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Amy M. Latta-Won

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**MALE AND FEMALE EXPERIENCES IN SCIENCE AND MATHEMATICS**

**UNDERGRADUATE PROGRAMS**

By

Amy M. Latta-Won

A Dissertation  
Submitted to the Faculty of  
Columbus State University  
In Partial Fulfillment of the Requirements  
For the degree of Doctor of Education  
in Curriculum and Leadership

Columbus State University  
Columbus, GA

April 2014

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2014

# MALE AND FEMALE EXPERIENCES IN SCIENCE AND MATHEMATICS

## UNDERGRADUATE PROGRAMS

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Pages in Study: 173

## **Candidate for Degree of Doctor of Education**

This dissertation examines the experiences of males and females in science and mathematics undergraduate programs. It emphasizes particularly the undergraduates' experiences within the STEM fields related to gender and how they negotiate gender by using a phenomenological approach. Ten STEM undergraduates (five males and five females) participated in semi-structured interviews to also examine why they chose to major in a STEM field, understand gender as it impacts their experiences, and identify obstacles that impact their persistence in the completion of their degree. There are more women than men attending colleges and earning degrees. However, men still outnumber women who major and complete degrees in the STEM fields. By understanding the experiences of both male and female students and how they navigate through STEM coursework, educators may use this acumen to modify instructional practices.

Results from the participants' interviews yielded that both males and females believe that choosing a STEM major and successfully pursuing it is based on their

individual interests and experiences rather than on their gender. Participants also divulged about the obstacles they encounter such as, difficult coursework and societal pressures. Pressure to be the breadwinner, empowerment to overcome the odds, forming bonds with fellow STEM majors, and encouragement from teachers were found to be the reasons STEM undergraduates continued to pursue their degree.

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## CHAPTER 1

### INTRODUCTION

Within the classrooms across the United States, females have taken giant leaps forward in their education (Callas, 1993; Kerr & Kurpius, 2004; Sadker & Sadker, 1994; Varma, 2010). For two centuries, following the European tradition, American females were excluded from schools. Limited to learning domestic skills, women in the Colonial times secretly wrote in letters and diaries of their desires to learn, while the social culture considered them mentally and morally inferior (Sadker & Sadker, 1994). Women have scaled the mountains of this gender injustice. For example, with respect to college enrollment, Lewin (2006) claims that “women are leaving men in the dust.” The number of women enrolled in higher education in the United States increased from 38% in the 1960’s to over 56% in the 2000’s. Clark Kerr labeled this trend “the great transformation,” and not only are college women outnumbering the men they are also outperforming them and putting more efforts into their study (Clifton, Perry, Roberts & Peter, 2007).

Although the number of women attending college is increasing and are outperforming males, women are still underrepresented in the fields of science, technology, engineering, and mathematics (STEM) (Taasobshirazi & Carr, 2008). The National Science Foundation (2012) reported that women received 17.9 % of computer science degrees, 38.9% of earth science degrees, 43% of mathematics degrees, 41.5 % of physical science degrees, and 18.1 % of engineering degrees. These are small percentages

when compared to the fields of education and nursing. Women receive 73.8% of the degrees in education and 88.2% in nursing (U.S. Bureau of Labor Statistics, 2011). Gender differences in science achievement on standardized tests, such as the National Assessment of Educational Progress, throughout elementary, middle, and high school have been thought to be one factor keeping females from pursuing advanced courses and careers in science (Taasobshirazi & Carr, 2008).

Gender differences in achievement on standardized tests in the STEM subjects start in middle school with males dominating the gap, and the differences widen throughout high school and college (AAUW, 1995; Good et al., 2010; Rosser, 1995). However, a different pattern emerges when comparing grades assigned by teachers. Females make higher grades than males in all subjects, including science (Taasobshirazi & Carr, 2008). This gap could be attributed to females pleasing the teacher and having fewer disciplinary problems in the classroom (Taasobshirazi & Carr, 2008). However, males still outperform females in college introductory physics and engineering courses. This difference in achievement could help explain the higher percentage of women switching to non-science majors. Females typically lose confidence when they get a low score, such as a C, and feel that they are not good enough (Kerr & Kurpius, 2004). Males do not take the low scores as personally as females (Taasobshirazi & Carr, 2008). Within the science gamut, there are even fewer females in the physics and engineering subjects (Vogt, Hocevar, & Hagedorn, 2007).

Since fewer women major in the STEM fields, there are fewer candidates to fill the positions needed in science, technology, engineering, and mathematics careers. The prediction of critical workforce shortages in jobs that require high-level mathematical and

science skills means a lack of scientists and mathematicians in the United States which has fueled concerns that the country will not be able to maintain its leadership in science and technology (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007). The United States has relied on foreign graduates from U.S. universities to supplement the STEM workforce; however, in recent years more and more of these foreign students are returning to their homeland after completing their degrees (Zhang, 2011). Without leadership in science and technology the country's economy, homeland security, and overall well-being will suffer. In 2010, women made up nearly 47% of the U.S. workforce but held less than 25% of the STEM jobs (U.S. Department of Labor, 2010; U.S. Department of Commerce, 2011). Making further use of the female talent pool could supplement the dwindling workforce shortages in science, technology, engineering, and mathematics employment opportunities.

In order for the United States to remain a world leader in science and industry, it cannot afford to neglect the largely under-tapped potential that lies within this substantial segment of the college population (Tsui, 2009). This is not just a problem isolated to the United States, but even in foreign countries. However, some countries have minimized this problem in their workforce. Smith and Dengiz (2010) conducted a study on the women in science and engineering in the country of Turkey. Since the formation of the Turkish Republic in 1923, the country has moved from virtually having no female participation in science and engineering to outnumbering those in the United States and Europe. Foundations of the Turkish Republic focus on respecting teachers and believing they can save nations, valuing science, and understanding that the reason for lack of success in society is due to the indifference and discrimination towards women. If science

and engineering are essential for the success of nations, then both men and women must equally master them (Smith & Dengiz, 2010). Science, technology, engineering, and mathematics are crucial in the development of a nation and solving the many problems that arise. However, women are marginalized in these areas. With women making up over half of the world's population, they cannot be ignored. Their talents must be utilized to continue the meaningful development of the world's nations (Aguete, Idialu, and Aluede, 2008).

