1 & 2)

### STEM Student Identity

In many ways the majority of the participants' pre-college experiences reflect what researchers have found about FGCS in general and about attracting young women to STEM. FGCS are typically from families with lower socio-economic status (SES) (Terenzini, Springer, Yaeger, Pascarella, & Nora 1996). Choy (2001) and Bui (2002) also found FGCS were more likely to be from families in the lowest income quartiles, from Black or Hispanic racial/ethnic populations, and from groups that speak a second

language. Approximately two-thirds or 17 out of 25 women in this study were from families with lower SES, four women (16%) were Black or Hispanic, and two women (8%) spoke a second language.

**Academic preparation.** The women in this study were curious, high achievers who had high GPAs in high school. They enjoyed learning and had strong foundations in mathematics and science. Thirteen participants (52%) indicated their favorite subject in high school was science, often biology related. Eight participants indicated that their favorite subject was mathematics; five of the eight specified calculus. They reported taking advanced placement classes in math and science when available in their high school. As suggested by research, academic preparation, especially in mathematics, increases the likelihood of college enrollment for FGCS (Choy, 2001). Additionally, academic preparation is a key factor for success in a STEM majors. Those who chose to take the advanced math and science courses in high school broadened their opportunities to attend selective universities and enroll in STEM programs (AAUW, 2010; Poirier, et al., 2009). The participants in this study saw themselves as college-goers. They expected to attend selective institutions. Taking the challenging courses helped the participants prepare for admission to selective colleges.

Although the participants fit the FGCS profile in SES, they did not fit the typical FGCS academic profile. The women in this study were admitted to a competitive, STEM program at a selective university; therefore, they were high-achievers. On the other hand, FGCS typically have high school profiles that consist of lower GPAs, lower college entrance exam scores (ACT and/or SAT) and fewer advanced mathematics courses when compared to non-FGCS (Bui, 2002; Choy, 2001; Terenzini et al., 1996). These academic

profiles suggest that the typical FGCS would not gain entry into more selective, STEM programs.

**Extracurricular activities.** The women in this study were involved both in academic and extracurricular activities. All the women except three were involved in sports, music and dance (performing arts), and/or competitive organizations. They were student council and club leaders. The women gained practical experiences related to their college majors through programs, such as 4-H, Robotics and pre-college STEM career exploration camps offered by universities. The women reported gaining strong work ethics, practiced individual and team goal-setting, learned how to deal with winning and losing, and learned discipline by participating in these activities. When difficulties arose, they did not foreclose on their goals. On the contrary, they identified weaknesses and implemented actions to strengthen those areas. They reported trying new strategies or reaching out to knowledgeable others. In general, the women in this study were confident in their abilities and had support from parents and surrogate family members. These results suggest that the women were able to draw from these earlier experiences and relationships and persist in their STEM majors. The results further suggested that the practical, STEM-related opportunities the women experienced increased their interest in STEM career. This finding was consistent with previous research findings that young women need to be exposed to engaging, relevant, and positive science experiences to learn about the various STEM careers and how those careers are relevant to their futures (Hanson, 1996; Maltese & Tai, 2010; Shapiro & Sax, 2011; Thompson & Windschitl, 2005).

## Influential Relationships

**Parents.** For the women in this study, parents played a significant role in their daughters' educational trajectories even though the parents, themselves, did not attend college. All but one woman in the study stated that their parents expressed strong expectations for college attendance. Early studies of FGCS indicated that parents were less encouraging and supportive than non-FGCS parents (Terenzini et al., 1997). However, Saenz et al. (2007) noted that FGCS parents were encouraging and motivated their children to attend college. The women also described sharing experiences with their parents related to nature and design. The participants described scenarios where parents modeled attitudes of persistence in challenging times. These results parallel previous research that suggests that parents who did not attend college can increase their daughters' likelihood of participating in STEM by teaching them to learn from their mistakes and encouraging them to consider activities related to STEM fields (Hill, Corbett, & Rose, 2010; Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008; Turner, 2004).

**Teachers.** Teachers also played a critical role in developing science interests. All the women in this study mentioned positive and negative experiences with mathematics and science teachers. Those negative experiences gave them pause until a new teacher, expressing enthusiasm for the subject, would reaffirm their respective interests. The science majors were specifically influenced by high school science teachers who demonstrated passion and made the topics relevant to the real world. Like the women in this study, many of the women scientists in Maltese and Tai's (2010) study attributed their science interest to engaging teachers. These educators were motivated by a sense of

belonging in a field and an understanding of the relevance of a field to societal contributions (Brickhouse, 2000; Hazari, 2010; London, Rosenthal, Levy & Lobel, 2011).

## Transition to College

**Choosing college and major.** Twenty-three of the twenty-five (92%) women applied to STEM major programs. Two participants initially applied to non-STEM majors, and officially switched to STEM majors during their sophomore year. Several factors contributed to the participants' college selection process. Many considered the ranking and reputation of their colleges' STEM programs. Similar to other FGCS, participants in this study chose colleges that were close to home and that provided financial support offered from the institutions, including in-state scholarships (Saenz et al., 2007). The participants also expressed that the college application processes (admissions, financial aid, and scholarship applications) were time-consuming and costly. Additionally, only a few reported receiving help from guidance counselors and parents. The FGCS in Saenz et al. (2007) study reported similar experiences with the application processes. The application processes are critical for enrollment; however, many FGCS find the processes overwhelming and do not complete the process (Bui, 2002; Choy, 2001; Saenz et al., 2007; Terenzini et al., 1996). Although the women expressed being frustrated and stressed, while unpacking the various college application processes, they were resourceful, strategic, and tenacious as they successfully applied for financial aid and scholarships and to the colleges they selected.

## Persisting in STEM Majors as FGCW (RQ 1 & 2)

### Being First

College students benefit from a positive academic environment and a sense of community. Moreover, students have expectations of college life that typically come from their families (Kuh et al., 2006). The women in this study were excited to start a new chapter in their lives, yet, once at college, they dealt with varying degrees of apprehension. Most of their anxiety stemmed from the unanticipated rigor of coursework related to their majors. They also reported anxiety about, being away from home for the first time, having to be mindful of their spending and educating their parents about the academic landscape of college, specifically related to the competitive grading systems in STEM courses.