The economic success of the United States depends on students receiving a first-rate education, especially in the areas of science and mathematics (Zhang, 2011). In 2009, among recent high school graduates, 74% of the females entered college where only 66% of the males entered college (U.S. Census Bureau, 2012). Since female students currently occupy a greater number of seats in four-year colleges and universities than males, it is important to understand the experiences of men and women in STEM classes during elementary school, middle school, high school, and college, in order to prepare them to enter the STEM career fields that will help our country thrive economically and defensively. It is obvious that no nation can afford to lose out on the potential contributions of half its population. Also, questions regarding social justice and inequality of opportunity are raised when social structures impede or discourage women from attaining success in STEM. STEM fields can benefit from the input of different voices and viewpoints, including those of men and women (Machina & Gokhale, 2010). It is vital to have women in the STEM fields, because they ask different and essential questions and challenge the methodology of male researchers (Minerick, Wasburn, & Young, 2009). For example, the absence of women subjects from medical research and

drug trials could lead doctors to prescribing high doses of drugs or drugs that act differently in women than men (Rosser, 1997). All-male design teams can produce flawed products. Jane Margolis at Carnegie Mellon University cited the example of air bag development, which were normed on the male body, and could have sometimes been deadly to women and children (Margolis & Fisher, 2000). These examples show that having a balance of male and female expertise in the STEM fields will greatly benefit society.

### **Statement of the Problem**

Experiences in the classroom and in college have been found to influence students' aspirations and persistence (College Experiences, 2007). Questions exist about whether appropriate changes have been made in STEM classrooms to accommodate the diversity of students. Professors may recognize that students have different learning styles, but what is done to cater to these learning styles to ensure success of the different individuals, namely males and females? Many women who start college majoring in science and engineering fields do so because they love the subject and because they have excelled in these subjects in their previous school experiences (Jesse, 2006). However, they are more likely than their male counterparts to drop out of science in college and as a career (Jesse, 2006). Are they intimidated by the male dominance in the classroom? Are they ready to expedite their career path and experience the "real world"? Do they feel that they are not good enough in class? These may be situations that many females encounter, and thereby forego a career in the sciences, opting for an easier, more acceptable path for females. Women tend to be more communal than men and concerned with the well-being



of others, and men tend to be more assertive and controlling than women (Kaenzig, Hyatt, & Anderson, 2007). Professors may give more support and feedback to male students who tend to be more assertive, which may help them to persevere and complete STEM courses. Women on the other hand, may withdraw from STEM courses due to their gentle and yielding tendencies, which are not typically rewarded in the competitive courses. Conflicts may also arise between males and females due to their different temperaments, and these negative experiences may also contribute to the attrition of students in STEM courses (Kaenzig et al, 2007). Women may not persist in the sciences because of negative experiences and lack of full support by their male peers (Fuselier & Jackson, 2010). The interactions between the students and professors and between students may foster experiences that encourage or discourage the completion of STEM degrees.

### **Inspiration for this Study**

Goldman (2010) conducted a study to better understand the experiences of undergraduate women in their pursuit of STEM degrees. Most of the important studies to explain the choice of majors, role of gender, and experiences of women in college are based upon quantitative studies. These quantitative measures do not always yield a complete picture; therefore, qualitative studies need to be conducted to look in depth at the experiences women have while majoring in STEM fields (Goldman, 2010).

Goldman's study included the interview of ten female participants all of whom were STEM majors. The interviews elicited participants' experiences and individual stories, including information about their family, peers, role models, and academic and

social experiences, as well as why they chose to pursue a major in the STEM fields. The interviews also unearthed how the participants negotiated gender within their pursuits of STEM fields. These interviews yielded eight themes and it was surprising that the women did not feel that the concept of gender related to them as undergraduate women pursuing STEM fields. Women may be the victim of gender disadvantages without knowing it.

Being among the statistics of women who failed at completing a STEM degree, the researcher connected with Goldman's study because it was interesting to see how and what the women experienced as they were pursuing a STEM degree. While majoring in the STEM degree the researcher did not have any colleagues to discuss experiences and coping strategies with in order to traverse the obstacles associated with the major. It may be too late for the researcher to change her course of earning a STEM degree, but by understanding the experiences shared by both females and males as they follow their STEM coursework, she may use her platform as an educator to help students overcome obstacles they may experience and retain them in their pathway of earning a degree in STEM.

This study is different from Goldman's in that it looks not only at the experiences of females, but it also includes the experiences of males. Acquiring the experiences from the male point of view will allow a comparison of how men and women understand gender and its relationship to the choice to earn a degree in a STEM field, and how men negotiate gender while completing STEM coursework.

Research regarding males in the STEM fields is lacking. Most research focuses on the fact that men outnumber women in completion of STEM degrees and emphasizes the obstacles faced by women while pursuing degrees in a STEM field. Since research

suggests that males are more successful than women in the completion of a STEM degree, it is essential to study the male insight and experiences and compare it to that of females. By understanding the experiences of both male and female students and how they navigate through STEM coursework, educators may use this acumen to modify instructional practices. Recognizing similarities and differences in experiences among both genders may encourage educators to utilize methods that are beneficial to the classroom climate and assignments given in order to make it more equitable for both genders. Understanding the experiences of males may provide insight into environmental factors or instructional strategies that tend to be perceived differently and those perceived similarly by males and females. This comparison may help identify critical factors in a female's experience of and persistence in STEM education. Therefore, this study will not only include the female experience, but also the male experience of undergraduates who are majoring in a STEM field.

The question to be investigated in this study is: How do undergraduates who have chosen to pursue majors in STEM fields experience and negotiate gender? The goal of this study is to better understand the experiences of undergraduate men and women who have made the decision to complete a degree in a STEM field. It emphasizes particularly the undergraduates' experiences within the STEM fields related to gender and how they negotiate gender. Gender negotiation is when an individual possesses the realization that life experiences, expectations, and the needs of women and men are different. To examine the role of gender in STEM education, a qualitative research study that relies on semi-structured interviews with undergraduate men and women in STEM fields will be carried out. Information from these interviews will be used to paint a more detailed

picture of experiences endured by undergraduates enrolled in STEM fields. Information collected from this study may be used by the college administration and professors to better assist undergraduates of both genders as they work towards the completion of a STEM degree. Educators could also use information from the study to enhance STEM preparation at the middle school and high school levels, since the interviews will inquire about all levels of the participants' education experience.

### **Limitations of the Study**

Limitations of this study are due to the nature of the methodology. A phenomenology provides a deep understanding of a phenomenon that is experienced by individuals with similarities (Creswell, 2007). Knowing the common similarities and differences between the experiences of men and women can be valuable to groups such as educators and policy makers.

The study will be conducted by purposely selecting participants, undergraduate men and women who are majoring in STEM fields, from one university. Since the participants will be purposely selected from one university, the results may not be generalizable to different types of educational institutions. In addition, the study will only include a small sample of undergraduates, further diminishing the generalizability.

Participants in the study must be volunteers. Since the participants are volunteers they may be reluctant in sharing their experiences with the researcher. In order to acquire robust information from the participants, they must feel secure in sharing their experiences with the researcher. One way to garner complete disclosure from the participants is to ensure the confidentiality of their statements. Confidentiality is of

utmost importance for assembling participants for the study. This will promote hearty revelations from the participants as they will not have to be concerned with others, such as professors and peers, being informed of their statements. Each participant will complete a consent form. By placing an emphasis on the importance of confidentiality during the research project, hopefully the impact of this limitation will be minimal.

The method of gathering information for this study is through the use of semi-structured interviews. Participants can express their experiences and beliefs in order to help the researcher understand the situation. Interviews can allow the researcher to probe deeper into the participants' reactions such as, facial expressions, tone of voice, and body language. A limitation to this is that participants may state what they believe the researcher wants to hear. Establishing rapport and trust of the participants is essential in order to gather unrestricted information. Allowing the participants to select a meeting location and time for interviews may help address this particular limitation.

Another possible limitation is researcher bias which can cause unfounded conclusions. After the researcher codes the information, a second person will also code the information as a comparison to alleviate unfounded conclusions. However, this study is not focused on generalizability but on understanding the experiences of undergraduates majoring in STEM fields.

## **Summary**

There are more women than men attending colleges and earning degrees. However, men still outnumber women who major and complete degrees in the STEM fields. Research suggests that females are discouraged from pursuing degrees in STEM

fields due to lack of achievement in STEM subjects on standardized tests, pressure to conform to the traditional female social roles, and lack of confidence of succeeding in their academic endeavors. The shortage of women completing STEM degrees reduces the number of scientists and mathematicians needed to help our country thrive economically and defensively. The viewpoint of half of the population is neglected when there are fewer women represented in STEM fields. Most research indicates that there are less women pursuing and completing STEM degrees; however, it does not consider the values, pressures, and expectations afforded to young college-age women and men, and how they negotiate gender. These factors may be reflected in their choices while pursuing a degree in a STEM field. By taking a profound look into the experiences of both men and women, it will be possible to gain a deeper understanding of why a gap exists between the number of men and women completing degrees in STEM fields. The study may also provide insight into how to deal with this situation.

## **CHAPTER II**

### **REVIEW OF THE LITERATURE**

#### **Introduction**

This chapter will provide impressions from the current literature. It will open with a discussion on how and why college undergraduates choose their major, as well as factors that help determine their major. Also, the many explanations on why there is a gap in the number of males and females enrolled in the fields of science, technology, engineering, and math (STEM) will be examined. These explanations have been divided into the categories of biological differences, social and structural backgrounds, and psychological explanations (Goldman, 2010). This chapter will also discuss the occupational aspirations of males and females. The chapter will conclude with the theoretical framework on which the study is based.

#### **Choosing a Major in College**

The choice of major is not only significant for the four years of college life, but it also determines the path an individual will follow after graduation. Undergraduate majors are highly associated with job stability and satisfaction, as well as career opportunities and rewards. While this choice is one that is vital in establishing a career and idyllic life; it is also a choice that may be influenced by many different factors. The income, education, and occupation of parents; gender; personality type; previous experience; interest in major; expected level of pay; ethnic background; and political orientation may influence an undergraduate's major choice (Malgwi, Howe, & Burnaby, 2005; Porter &

Umbach, 2006; Yazici & Yazici, 2010). This research will address just a few of those factors, including gender.

Gender is a robust factor that contributes to the choice of college major on an international scale (Yazici & Yazici, 2010). Although there are higher numbers of women enrolled in college, they remain underrepresented in science, technology, engineering, and mathematics and overrepresented in education and helping professions when compared to men (Karpiak, Buchanan, Hosey, & Smith, 2007; York, 2008). Women continue to pursue careers that have been traditionally associated with them, especially in the health professions, education, and the social and behavioral sciences, despite the much higher salaries of male-dominated fields (Morris & Daniel, 2006). The number of females enrolled in pharmacy programs has increased dramatically, with 59.2% of the applicants being female in 2007 (Keshishian, Brocavich, Boone, & Pal, 2010). While pharmacy programs require strength and interest in math and science, they also require interest in caring for and helping other humans. This is the type of helping profession to which females tend to be drawn. On the other hand, engineering is among the least gender-equitable majors in the United States. One reason is that most women do not consider engineering as a viable career choice, because they may believe it is incompatible with their interests and values of helping individuals and improving society (Baker, Krause, Yasar, Roberts, & Robinson-Kurpius, 2007).