Twenty of the women (80%) described the academic and social challenges faced their first year on campus. They were unprepared for the academic intensity of college and did not know who to go to for information and support. They wrongly assumed that isolating themselves and having a laser focus on their studies would yield success. Twelve of the women in this study said it took them approximately three semesters of personal turmoil and trial and error strategies before they decided to reach out to peers, faculty, and organizations; they learned that having a college community was extremely helpful; they developed time management and study habit strategies; they established their college student identity and integrated academically and socially into campus life. Many of the experiences the participants discussed were acknowledged in other studies of FGCS (Kuh et al., 2006; Saenz et al., 2007; Tinto, 1993; Wilson & Kittleson, 2013);

however, being a FGCW majoring in STEM amplified the participants' distress as they were learning to navigate the culture of the STEM undergraduate programs while, at the same time, learning the nuances of the overall campus culture. Participants stated they were: unprepared for the STEM programs' "weed out" cultures, distressed by unexpected academic rigor and lower grades and GPAs, and concerned that scholarships were in jeopardy given time-to degree constraints. Twenty (80%) of the women in this study worked during college. Working presented limited opportunities to attend help sessions, study groups, and faculty office hours, strategies known to increase academic success in college and especially in STEM programs (Kuh et al., 2007; NRC, 2011). Additionally, the women in this study did not want to disappoint family members. This concern was heightened since they saw themselves as roles models and trailblazers in their families.

**Academic Integration**

Generally, the women in this study were academically gifted and the top students in their high school cohorts. They anticipated doing well in their college coursework, as did their parents. For the majority of these "well-prepared" participants, coursework in science and mathematics presented considerable obstacles to maintaining college GPAs that were comparable to their high school performances. Even more disconcerting was maintaining GPAs that satisfied scholarship requirements. For example, one participant reported losing her scholarship as a result of a low GPA. Participants frequently discussed the competitive grading systems used in mathematics and the "weed out classes" that they had to take concurrently to stay in their program queue. It was during

these early semesters that many experienced their first C grade or worse. This finding paralleled results from Seymour and Hewitt's (1997) research about STEM attrition. Their results indicated that several factors were associated with women's departures from STEM majors: the competitive, "weed out" culture of science courses, lack of cohesive and consistent instruction and materials, and lack of encouragement, particularly from faculty. The women who left felt overwhelmed by the curriculum and pace, and they began to lose interest and doubt their abilities. Alternatively, those who continued enacted personal coping strategies, accessed institutional programming, and sought out advisors at the departmental and university levels. Similar strategies were used by the women in this study. In addition to campus relationships, they reached out to family members to help carry them through the tough times. Many also found specific faculty members who demonstrated genuine concern for them and interest in their success. Many "persisters" in Seymour and Hewitt's (1997) study stated that faculty also intervened with encouragement and practical suggestions at critical decision points.

**Social Integration**

The participants were extremely concerned about maintaining good GPAs. Given the unexpected rigor of the "weed out" coursework, they spent considerable time studying. Managing work, studying, experiencing culture shock, and having family responsibilities left little time for the women in this study to socialize. Several participants made calculated decisions not to participate in campus organizations their first year. Previous research has shown that many FGCS have limited financial resources and must work for pay while attending college (Bui, 2002; Choy, 2001). Working often

prevents involvement with campus life, campus programs, and campus organizations. Consequently, the students have less exposure to the campus culture when compared to non-first-generation students (Pascarella, Pierson, Wolniak, & Terenzini, 2004). This point about exposure to and participation in campus culture is noteworthy given the importance of campus social integration for persistence in college (Astin, 1993; Tinto, 1993). Although Saenz et al. (2007) found that FGCS did not consider participating in campus life to be a priority, many of the women in this study explicitly said that they regretted not getting involved in campus life during their first year. Once they acclimated to the rigor of their coursework and began joining groups on campus, they discovered connections with faculty, senior peers, and students in their cohorts. This network provided strategic relationships. Participants were able to develop effective academic strategies with people who understood the challenges that they were experiencing. In retrospect, participants reflected that these relationships would have made their first year transition to college less stressful.

**Influential Relationships**

The interactions with the people in the participants' lives were influential. Parents were the first anchor relationships the participants reported having during college. The women in the study reported reaching out to their parents to share successes and receive encouragement when things were not going well. Family members and friends added to the circle, as did former coaches and teachers. During college, the women met peer mentors, advisors, and faculty who expanded their network of support. Participants frequently touted the benefits of these relationships, personally and professionally. In

addition to the psychological benefits, these relationships opened doors to career-related opportunities like undergraduate research programs, study abroad events, and internships. Researchers have also documented the value and significance of developing a community of support. Building community, plus acceptance and recognition from others are all important factors for persistence for women in STEM. Peers and representatives of the university (faculty, advisors, and program directors) play a critical role in providing a supportive environment (Blickenstaff, 2005; Cohoon, 2006; Conrad, Canetto, MacPhee, & Farro, 2009; Espinosa, 2011; Jackson & Laanaan, 2011; Wilson & Kittleson, 2013).

**Financial Responsibilities**

Financial concerns are common among FGCW and particularly those in STEM majors (Jackson & Laanan, 2011). Many FGCW do not have parents with the financial resources to pay for college expenses so they typically incur student loan debt and need to work for pay while attending classes (Saenz et al., 2007). Also, the heavy and competitive course load often leads to a longer time-to degree than for non-STEM majors (Gayles & Ampaw, 2011). The FGCW in Wilson and Kittleson's (2013) study struggled to balance work, studies, and family responsibilities. Other women in STEM have expressed similar concerns (Ong et al., 2010; Packard et al., 2011). In Seymour and Hewitt's (1997) landmark study, concerns about time-to-degree and the financial consequences led "switchers" to decide that succeeding in a STEM major was no longer a realistic objective. In the Saenz et al. (2007) study, FGCS expressed concern about limited financial resources for college. Additionally, they were concerned about their future economic positions. For example, a major reason cited for attaining a degree was

to earn more money and to have a secure financial future; many were pursuing higher education to position themselves to help family members (Bui, 2002; Hicks, 2002; Saenz et al., 2007). Similar to what previous researchers found, financial concerns were also prominent for the participants in this study. Yet they persisted. The women receiving scholarships and other women being helped by family conserved their funds and were mindful of time-to-degree limitations. Several participants worked during college. Their thoughts about mounting student debt were mixed. Some decided to forego graduate school due to financial constraints. Others took having loans in stride and decided education would provide the career opportunities they desired.

## Persisting in STEM Majors while Encountering Challenges (RQ 3)

### Assertions

What follows is a list of five assertions related the strategies the women in this study reported taking in an effort to persist as STEM majors.