In a study conducted by Karpiak et al (2007), undergraduates declare “sex-segregated” majors upon entry to college, and by the time graduation occurs the distribution of majors is even more strongly “sex-segregated.” Women are more likely to choose majors that are traditionally dominated by women due to their gender role



orientation (Porter & Umbach, 2006). The nominal few women who choose majors in the STEM fields are under tremendous pressure, which results in a greater chance of attrition (Porter & Umbach, 2006). Even female college graduates expect more out of other women in male-dominated fields, including female science professors. Female students expect that female faculty members are especially exceptional, and not only do they need to vindicate their inclusion in the higher ranked positions, but they must continue to defend themselves by demonstrating outstanding ability (Alpay, Hari, Kambouri, & Ahearn, 2010).

Students' college choices can also be linked to measures of occupational returns (Goyette & Mullen, 2006). Graduates in engineering, business, and math earn the highest annual salaries, while education and psychology students earn significantly less. Men typically concentrate in fields such as business, engineering, chemistry, and physics, while women have studied education, humanities, nursing, and psychology (Goyette & Mullen, 2006). Hearn and Olzak (1981) conducted a study with an effort to explain gender differences in a choice of field. They deduced that males would choose majors with less supportive climates and more competition to achieve higher rewards, while women would elect to choose a major with more supportive departments and less rewards.

Social background or socioeconomic status (SES) can also contribute to the major an undergraduate selects (Bers, 2005; Goyette & Mullen, 2006). Money was a factor most often mentioned by parents and college students in their choice of college, more so than the types of programs offered at that post-secondary institution. Since affordability is a major concern of college choice, many students coming from a low SES choose

community colleges, which are typically more affordable, but may mostly offer vocational programs. Women are more likely to receive bachelor's degrees in vocational subjects. People generally choose majors associated with their social class. SES is a fairly strong predictor of choice of college major for both men and women. A higher SES contributes to non-traditional major choices, such as STEM majors, for women more so than men (Trusty, Robinson, Plata, & Ng, 2000).

In summary, many factors influence an individual's choice of major in college. Gender is a major factor in this decision. Women typically select majors that are traditionally female which include "helping professions" or areas such as education and health. Females also tend to base their major selection on their aptitude which typically involves majors that are heavily dominated by women which may have a more supportive climate but less occupational returns and rewards. Males, on the other hand, tend to select majors that are linked to higher occupational returns and involve a more competitive nature with less supported climates. The socio-economic status of individuals also predicts the type of major selected in college. Students typically select majors that align with their SES; females from a high SES are more inclined to select non-traditional female college majors.

### **Possible Reasons Males Outnumber Females in STEM Fields**

During elementary school, girls outperform boys in almost every subject except for science on standardized tests. (Sadker & Sadker, 1994). In middle school, the test scores of females begin to plummet and a gap in academic achievement begins between the genders in the areas of science and math (Sadker & Sadker, 1994). It is in high school

where the gender differences in math and science performance truly increases, with the males outperforming the females on tests such as the PSAT and SAT (Hill, Corbett, & Rose, 2010; Tsui, Xu, & Venator, 2011). The differences in SAT and ACT scores during the 1990's, favored by males, could be due to the fact that females were less likely to take advanced mathematics and science courses in high school (Doolittle, 1989). However, that gap has equaled out over time with females taking more advanced math courses, but there is still a difference in science courses. While females have enrolled in more advanced science courses, they are concentrated in the area of Advanced Placement (AP) Biology, leaving a larger gap in AP Chemistry and AP Physics (Combs, Slate, Moore, Bustamante, Onwuegbuzie, & Edmonson, 2010). Of these girls who completed advanced science courses in high school, most did not continue enrolling in science courses in college (Combs et al., 2010). Possible contributing factors to the gap between the numbers of males in females majoring in STEM fields include biological differences, social expectations and structural backgrounds, and psychological reasons.

### Biological

There is still a notion that males are better at mathematics and therefore more suited to pursue STEM fields than women due to biological reasons (Hill et al., 2010). In January 2005, Lawrence Summers, former President of Harvard University, started a firestorm of controversy when he proclaimed that men outperform women in math and sciences because of biological differences, and discrimination is no longer a career barrier for female academics (Bryce & Blown, 2007). Neurologist Dr. Norman Geschwind suggested male superiority in mathematical skills was due to exposure to more testosterone while in utero (Hensel, 1989). Other biological mechanisms to explain

the gap are genetic differences, different brain lateralization, and hormonal factors (Quaiser-Pohl & Lehmann, 2002). Highly debated claims such as these lack evidence, and in fact more recent studies suggest that the gender differences that do exist are small and have decreased over time (Callas, 1993). With advancing technologies in neurological studies, researchers have been able to show that the differences in the brains of men and women are greater than previously understood. Different regions of the brain develop differently during childhood, which can lead to conclusions that favor girls in the areas of verbal fluency, handwriting, and facial recognition, and favor boys in the areas of spatial and mechanical reasoning and visual targeting (Bryce & Blown, 2007; Callas, 1993; Halpern et al., Hill et al., 2010; Neto, Ruiz, & Furnham, 2008; Quaiser-Pohl & Lehmann, 2002). When a problem can be solved by either using verbal computation or spatial imagery, males typically use the latter (Klein, Adi-Japha, & Hakak-Benizri, 2010). These group strengths, which are found in early school years become more established in adolescence and remain constant through adulthood (Parsons, Rizzo, Van der Zaag, McGee, & Buckwalter, 2005).