*Assertion 1: The women in this study demonstrated **thoughtful determination** as they selected and persisted in STEM.* Thoughtful determination is contextual. The women in this study were met with a multitude of challenges as they pursued their career dreams. They evaluated and reevaluated their interests, abilities, and goals. They considered their positions in their families as role models and trailblazers. They learned from past failures. They were resilient. They identified problem areas, and sought solutions. They made sacrifices. They learned that working hard, working smart, and "staying with it" led to accomplishing their goals. They consciously considered how not continuing toward their goals would affect their families, the people they would like to help, and their own future

possibilities. The participants' determination mindset includes the aspects of Carole Dweck's (2006) growth mindset. A growth mindset is not limiting. People with a growth mindset believe that learning is dynamic, and intelligence can be developed over time with the appropriate techniques. They do not shy away from challenges; they bounce back from setbacks; they believe working hard can get them closer to their objectives. People with a growth mindset welcome constructive feedback. They learn from and are inspired by others (Dweck, 2006). As described in the 2010 AAUW report, *Why So Few?,* having a growth mindset leveled the playing field for women and men in terms of mathematics and science performance, factors for entry and persistence for women in STEM.

*Assertion 2: The women in this study experienced* ***shifting identities.*** Their views of themselves changed over time as they experienced college and learned how to navigate being FGCW in STEM. The women in this study shifted from seeing themselves as people getting excellent grades in their primary and secondary years to getting average or failing grades in early college years and again to acceptable grades within the scope of their goals. They were involved in social activities, then isolated and focused on their studies and now as they neared degree completion, they were balancing academics, work responsibilities, and social involvement. Initially, they doubted their abilities because they lacked knowledge about college life. They struggled with the academic rigor of college. They lost their early student identities temporarily. Gradually, through trial and error and help from knowledgeable others, they reemerged as 'successful' college students. They were now studying more effectively and being more strategic with their time. They reassessed the meaning of their grades and worked themselves back on track

toward achieving their goals. The participants engaged their academic and social self-efficacy beliefs (Bandura, 1994) during this period. In particular, they drew from their identities as excellent and involved students (mastery experiences) to stay the course as they faced various challenges during college. They were also able to quell their stress responses and doubts (physiological reactions), often with the help of others (social persuasion). Additionally, college life improved when they became involved and developed mentoring relationships with faculty and other college students (vicarious experiences).

Before college, the majority had limited exposure outside their communities. During college many studied abroad, explored internships, and graduate schools. Most participants said they were family role models; they were conflicted, now living in two worlds. They wanted to be independent, yet stay loyal to their families. The participants now enacted multiple identities that were situational and contextual. Their experiences mirror what Ropers-Huilman (2008) branded as "the dance of identities."

*Assertion 3: The women in this study applied **forward thinking** during their journeys. They were curious and engaged.* At various stages they planned for the future, imaging what that could be and, committing to doing what was necessary to attain their long term goals. They wanted to share their talents, give back to their families and communities, and make a difference where they could. The women in the study employed possible selves thinking. Markus and Nurius (1986) discussed the value of envisioning ourselves in a future that is attainable. These researchers brought to the forefront the idea that enacting possible selves thinking was motivating, contextual and could influence one's self concept.

*Assertion 4: The women in this study established **purposeful relationships**.* The relationships included a varied group: parents and extended family, peers, program leaders, teachers, and faculty. The women in this study reported that these influential others often initiated contact. The relationships served multiple purposes. Supportive relationships were encouraging and sustaining. Social relationships served to make connections around common interests and shared experience. The mentoring relationships were informative, content-oriented, and offered first-hand knowledge.

The strategic relations were advocating and action-oriented. The people in these relationships were invested in the aspirations and successes of the women. Especially in college, these relationships facilitated the academic and social integration of the women and offered various opportunities that enhanced their future possibilities. Therefore, the women in the study became part of their respective communities of practice (Wenger, 1998). Researchers agree that building community, establishing mentoring relationships, and providing successful role models contribute significantly to persistence for women in STEM (Blickenstaff, 2005; Cohoon, 2006; Conrad, Canetto, MacPhee, & Farro, 2009; Espinosa, 2011; Jackson & Laanaan, 2011; Wilson & Kittleson, 2013).

*Assertion 5: The women in this study practiced **high-stakes decision-making**.* Their decisions affected their persistence, self-views and confidence, opportunities for their futures, and the caring people who shared their journeys. Although people make numerous decisions every day, the women in this study perceived that they had to be especially vigilant with their choices or they might foreclose on options critical for reaching their personal, academic, and career goals. For example, many of the women delayed accessing academic resources because they had not struggled in earlier grades,

and it did not occur to them to seek help until they were in crisis. The women in this study delayed accessing social resources because they thought socializing would detract from their studies, not realizing the benefits of academic support and networking opportunities. The majority did catch up during sophomore and junior years; however, these misperceptions placed scholarships, staying in their major programs, and future academic pursuits in jeopardy.

The first-generation college women (FGCW) majoring in STEM in this study surmounted many obstacles. Along the way they learned how to "do college." They reestablished their student identities and they contributed to a new community. They accomplished a great deal by employing perseverance, forming strategic partnerships, and addressing unexpected circumstances with openness and flexibility, all while staying focused on their futures. Moreover, the women in this study believed that the choices they made had far-reaching consequences for themselves, their families, and their communities at large.

## Implications of the Study

Decades of research have addressed the women in STEM issue. There is also much information about the experiences of first-generation college students. What is missing is *how* being first in your family to go to college shapes the experience of being a woman in STEM at a selective institution. The challenges of being a first-generation college student are often overlooked by those on campus (Davis, 2010). Unless this information about challenges is shared, it is unlikely that anyone would realize the impact being first in one's family was having on your college experience. Likewise, women who

major in STEM face varied obstacles. First-generation college women in STEM majors face double jeopardy and triple jeopardy for FGCW of color in STEM.

The following implications of this study are directed to the educators and knowledgeable others who come in contact with the girls and young women who could be future STEM college graduates. The pre-college years (K - 12) address the implications of this study for parents, teachers, and guidance counselors. The college years (13-16) address implications of this study for administrators, college student affairs professionals, and STEM professors.

## Pre-College Years

The women in this study reported two overall factors associated with their college-going attitudes and their decisions to major in STEM: their relationships with parents, teachers, and guidance counselors plus their exposure to STEM-related, practical experiences in and out of their classrooms.

**Parents.** Parents are the first teachers. The majority of participants experienced and practiced science as part of everyday lives, especially the agriculture and science majors. The majority of parents were able to be hands-on; they were actively involved with their daughters' education during the elementary years (K-5). Typically, the parents' involvement became more indirect as their daughters advanced to higher grade levels. Parents witnessed their daughters' accomplishments and struggles; they cheered them on and encouraged them to continue toward their goals. Not unlike other FGCS, the parents in this study encouraged their daughters and had expectations for them to attend college.

However, they often did not have the information and experience to counsel their daughters on school matters related to STEM and STEM college majors.

Parents of FGCW can be given the tools to nurture STEM career aspirations. Parents of PFGCW might benefit from receiving STEM-related materials that describe the appropriate steps to major in STEM and outline the career opportunities and associated economic advantages available for women with a degree in a STEM field. The information should be disseminated early and often, tied to grade level. Additionally, accessible, informal workshops should be developed for parents that align with the related materials. Parents should be informed, often and early, about state scholarships offered and assistance available through schools and communities. FGCW's parents should be encouraged to attend scholarship and college application information sessions with their daughters.

**Teachers.** Teachers are especially important for FGCW as they often serve as "academic parents" particularly at higher grade levels. Several women in this study cited having engaging and interactive science classroom experiences, and developing one-on-one relationships with high school science teachers as critical to their academic motivation and their willingness to consider STEM majors in college. The women in this study recalled how their high school teachers fostered their interest in particular science fields and mentored them. Many women reported that science teachers guided their high school course decisions that related to STEM, personally invited the women to high school clubs and pre-college programs related to STEM, and, informed them about STEM majors and related STEM careers.

Teachers should be encouraged to make science and mathematics applicable to real world issues that are age appropriate. Moreover, using collaborative, interactive strategies for science experiments engages students. Many of the teachers described by the women in this study employed a growth mindset philosophy for student learning (Dweck, 2006). Teachers could encourage girls to step out of their comfort zone; teachers could model that making mistakes are part of the learning process. Several women in this study reported that teachers' words of encouragement and explicit belief in the women's abilities motivated them to work harder and stay the course when challenged. Teachers should be made aware of unconscious gender-related biases and the different ways girls and boys enact science and mathematics in their worlds. In high school, early mathematics and science interests and achievement can be fostered with expanded exposure to programming and quality instruction.

Many of the women in this study solidified their career choices during this time as they began to discuss and prepare for college. Teachers, who also acted as club leaders, were often a deciding factor for majoring in STEM for several of the women. Academic preparation for college is paramount as well as educating parents and students about post-secondary options. Students who actually participate in programming at nearby colleges during high school can more easily envision college life for themselves. Educators should also be aware of students who would be first in their families to attend college and how that might impact their knowledge and options for college attendance. Given their influence with FGCW, teachers should be encouraged to identify high achieving FGCW and plant the seeds for majoring in STEM degree programs. STEM teachers can become mentors and advocates; they can recognize talent and encourage STEM.

**Guidance counselors.** Guidance counselors, like teachers, can make a difference in the lives of FGCW. They are often charged with disseminating information about courses, college preparation, and career possibilities. The women in this study had mixed experiences with their guidance counselors. A few women reported that their guidance counselors were instrumental in their college application processes; while the majority of the women in this study expressed they would have benefited from more timely information, direction, and encouragement from the guidance counselors at their high schools.

PFGCW would benefit from additional positive interactions with their guidance counselors. Counselors should avoid being naysayers and realize that their opinions matter especially to PFGCW who often look to adults, other than their parents, for guidance in matters related to college. PFGCW's parents may be unfamiliar with the benefits of STEM options for their daughters. Counselors should inform the PFGCW about non-traditional STEM career options, highlighting economic advantages, and the many contributions to communities that can be made with a STEM career. High-achieving PFGCW should be identified by guidance counselors upon enrollment in high school and be encouraged to take courses that would prepare them to major in STEM in college. Finally, counselors can work closely with PFGCW and parents to minimize the stress and confusion associated with the complicated financial aid, scholarship, and college application processes.

**College Years**

FGCW in STEM face many challenges at the college level. The first year can be particularly difficult for women in STEM, especially if the competitive culture in STEM departments is thriving. The women in this study did not anticipate the rigor of so-called "weed-out" courses and had never experienced the competitive grading system employed. Several of the women doubted their academic abilities for the first time. The women in this study were concerned with time-to degree and financial constraints; many needed to work during the semesters. These same concerns were common reasons given by women who switched to non-STEM majors or left college (Seymour & Hewitt, 1997). The women in this study persisted. They attributed their persistence in the face of challenges to their determination, goal orientation, and relationships with knowledgeable and supportive people (parents, peers, faculty, student affairs professionals, and interested others).

**Administrators (Provosts and Deans).** The women in this study were negatively affected by the "weed out" culture in their STEM majors. In order to increase women in the STEM disciplines, structural changes need to be made to the dominant male-culture existing in some first and second year programs. Resources need to be available to implement strategies to increase persistence for women in STEM and particularly FGCW in STEM. Campus cultures that respect varied perspectives are made evident through the diversity of students, graduate students, and faculty members especially in engineering and computer science. Hence, "administrators" must consider how "weed out" curricula practices and competitive grading systems affect the

persistence of women and underrepresented minority (URM) undergraduates in STEM, thus contributing to the lost potential for those students to attend graduate school in STEM programs and become future leaders in STEM fields.

**Student affairs professionals and academic advisors (advising staff).** The advising staff members are the front line representatives of the university. Many women in this study reported being overwhelmed their first year on campus. They expressed a sense of cluelessness; one participant stated "I feel you're in a darkroom having to guide yourself" (Sophia, individual interview, November 4, 2014). The women reported these feelings even after attending the week-long orientation sessions offered by the university.

Given the experiences of the women in this study, FGCW in STEM would benefit from more interactions with advising staff tailored to their specific needs. FGCW in STEM would benefit from one-on-one relationships with advising staff that were sustained until graduation. FGCW in STEM may not have the foundational knowledge or understanding of programs and opportunities to help themselves. One cannot assume that FGCW know the purpose and value of learning communities, disciple-based societies, help sessions or office hours. Therefore, advising staff should incorporate orientation topics relevant for this cohort during the first weeks of each semester. Topics could include: adjusting their study habits and time management skills given the rigor of the "weed out" courses, getting involved in learning communities, professional societies, clubs, and volunteer organizations to be academically successful, and informing them about various STEM-related groups to nurture their passions.