The IQ's of males and females can be influenced by play materials available and utilized at an early age. The IQ of males is highly associated with an organized environment with a variety of play materials and encouragement for development, where the IQ of females is highly associated with maternal responsivity and the level of punishment (Bradley & Caldwell, 1980; Kamin, 1978). It was also suggested that brain size could correlate to an individual's IQ. Sex differences in the percentage of cranial tissue and its asymmetry could contribute to cognitive differences. Reiss, Abrams, Singer, Ross, and Denckla (1996) stated that the total cerebral volume in males was 10%

larger than in females, and little differences in brain volume may be equivalent to millions of neurons. Akgun, Okuyan, and Baytan (2003) found the relationship between brain size and IQ to be significant among right-handed and left-handed males. Only a correlation was found between brain size and IQ among left-handed females, which indicated that the asymmetric organization of the brain should be considered when studying relationships between brain size and IQ (Akgun et al., 2003). Up to the age of 14, it is suggested that there is not a sex difference in cognitive ability. At the age of 15, a significant sex difference is apparent in favor of males (Blinkhorn, 2005). More current literature suggests that there are no significant differences in overall IQ between the sexes (Szymanowicz & Furnham, 2011). The widespread use of video games can contribute to the improvement and changing of an individual's spatial orientation, mental rotation, and spatial visualization (Smith, Majchrzak, Hayes, & Drobisz, 2011). Feng, Spence, and Pratt (2007) conducted a study to see if the gender differences in spatial cognition could be modified by training with action video games. These types of video games usually involve first-person shooting, which is more appealing to boys (Feng et al., 2007; Quaiser-Pohl, Geiser, & Lehmann, 2006). Therefore, males may develop skills in spatial cognition more than females who utilize these action games in smaller numbers. The researchers conducted an experiment in which a group of both males and females trained by playing a 3-D, first-person shooting game over a number of weeks. After taking pre-tests and post-tests on spatial attention, females showed much more improvement than did the male participants, virtually eliminating prior gender differences in spatial cognition (Feng et al., 2007). Spatial abilities have been linked with success in math and science courses and the choice of mathematics and science majors in college (Klein et al.,

2010). Training females with appropriately designed action video games could be a strategy to interest women in science and engineering careers by providing training to enhance their spatial abilities (Quaiser-Pohl et al., 2002). Gender differences in spatial abilities cannot be attributed to biological make-up alone; learning plays a major role, and activities that engage and nurture spatial skills are vital to achieve greater accomplishments (Spence, Yu, Feng, & Marshman, 2009).

The genetic explanations for the gap between the sexes in math and science have received little empirical support (Hines, 2007). A lack of interest in mathematics and science begins around the time a female enters high school, despite the dearth of differences in biologically based precursor skills and abilities in young girls and boys, which implicates social factors (Halpern et al., 2007; Karpiak et al, 2007; Tsui et al., 2011). Thus, biological differences do not completely explain the differential representation of men and women in high-level careers in math and science. Data suggest that social and psychological factors, such as personality, interests, and motivation, may also help to explain some of the gender differences in domain knowledge (Ackerman, 2006).

## **Social and Structural Backgrounds**

Gender socialization is linked to the separation of academic and career interests between males and females. Research has shown that teachers, parents, peers, media, schools, and individuals themselves hold a mindset that encourages different academic and career expectations for males and females (Karpiak et al, 2007; Masnick, Valenti., Cox, & Osman, 2010). Parents' evaluations of their children's abilities strongly influence

boys' and girls' achievement-related beliefs (Bhanot & Jovanovic, 2009). Parents engage with sons and daughters differently around schoolwork, especially in sex-type domains such as math and science. The involvement of fathers with their sons and daughters varies more than the mothers' involvement. Fathers were found to make more cognitive demands on the child's learning physics-related tasks if the child was a boy (Bhanot & Jovanovic, 2009). Social structure illustrates that society has different and higher expectations for males than females. MSALT (Michigan Study of Adolescent Life Transitions), a study that looked at the influence of parents' education on their children's educational attainment (Eccles, 2005), showed that parents of daughters had lower expectations of their child's future performance in math, engineering, or physical sciences than parents of sons. Parents with higher levels of education can induce lower gender-role stereo-types and less gendered socialization practices within their families (Eccles, 2005). Children are taught by their teachers and family members that boys are good in 'hard' fields (physical science, mathematics, computer science, and engineering) and girls are good in 'soft' fields (social, psychological, and biological/life sciences), and it is suggested that there is a lack of role models for girls at home and in schools in the areas of science, math, engineering, and technology (Baker et al., 2007; Brandell & Staberg, 2008; Camp, Gilleland, Pearson, & Vander Putten, 2009; Varma, 2010).

In a study conducted by Varma (2010), perceptions of males and females of different ethnicities in the computer and technology field were examined. The men of White, African-American, Hispanic, and Native American descent all expressed the feeling that men were technical and women were not. Some proclaimed that "men are technical and women are emotional," and "society teaches children that men are

supposed to take on the larger and important tasks while women are supposed to take on the manageable tasks.” One male even explained, “Women are supposed to get some sort of careers so they can have enough time to be a housewife, raise children, and prioritize family.” Shockingly the women in the study agreed with resentment, “We have children, so we have to take care of them...Men get out easier than women.” Not only do men perceive differences in which type of work is appropriate for the different genders, but starting in high school they rate women teachers lower than men teachers. Data from a national survey of college students suggested that male students evaluated their female high school biology, chemistry, and physics teachers significantly lower than their male teachers; female students rated female teachers lower only in physics (Minerick et al., 2009). The students in the study have adopted gender stereotypes and could have negative views of their female peers and colleagues if and when they become successful scientists.