In addition, given the experiences of the women in this study, advising staff should discuss the benefits of mentoring, and encourage FGCW in STEM to reach out to

faculty, group leaders, and other students. Specifically, persuade them to develop relationships with faculty who can offer undergraduate research experiences, information about internships, and introduce them to knowledgeable others who want them to succeed. The advising staff members should inform FGCW in STEM about the competitive grading environment in "weed out" courses. The advising staff should provide strategies for earning GPAs that meet scholarship requirements while staying in STEM major programs. Advising staff should discuss stereotype threat with the FGCW in STEM; letting them know that some men tend to be overconfident and explicit about their academic abilities while women often underplay their talents (Bench, Lench, Liew, Miner, & Flores, 2015).

In general, advising staff should develop mechanisms to inform FGCW in STEM about appropriate resources frequently. In addition to using technology for targeted tips and strategies, include informative discussions during scheduled meetings. FGCW in STEM would also benefit from peer mentoring programs within STEM departments. Finally, advising staff should be creative and encouraging while addressing the challenges faced by FGCW in STEM to keep them engaged and persisting to graduation.

**STEM professors.** Professors are influential. A classroom environment that is welcoming, collaborative, and respects different viewpoints sets the stage for learning. The women in this study had positive and negative impressions of faculty members. Several women mentioned that the faculty members in their first year courses were apathetic toward undergraduates and were not engaging in the classroom. Given the responses of the women in this study regarding student engagement, professors could incorporate interactive learning strategies and avoid the "sage on the stage" phenomenon,

especially in large classes. Professors can emphasize the value of help sessions and going to office hours; they can offer course incentives for students who participate. Initially, several women in this study reported feeling intimidated by their professors. Professors should be made aware of unconscious gender bias and provide a welcoming, learner-centered classroom environment.

Eventually, the majority of the women in this study each found one or two professors in STEM who became mentors to them. The professors facilitated undergraduate research experiences, internships, and study abroad opportunities. These relationships typically developed after freshman year. Several women in this study reported that having faculty mentors, who facilitated various opportunities for them, were instrumental in their decisions to attend graduate school. FGCW in STEM would benefit from becoming part of the departmental community by participating in research and other faculty sponsored opportunities to showcase their talents.

## Limitations of the Study

There are several limitations to this study. The first limitation of this study is the size and characteristics of the sample population. A small group of women (n=25) who attended the same university and were majoring in a STEM field were interviewed. The women reported their recollections of primary and secondary school experiences so their perspectives may be biased toward salient experiences.

The second limitation of this study is that I purposefully interviewed high-achieving women in STEM who were first in their family to earn a bachelor's degree. The women were upper division and close to graduation. I did not interview first year

students with similar characteristics nor FGCS in STEM who switched to a non-STEM major or who dropped out of college or transferred to another college. I did not interview FGC men in STEM to compare their experiences.

The third limitation was that I conducted individual interviews lasting approximately 75 minutes and held four group sessions lasting approximately 90 minutes. I have not had additional contact with the women since the group discussions. So my exposure to them was limited. Conducting follow-up interviews with the women in this study would shed light on their post- baccalaureate career-related decision-making.

The fourth limitation was self-selection bias. The participants in this study chose to participate so I only have the perspectives of those interested in telling their stories. It is possible that the FGCW who did not choose to participate differed in their background and experiences

The fifth limitation was the limited scope of the various STEM disciplines represented. Specifically computer science was not well represented and animal and biological science majors were over-represented.

Therefore, my results may offer some insights into their academic journeys; however, the intent was not generalization from a quantitative perspective rather the assertions made and the data shared could provide ‘food for thought.’ Additionally lessons learned based on this study can inform practice and policy.

## Future Research

This study revealed several issues related to first-generation college women in STEM majors. Extending these findings could provide further insights about persistence in STEM majors and careers. First, examining the post-baccalaureate career trajectories of the women in this study would expand our understanding of how first-generation women access the STEM pipeline. Half of the women in this study planned to continue their education, half planned to start their careers and one woman was interested in joining the Peace Corps. Following up with the women in this study, as they navigate graduate school and find their place in industry, would uncover additional issues that relate to first-generation women in STEM graduate programs and careers.

Second, research that examines the experiences of FGCW in STEM who switched to non-STEM majors or were non-"persisters," and high-achieving FGCW who chose non-STEM majors could provide differential understanding of the FGCW's affiliation with STEM. The women in this study were chosen because they ultimately chose and persisted in a STEM major. Understanding the pre-college and college experiences of FGCW who began with STEM but did not persist, and the FGCW who qualified for STEM majors but chose non-STEM majors would broaden and enhance our understanding of best practices to recruit FGCW in STEM majors, and help them persist to graduation.

Third, high school science teachers and guidance counselors played a significant role in the educational decisions of the women in this study. Conducting a study about their interactions with PFGCW, their level of awareness of first-generation status, and their level of participation in college major selection would provide a broader

perspective. A similar study with advisors in STEM departments about their interactions with FGCW in STEM and issues related to persistence would provide further insights.

Finally, using the results from this study could inform the development of a quantitative study that could reach a larger cross-section of FGCW in STEM majors. This study employed a purposeful sample of FGCW from one research intensive university. Furthermore, twenty of the women (80%) attended high school in the same state, nineteen of the women (76%) were Caucasian, and seventeen of the women in this study (68%) were from families with lower socio-economic status. Although much was learned about FGCW in STEM from the experiences of the women in this study, a larger sample of FGCW in STEM might reveal new and nuanced factors related to persistence in STEM programs.

## Conclusion

The women in this study faced numerous challenges during their educational journeys. Yet, they employed personal and relational strategies that allowed them to continue toward their goals. Due to family obligations, role expectations, financial constraints and their first-generation status, the participants' academic and social decisions were paramount. Beyond those considerations, the women entered an academically competitive STEM culture that afforded few missteps. They were first in their families to finish college. Many felt earning a college degree was the first step to career advancement and economic opportunity for themselves and their families. For many, their families' hopes and dreams were bound to their success.

For the women in this study, concerns about finances and graduating on time were salient and troublesome. The rigor, competitive nature, and specific course-taking

requirements in science, engineering, and technology (STEM) created a "perfect storm" for these FGCW who had significant time-to-degree constraints. First, FGCW were enrolled in Bachelor of Science programs that many students--men and women—typically took 5-6 years to complete. Second, their scholarship criteria mandated that they had to maintain certain GPAs. Many did not have the resources, particularly money, time, and flexibility to withdraw from and/or repeat difficult classes to enhance their grades. Third, they did not have safety nets as they walked the tightrope toward their degree; meaning that they perceived that a wrong decision could foreclose on their futures and their families' futures from their perspectives. Without already formed safety nets, some FGCWs became temporarily paralyzed with inaction because they were concerned about missteps that they could not and did not anticipate. Moreover, they did not know what to do and with whom they could discuss options. Eventually, what helped them succeed was indeed a safety net, but one that took them considerable time and effort to fashion. This safety net was materialized in key relationships that grounded and supported them but also took the form of thoughtful determination, shifting identities, purposeful relationships, and forward thinking that informed their high-stakes decision-making and contributed to their persistence in their STEM majors.