The social structure and expectations that surround girls and boys from the time they are born may determine their personal characteristics. Girls tend to be more “people oriented” and boys tend to be more “things oriented” (Galambos, Berenbaum, & McHale, 2009). Girls tend to spend more time in relationship activities, and boys tend to spend more time alone, playing video games, watching TV or playing ball. This may lead to girls’ preference for people-oriented occupations such as teacher or social worker, and boys’ preference for manual labor or working with tools, which can lead to an occupation such as mechanic or engineer (Perry & Pauletti, 2011). Women with an interest in science are more likely to enter fields such as psychology, biology, and agricultural sciences (Little & Leon de la Barra, 2009). Even from the time children are in early elementary



grades, the trend of boys being interested in physical sciences and girls being interested in biological sciences are evident (Baker et al., 2007; Little & Leon de la Barra, 2009).

Another social factor that can explain a gap between the numbers of males in females in math and science is the due to the way teachers manage their classrooms. Classroom management can make a difference in the willingness of female students to engage in the subject. Males more typically talk and blurt out in class; these risk takers may shut down more deliberative thinkers. Teachers are more likely to stop girls if they respond incorrectly, but encourage boys even if they are giving the wrong answer (Hua, 2011). Teacher-child interactions may reveal different socialization processes for boys and girls (Marsh, Martin, & Cheng, 2008). Teaching practices that may help engage the interests of females include working in small groups and learning through practical activities from a young age (Little & Leon de la Barra, 2009). Younger children may have difficulty learning abstract ideas and should have science activities that include personal involvement and hands on investigations (Little & Leon de la Barra, 2009). These gender-linked differences in socialization patterns are umpired by classroom teachers and these processes may fail to adequately reinforce boys' positive attitudes, expectations, and performance in verbal areas and likewise for girls' in the area of mathematics and science (Klein et al., 2010). Environmental factors, such as the teachers' behavior may suggest that the difference in mathematics performance between boys and girls is not to be determined by genetics (Klein et al., 2010).

The environment of the classroom can also contribute to the gap between the number of males and females who major in STEM fields. Over half of all women who major in a STEM field switch to other majors before completing an undergraduate

degree. A suggested reason for this trend is that women do not feel welcome in traditionally male-dominated college majors and fields (Morris & Daniel, 2008). This experience can arise from being ignored, treated differently, or sexually harassed; and is branded the “chilly climate” (Barr & Birke, 1995; Morris & Daniel, 2008). The “chilly climate” is an effect caused by a number of practices which communicate lack of confidence, lack of recognition, and devaluation, which result in women’s marginalization (Prentice, 2000). Often behaviors of perpetrators contributing to the chilly climate are unintentional, but may persuade women or minorities to refrain from participating in class or persevering in their decided major (Allan & Madden, 2006). Even in high school physics classes, the boys and girls were aware of gender inequities, and this made the girls fearful of participating in large and small group discussions and activities, which can hinder their achievement in the subject (Baker et al., 2007). Asking questions during class could be perceived as academic weakness. Not asking questions and evading peer study groups have been known as two ways in which male students preserved their “smartness rating” (Vogt et al., 2007, p. 343). Women, who are the minority in male-normed engineering classes, feel intimidated and discriminated against and therefore less confident. Programs such as science and engineering have environments that are based on male cultural norms (Ferreira, 2003). Females who were exposed to science classrooms that were competitive, hierarchical in nature and less interactive were more likely than their male peers to lose interest in STEM fields (Amelink & Meszaros, 2011). Social norms, such as lack of support in the traditional STEM environment, may be harmful to women given that researchers and theorists have constantly emphasized the importance of relationships and interpersonal connections to

women's psychological development and well-being (Morganson, Jones, & Major, 2010). Female students in technical disciplines such as physics, engineering, or technology are especially vulnerable to poor teaching and hostile teaching environments (e.g. large classes and unhelpful faculty) and feel like "outsiders" (Margolis & Fisher, 2002). Engineering or "male-normed" classrooms may cause women to feel more susceptible to negative opinion from professors and classroom peers. Morganson et al. (2010) conducted a study to see if coping strategies used by men and women majoring in STEM majors would help them overcome their barriers and thereby increase persistence and performance, especially for women. Typically men cope by trying to change the stressor or ignoring the stressor, but women engage in social support coping. Social support coping involves looking to others for emotional support; this inclination is representative with cultural typologies of women as communal and relationship oriented (Morganson et al., 2010). Women majoring in a STEM field used social coping more than men; however, the chilly climate of the STEM environment does not support the act of using social coping, which may contribute to women's lack of persistence in the field. Problem-focused coping strategies, favored by males, have positive effects on their academic achievement, whereas emotion-focused strategies, favored by females, do not (Clifton et al., 2008). Males typically have proactive personalities which were found positively linked to commitment in STEM majors due to the characteristics of active planning and increased participation when coping with stressors (Major, Holland, & Oborn, 2012). The more actively engaged students are with the college faculty, staff, and other students, the more likely they are to persist in their studies. The environment set by the faculty in the classroom can set the tone for how students treat one another. Creating

supportive learning environments that encourage positive cooperation can accommodate many different student groups, including those that are underrepresented (Amelink & Meszaros, 2011; Ferreira, 2003).

Not only is the “chilly” classroom environment a factor in the gap between the numbers of males and female majoring in STEM fields, but the bias in course textbooks may also contribute to this disparity. Even though women are lured into the medical fields, they do not escape the gender bias. Dijkstra, Verdonk, and Lagro-Janssen (2008) found that medical textbooks fail to consistently integrate gender-related aspects of topics such as depression and alcohol abuse. Gender specific information is difficult to find in the textbooks, and they exhibit women’s health problems as abnormalities of a male norm. Textbooks on dermatology, epidemiology, and occupational medicine at a Swedish university displayed the male as the norm with which the female was compared. The biological and psychosocial differences between the sexes were obscure (Alexanderson & Wingren, 1998). A study of textbooks lacking gender equitable photos and language is connected to the underrepresentation of females in science in Brunei (Elgar, 2004).