## Researcher's Reflection

My impetus to conduct this study was a curiosity about how women who are from families who have not attended college and who do not have STEM career role models in their homes, decide to go to college, major in STEM and stay the course through graduation. I learned the women in this study were high achievers whose favorite subjects were often mathematics or science. I learned that they had various opportunities to develop and nourish STEM-related passions.

Their parents supported participation in sports, clubs, and activities where the women competed. The women learned that if they worked hard, they could succeed and if they lost in a particular event, they could try again. I heard how much they wanted to make their parents and families proud. I heard how they were committed to helping their siblings go to college. The women shared that their parents wanted better lives for them; their parent believed a college education would provide rich opportunities.

I watched their faces and heard the discouragement in their voices when they recalled their early college struggles and their concerns about disappointing those important to them. I saw their relief and pride as they shared that they had learned how to do college and were succeeding again. The relationships, that they established and maintained, were critical factors in their success. Each woman found her circle of support: parents, teachers, professors, counselors, peers, and adult leaders were there to assist and encourage them as they journeyed to graduation.

I learned the women in this study were savvy, goal-oriented, and resilient. They were mindful of contributions they wanted to make to their families and society. And because of who they were and what they wanted to accomplish, graduating from college was necessary and majoring in STEM was prudent given their long-term objectives.

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# APPENDICES

# Appendix A: College STEM Majors

## Agriculture majors:

| | | |
|---|---|---|
| Agribusiness | Animal Sciences | Horticulture |
| Agriculture Education | Entomology (Insect Biology) | Plant Science |
| Agronomy | Fisheries and Aquatic Sciences | Wildlife |

## Science majors:

| | | |
|---|---|---|
| Biochemistry | Ecology, Evolution and Environmental Sciences | Neurobiology |
| Biology | Genetic Biology | Physiology |
| Chemistry | Microbiology | |

## Engineering majors:

| | | |
|---|---|---|
| Aeronautical and Astronautical Engineering | Environmental and Ecological Engineering | Materials Engineering |
| Civil Engineering | Environmental and Natural Resources Engineering | Mechanical Engineering |
| Electrical Engineering | Industrial Engineering | |

## Technology majors:

| | | |
|---|---|---|
| Animation | Electrical Engineering Technology | Web Programming and Design |
| Building Construction Technology | Mechanical Engineering Technology | |
| Computer and Information Technology | Robotics Engineering Technology | |

Adapted from Purdue University Website, 2016

# Appendix B: IRB Exemption Letter

PURDUE UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

**To:** DEBORAH BENNETT
BRNG 5154
**From:** JEANNIE DICLEMENTI, Chair
Social Science IRB
**Date:** 04/30/2014
**Committee Action: Exemption Granted**
**IRB Action Date:** 04/30/2014
**IRB Protocol #:** 1404014775
**Study Title:**
The Educational Journeys of First-Generation College Women in STEM: A Grounded Theory Study

The Institutional Review Board (IRB) has reviewed the above-referenced study application and has determined that it meets the criteria for exemption under 45 CFR 46.101(b)(2) .

If you wish to make changes to this study, please refer to our guidance "**Minor Changes Not Requiring Review**" located on our website at http://www.irb.purdue.edu/policies.php. For changes requiring IRB review, please submit an **Amendment to Approved Study** form or **Personnel Amendment to Study** form, whichever is applicable, located on the forms page of our website www.irb.purdue.edu/forms.php.

Please contact our office if you have any questions.

Below is a list of best practices that we request you use when conducting your research. The list contains both general items as well as those specific to the different exemption categories.

General
• To recruit from Purdue University classrooms, the instructor and all others associated with conduct of the course (e.g., teaching assistants) must not be present during announcement of the research opportunity or any recruitment activity. This may be accomplished by announcing, in advance, that class will either start later than usual or end earlier than usual so this activity may occur. It should be emphasized that attendance at the announcement and recruitment are voluntary and the student's attendance and enrollment decision will not be shared with those administering the course.
• If students earn extra credit towards their course grade through participation in a research project conducted by someone other than the course instructor(s), such as in the example above, the students participation should only be shared with the course instructor(s) at the end of the semester. Additionally, instructors who allow extra credit to be earned through participation in research must also provide an opportunity for students to earn comparable extra credit through a non-research activity requiring an amount of time and effort comparable to the research option.
• When conducting human subjects research at a non-Purdue college/university, investigators are urged to contact that institution's IRB to determine requirements for conducting research at that institution.

• When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Category 1
• When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Categories 2 and 3
• Surveys and questionnaires should indicate
° only participants 18 years of age and over are eligible to participate in the research; and
° that participation is voluntary; and
° that any questions may be skipped; and
° include the investigator's name and contact information.
• Investigators should explain to participants the amount of time required to participate. Additionally, they should explain to participants how confidentiality will be maintained or if it will not be maintained.
• When conducting focus group research, investigators cannot guarantee that all participants in the focus group will maintain the confidentiality of other group participants. The investigator should make participants aware of this potential for breach of confidentiality.
• When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Category 6
• Surveys and data collection instruments should note that participation is voluntary.
• Surveys and data collection instruments should note that participants may skip any questions.
• When taste testing foods which are highly allergenic (e.g., peanuts, milk, etc.) investigators should disclose the possibility of a reaction to potential subjects.

## Appendix C: Research Participant Information Sheet

RESEARCH PARTICIPANT INFORMATION SHEET
The Educational Journeys of First-Generation College Women in STEM
Dr. Deborah Bennett – Purdue University
Susan R. Geier – Purdue University

What is the purpose of this study?

You are being invited to participate in a study of college women who are first in their family to pursue an undergraduate degree, first-generation college women (FGCW), and who are studying science, technology, engineering or mathematics (STEM). Our goal is to gather insights about your educational choices and experiences that influenced your decision to major and continue in a STEM field. The information that we collect will be used to inform educators, programming and policies, and interested others about the recruitment and retention of women in STEM majors. We hope to enroll 20 – 30 participants in the study.

What will I do if I choose to be in the study?