The lack of female role models in STEM fields may also contribute to the disparity in numbers between men and females majoring in STEM fields. Research shows that women performed better in math and were more confident about their math skills when they were exposed to female role models who were good in math, and were made aware of women’s achievements in masculine fields (Oswald, 2008). Feminist scholars have argued that the most basic aspects of systematic theory in natural sciences have been saturated by masculine perspectives stemmed from masculine experiences (Siann & Callaghan, 2001). The lack of female role models in STEM fields is also an

issue of retaining women in these areas. In a case study conducted by Viefers, Christie, and Ferdos (2006), all three female participants mentioned having a female role model who inspired them to pursue science, but agreed that more role models were needed in physics education to attract and retain female students. Since having female role models in STEM is very important in gaining the interest of young women, and education has been the route to strengthen capabilities in STEM fields, female professors can serve as role models. However, only 23.6% of all full professors are women and only 2.8% of all engineering full professors are women (Minerick, 2009). Improving the number of women role model professors at the university level could be one key to gaining and retaining more females in the STEM fields, as well as helping these females form a STEM identity, or recognize and develop characteristics that are necessary to be a scientist, engineer, or mathematician, especially in engineering and technology (Alpay et al., 2010).

Another social aspect that may affect the number of males and females who major in STEM fields are cultural stereotypes. Cvencek, Meltzoff, and Greenwald (2011) found that as early as second grade, children demonstrate the American cultural stereotype that math and science is for boys, and that elementary school boys identified with math and science more strongly than girls on implicit and self-report measures. The math and science-gender stereotype develops early, even before it shows on academic achievement tests. Science and mathematics careers are still perceived as jobs for men among students as young as age five (Baker et al., 2007). While males and females may have similar interests in science, math, and technology at elementary school age, by the time they reach puberty the gap in interests widens. This period is known as gender intensification

in which boys' and girls' interests in doing gender appropriate activities increases (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Adolescence is a difficult time for all, but more so for females. As adolescent females work to establish their identity, STEM areas become less interesting to them. Knowledge of social stereotypes may cause children to have reduced interest in future academic courses and occupations that are incompatible with their academic self-concept, which is the association of the individual with an academic subject in which they feel confident (Cvencek et al., 2011). The lack of interest in the sciences from females can also be due to not knowing about them. The Extraordinary Women Engineer Project of 2005 found that high school girls do not understand what an engineer does. All they know is that it is for people who love math and science. All they know is that engineering is typically nerdy and boring (Sinkele & Mupinga, 2011).

According to Perry and Pauletti (2011), adolescent girls choose easier tasks, avoid competition, and have lower expectations than boys. If aware of the stereotype that girls are inferior at mathematics, they are apt to experience anxiety that can inhibit their performance in math. Females lose their confidence and doubt their abilities more so than males. The students also expressed the opinion that boys like challenging mathematics problems and find the subject easier than do girls. The females expressed that it is more common for girls than boys to worry about not doing well enough, and they are more likely to consider math as a boring subject (Brandell & Staberg, 2008).

Females become more aware of the cultural and societal roles during adolescence and may conform to fit in (Margolis & Fisher, 2002). Computer science and technology students are often classified as "super smart" and "nerdy" which can dissuade many

females from choosing those classes or fields (Margolis & Fisher, 2002). Adolescents characterize the “popular girls” to be attractive and thin, snobby, and cliquish, which does not fit in with the character traits of girls in STEM disciplines (Perry & Pauletti, 2011). Siann and Callaghan (2001) also found that both male and female scientists were seen to be introverted and socially withdrawn or nerdy. Women’s lower self-esteems may not stem from low confidence in their own abilities, but from self-presentation strategies. Self- presentation refers to how intelligent women appear in front of others. Females judged that peers felt worse and liked them less after immodest statements, such as revealing high scores on intelligence tests. On the other hand, men who boasted about their achievement expected to be liked more by their peers (Szymanowicz & Furnham, 2011).

In recent decades, researchers have probed into the disparity between the numbers of males and females who major in and complete degrees in STEM fields. Initially, the gender gap in science and engineering existed because women did not take the required pre-requisite classes prior to college and were lost at various leakage points in the pipeline from school to work (Schreuders, Mannon, & Rutherford, 2009). The “pipeline theory” developed in the 1990s was used to explain the gender disparity in science, mathematics, engineering, and technology areas (Morganson et al., 2010; Schreuders et al., 2009). In recent years, female students are more likely to complete an engineering degree and less likely to switch to a non-engineering program, but women are still less likely to enter science and engineering programs. The women who do enter these programs are more resilient (Schreuders et al., 2009; Vogt et al., 2007). While women have made great strides in medicine and biological fields; engineering is still a male-

dominated field. Few women express interest in engineering, math and hard sciences because they often do not feel that engineering is a career that can meet the needs of others (Schreuders et al, 2009). Women and society are often unaware of the societal relevance of engineering which contributes to the greater good. Projects such as designing prosthetic limbs and developing ways to provide fresh water to villages have been directed at women in engineering programs in colleges so they may see the relevance that engineering has with interacting and helping others (Baker et al., 2007). Since women are more drawn to the “helping” sciences, highlighting the contributions that studying engineering can make may increase their interest and perseverance in the engineering field.

Gender is taught to individuals from the moment they are born from the colors worn as babies to the toys with which they are expected to play. Our society has a great impact on the roles that children develop and choose to play. “Educators and parents carry the power to affect the attitudes, values, and beliefs of young people. Often these influential individuals are unaware of the ideals that they pass on through their words and actions” (Friend, 2006, p.12). Upbringing, peers, parents, teachers, media, and religion influence and shape gender identities from a young age, and influence individuals throughout their lives. People tend to adopt social norms and mold their behavior to meet the expectations of the norms. Women and men are coerced into differential social roles, and they often choose their gendered pathways (Risman, 2004).