You will first answer a few questions to confirm that you meet with the study criteria. Once qualified for the study, we will arrange a convenient time for you to participate in an individual interview (approximately 60-75 minutes), You may also be asked for follow-up information through email and/or phone communication associated with interview questions (as needed for clarification with anticipated time commitment less than 30 minutes). You may also be asked to be part of a group interview (approximately 75 - 90 minutes); a meal will be provided by the researcher during the group interview. The interview questions and follow-up communications will be related to your decision processes and experiences associated with your academic choices and decisions (educational journey). During the group interview you will also have the opportunity to comment on the preliminary findings of the study and share insights and experiences important to you. The interviews will be conducted by the researcher, audio recorded, and transcribed.

How long will I be in the study?

You will participate in one individual interview (approximately 60-75 minutes), you may be asked for follow-up email and /or phone communication associated with the interview questions (anticipated time commitment less than 30 minutes). You may also be asked to be part of a group interview (approximately 75-90 minutes). The total time commitment for this study is approximately between 2.5 and 3.0 hours.

What are the possible risks or discomforts?

The risk level of this study is minimal; i.e. no greater than you would encounter in daily life.

Are there any potential benefits?

You may enjoy sharing your experience during the interview. If participating in the group interview, you may enjoy meeting and hearing other FGCW in STEM share their experiences. Beyond that, you may derive no discernable benefit from participating other than the satisfaction that you were able to add to the conversation about how to encourage women to select and persist in STEM majors.

Will I receive payment or other incentive?

You will receive a 20.00 gift card after the individual interview and an additional 20.00 gift card after participating in follow-up communications and the group interview (if asked to do so). Therefore, those participating in the entire study would receive a total of 40.00 in gift cards in appreciation for your time and interest.

Will information about me and my participation be kept confidential?

Your interviews and any follow-up communications will be referenced with a code number and pseudonym; your name will not be associated with your interview responses. The code key and audio recordings will be
stored in the researcher's office in a locked file cabinet until destroyed within 3 years after the completion of the project. Audio recordings will be destroyed once information is transcribed. While every effort will be made to keep confidential all of the information you share, participation in a group interview may result in participants knowing the identity of other participants; therefore the researchers cannot guarantee that the other study participants will not breach your confidentiality.
The project's research records may be reviewed by departments at Purdue University responsible for regulatory and research oversight to ensure that participants' rights are being protected.

.

What are my rights if I take part in this study?

Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Moreover you may skip any question you feel uncomfortable answering.

Who can I contact if I have questions about the study?

If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Susan Geier at 765-xxx-xxxx; email: geiers@purdue.edu or Deborah Bennett at bennett@purdue.edu

If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (irb@purdue.edu)or write to:

Human Research Protection Program - Purdue University
Ernest C. Young Hall, Room 1032
155 S. Grant St.,
West Lafayette, IN 47907-2114

## Appendix D: Recruitment Email

Hello,
We are conducting a research study about women who are majoring in science, technology, or engineering (STEM). Our goal is to gather insights, through interviews and group discussions, related to the educational choices and experiences that led to selecting and studying STEM majors. We hope to enroll 20 – 30 qualified participants in the study.

If you are enrolled in the study, in appreciation for your interest and time, you will receive a total of $40.00 in gift cards for your participation in the entire study. The total time commitment for this study is between 2.5 to 3.0 hours.

We believe your story will add to the conversation about how to encourage women to select and persist in STEM majors; plus, by participating in our study, you may enjoy connecting with other women who are studying STEM and hearing about their experiences.

If you would like more details about how to participate in the study and/or have questions about the study, please reply to: **Susan Geier - email: geiers@purdue.edu**

Note: You have been selected to receive this email because we believe you meet the following criteria: 1) attended school in the U.S. (k-12), 2) currently a junior or senior woman majoring in STEM, and 3) are first in your family to pursue an undergraduate degree

Thank you for your interest in our study,

Susan

Susan R. Geier
geiers@purdue.edu
Department of Educational Studies
College of Education
Purdue University

Dr. Deborah Bennett
bennett@purdue.edu
Department of Educational Studies
College of Education
Purdue University

## Appendix E: Introductory Survey

Before we begin the interview, I would like to officially qualify you for the study and get some general background information from you. [Items are verbally asked and responses are written by the interviewer.]

Name: _____ Pseudonym:

_____

I attended grades K – 12 in the United States. Yes No

I will be first in my family to complete a bachelor's (4-year) degree. Yes No

Please list current major _____

Intended Graduation Date: _____

Traditional or non-traditional (3 year gap between high school and college or 24 and older)

City & State where I attended K – 8 _____

_____

City & State where I attended High School _____

_____

Would you describe your school(s) as: Rural Urban Suburban - Public or Private

Mother's education: _____

Father's Education: _____

Mother's Occupation:_____

Father's Occupation: _____

Number of Siblings ____brothers _____sisters Sibling birth order:

_____

Other family members included in your "immediate family"

_____

Favorite subject in elementary school _____

Least favorite subject in elementary school _____

Favorite subject in high school _____

Least Favorite subject in high school _____

I prefer to be contacted by email or phone _____ or either.

## Appendix F: Interview Protocol

### The Educational Journeys of First-Generation College Women in STEM

Individual Interview Protocol conducted by Susan Geier

November 3 through December 8, 2014

*The purpose of this interview is to gather your insights related to your academic choices and decisions that led you to major in [name of major] and to reflect on your experiences as a first-generation college woman in a STEM related field. Your insights are important for helping to inform educators, programming and policies, and interested others about the recruitment and retention of women in majors similar to yours, especially those who are first in their family to attend college. The interview will take ~ 75 minutes. All your responses to my questions will be recorded and later transcribed. Your interview will be referenced with a pseudonym so your name will not be associated with your responses. Your participation in this interview is voluntary and you can withdraw at any time without penalty. Do I have your permission to record?*

*The series of questions I will ask will start with your earlier experiences eg. Elementary school and move forward. However, feel free to mention experiences that come to mind out of sequence for example sometimes talking about college reminds you of a middle school experience please feel free to talk about that also.*

### Interview Protocol (Potential Questions)

**Part one:** First I'd like to get some background information about you and your family.

1. Please tell me about your family: where you are from, your family and the kind of work they do?

2. Siblings-(rank) and other family members and relationships

3. Proximity.

4. When you were growing up what were your parent's attitudes toward education, family expectations for your education

**Part two:** Early Years (Elementary) Background:

Educational Identity

Describe what kind of student you were/are? Elementary/ Middle School/ High School?

## Appendix F: Interview Protocol

## Interview Protocol (Potential Questions) Continued

How has your description changed/stayed the same over the years? Academic preparation? Supplemental instruction?

What is your earliest recollection that you wanted to be [in particular STEM field)? Tell me about that time in your life.

**Kindergarten to present:** Describe the important _____(who) that influenced your academic/career decisions either in a positive or negative way.

- people (immediate family, extended family, friends, teachers, community members, mentors, adult leaders, faculty, advisors),
- subjects/courses,
- events (field trips, family vacations, other travel opportunities, holidays, moving),
- communities (religious, neighborhood, friends, campus)
- resources (employment, scholarships, internships, assistantships, loans)
- extra-curricular activities (sports, music, dance, academic clubs, sororities, service organizations, volunteer work)
- formal and informal educational experiences (Favorite subjects, challenging subjects, libraries, computers, museums, camps, study abroad) Tell me more about what you expected in college, high school, middle school and how that compared to your actual experiences? How did that influence your choices?

**College Years**

When and why did you choose your specific area of study?

Tell me about how you came to be at Midwest University?

Discuss opportunities offered from the schools, college you attended; mentoring informal and formal; support systems, financial resources.

Describe your experience as a first-generation college woman in [STEM field] (unpack—meaning of FGCS status/meaning of being a woman in STEM). What would have made your academic journey easier, more fulfilling?

## Appendix F: Interview Protocol

## Interview Protocol (Potential Questions) Continued

**Insights**

What were the difficult, challenging, surprising, satisfying, meaningful experiences during early years, secondary years, and postsecondary years?

What key advice would you tell elementary school girls, high school girls, women in college about preparing/majoring in [STEM field]? Top five tips for college

**Other possible questions:**

How, if at all, have your thoughts and feelings changed about your academic and future plans during primary, secondary school, postsecondary?

Along your academic journey, have you identified any "unwritten rules" that either helped you or hindered your progress? If so, what were they, how did you identify them, and how did the "unwritten rules affect your decisions and success?

What helped you to be successful in your academic journey? People, resources, events

*Possible follow-up questions and probes used in response to interviewee responses:*

How did you happen to…? What happened next? How did you deal with…how did that affect you decision making? Would you describe the most important lessons you have learned about…Where do you see yourself in two years…? Can you tell me more about that…Could you explain that a bit more please?

What do you wish you had known [when] and would that have changed your decision-making?

What else should we be sure to include in this study; *[pause!]* Is there anything about you, your educational experience and aspirations that you would like to share…but we have not discussed?

## Appendix G: Group Discussion Protocol

### The Educational Journeys of First-Generation College Women in STEM

Group Discussion Protocol conducted by Susan Geier

January 2015

*Welcome back! The purpose of this group meeting is to discuss some of the preliminary findings from the data gathered and get your feedback and insights about the related topics. I also wanted to check in with you and see how things were going since your individual interview and also touch on your plans after graduation.*

*The interview will take ~ 90 minutes. As before, all your responses to my questions will be recorded and later transcribed and your names will be referenced with a pseudonym name will not be associated with your responses. I wanted to go through a portion of the information sheet again regarding confidentiality. Just to remind everyone, I ask that everything said here be kept confidential; however, in a group setting, I can only promise that I will keep our discussion confidential. I cannot guarantee the actions of others in the group. I gave you pads of paper for note-taking etc. during the discussion. Also if you would like to share information about a topic with me individually you can write me a note and give it to me after the discussion or send me an email.*

*Again, your participation in this interview is voluntary and you can withdraw at any time without penalty.* Does anybody have any questions before we proceed? *Do I have your permission to record?*

*I thought as an introduction and to get back in touch with everybody let's go around the room and tell me a little bit about anything that might be pertinent since our individual interview, anything that has happened since and how you feel about beginning a new semester. Please say your first name and major. If you don't want to say anything please say pass.*

*Catching up:*

1. Tell me about anything pertinent to our topic that's happened since the individual interview.
2. How are you feeling about this semester? What are your expectations for this semester?

3. Who is currently working –what are you working at—why—how many hours

*Discussions about initial findings:*

4. I would like to get your reactions to some of the preliminary findings for the group:
    a. Many of you mentioned that mathematics was your favorite subject in the elementary (K-8) and you had a positive attitude toward math. [Tell me something positive and something challenging about your math experience.]
    b. Most of you participated in competitions such as sports, 4-H [What have you learned from participating in those activities? Tell me about how being in those activities translated to aspects of your academic journey?]
    c. Many had some exposure to topics related to your major. [1.Were you exposed to experiences/people related to your major at a young age or later in your life and talk about that exposure] [2. Can you describe a specific event, or an encounter with a person that was the turning point that solidified your choice of major?]
    d. All of you are motivated to "stick with it" even in the face of challenges—[Tell me about your motivation—internal vs external where does it come from?]
    e. Another thing you have in common is that you are goal –oriented. [Can you tell me about your goal setting habits and their relative importance?]
    f. Women in male-dominated fields had more gender issues than the STEM fields that have more women who did not have the added burden of being in the minority in classes. [Talk about being a woman in STEM.]
    g. Many had a difficult first semester / first year experience- some described that prior to college academics etc. came easy and at college things were overwhelming [Please speak to that and how you moved forward from that.]
    h. Your concerns about financial issues were mixed. [What are your concerns in this area?]

*Reiterating individual interview questions:*

5. Talk about being first in your family to earn a bachelor's degree
6. What coping strategies have you used when you're faced with specific challenges (for example- I faced this challenge and this is how I dealt with it—even if you went at it one way and it didn't work out and you tried again—you can pick something that was a significant obstacle for you.

*If time allows:*

7. Talk a little bit about being in the first generation college student group.
8. How do you define success and what does it mean to you.
9. Think about where you are in your journey right now—what are your concerns going forward within the next 12 months.

Any other comments or questions? Thank you

VITA

# VITA

Susan Ruth Geier was born in Queens, New York and moved to Indiana during her teen years. Her parents and especially her mother and maternal grandmother inspired a love of learning, passion for music, and dedication to service. Although her parents did not complete a bachelor's degree, graduating from college was a family expectation. Geier graduated from Purdue University in May, 2005, with a bachelor's degree in psychology. Due to her passion for working with college students, Geier decided to pursue a Master of Science in Education degree with a specialization in College Student Affairs which was completed in May, 2007, at Purdue University. During her tenure as a doctoral student, Geier served as internal evaluator for several projects related to increasing participation in science, technology and engineering (STEM) for underrepresented groups. Her thesis examined the experiences of first-generation women undergraduates who majored in STEM. Geier currently is an independent evaluation consultant whose focus is developing and evaluating projects related to broadening participation in STEM.