## Psychological and Behavioral Expectations

Bandura's social learning theory may also explain why women are less successful in STEM majors and careers. Social learning theory explains an individual's perceptions of self, and these perceptions are interconnected with the impact of society (Bandura, 2003). Although most children enter school with a high interest in science and math, overtime their interest towards science decreases forming a negative attitude towards the subject, especially in middle school (Masnick et al., 2010). This negative attitude is related to decreased feelings of competence in the subjects.

When compared to the past, young women currently entering the engineering field are at the top of the mathematics test score range, are as likely as males to have taken the proper prerequisites in high school, are definite about their academic and career choices, and are confident in their academic abilities; however, the environment of the classroom can affect the self-efficacy of a student (Vogt et al., 2007). Self-efficacy is an individual's belief in his or her ability to succeed, and it can impact the psychological states of individuals which affects behavior and motivation. For example, if a female does not have confidence in a STEM major, then she may develop a negative attitude toward the subject and decide to quit pursuing it.

Not only is self-efficacy related to the success of a STEM student, but persistence is also important. In a study on graduate student attrition in a biology and chemistry department (Ferreira, 2003), females had a significantly higher attrition rate than males as a result of department and discipline contexts. The chemistry department was based on traditional male cultural norms of individualistic competition and aggressiveness. There was a lack of women professors and students, and in the chemistry department there was

not a single female professor. These cultural norms affect the psychological state and behaviors such as perseverance and motivation, of women and their ability to be successful in STEM fields.

“Women’s persistence may be based on the ecological variables, such as negative stereotypes conveyed by parents and teachers regarding the role of women in science and their talent in this arena, family and school support regarding scientific education, competition in courses and lack of mentoring experiences” (Amelink & Meszaros, 2011, p. 48).

Exposing females to cultural norms that encourage and respect women in the STEM fields could alter their psychological behaviors and foster success and perseverance in STEM fields.

A study conducted in 1981, called the Illinois Valedictorian Project, revealed that by the end of high school, male and female valedictorians rated their intelligence equally, but by the second year of college, over a quarter of the females listed themselves as merely average in intelligence. None of the males lowered their ratings of their own intelligence (York, 2008). In this same study, the females started to consider and plan their careers with future family issues in mind during the second year of college, many doubting they could successfully balance a high-powered career and family life (York, 2008). Starting in adolescence, males have a higher competence belief for math and computers than females do, although the real difference in their abilities is not that vast (Bhanot & Jovanovic, 2009; Perry & Pauletti, 2011). Women, both inside and outside the academic world, lack confidence in themselves as thinkers, and their successes do not ensure an increase in their self-esteem. Highly competent females are more likely to underestimate their abilities (Viefers et al., 2006). The low self-estimates of intelligence projected by females may be due to the fear of gender inappropriate behavior

(Szymanowicz & Furnham, 2011). This also suggests that other factors such as gender stereotypes, anxiety of losing their femininity, and possible social rejection are at work. Females become more negative about male-stereotyped subjects, such as math, computers, and science, and males become more negative about female-stereotyped subjects, such as language and arts.

Stereotype threat is assumed to be caused by the recognition of cues in the social context that activate an individual's beliefs and fears of how others view their group (Eriksson & Lindholm, 2007). Research has demonstrated that gender differences in math performance may be created, perpetuated, or eliminated by factors in the test situation. Women who indicated a belief in the stereotype about women's math abilities performed worse when their gender identity was made relevant during a math test than when gender was not mentioned (Eriksson & Lindholm, 2007). Making an individual aware of their gender stereotype invokes the self-fulfilling prophecy, as coined by Robert Merton, "a false definition of a situation evoking a new behavior which makes the original false conception come true." Chamorrow-Premuzic, Furnham, and Moutafi (2004) suggested that self-estimated intelligence can have self-fulfilling effects in relation to examination performance. If females have a lower self-estimate of intelligence than males, then their performance will also be lower than males regardless of their true abilities. Rather than deal with the apprehension of substantiating negative stereotypes, women may choose to follow a stereotypically consistent field.

While negative stereotypes can result in impediments to performance in certain subjects, positive stereotypes can enhance performance. For example, Asian American women's math performance was hindered when their gender identity was highlighted but

improved when their Asian identity was highlighted (Oswald, 2008). Negative stereotypes not only impede on achievement, but also on the interest level in certain subjects. Masnick et al., (2010) suggests that science as taught in high school is not perceived as intrinsically motivating, and students who like this subject are negatively stereotyped. These people are viewed by others as less attractive, unpopular, not socially competent, and less creative than students who like the arts and humanities. If students are not exposed to the excitement of discovery and creativity of experimentation, they will be unlikely to become scientists.

Male and female engineering students, in a study by Schreuders et al. (2009), claimed that they were academically prepared to pursue undergraduate programs in engineering. However, women reported that they were not as confident as the males because they were not as comfortable as the males and lacked experience with various tools and machinery associated with engineering. This lack of confidence and experience, or self-efficacy, in traditionally male dominated programs can lead to the females' internal defeat of majoring in and completing a degree in a STEM field. "Self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of actions required to produce given attainments" (Bandura, 2003, p.9). Men consistently maintain more positive attitudes and confidence in their abilities in technology courses, another STEM field, at the college level than women (Varma, 2010). Women that are more positive about technology courses still rate their ability to do well in classes negatively, and it may take longer than males for women to overcome their anxiety about the courses and to feel comfortable with the classroom and material (Varma, 2010). Likewise a study conducted by Desy, Peterson, and Brockman (2009) showed that men tended to be more

positive about science, and therefore received higher marks in science courses than women who had negative attitudes towards science due to a lack of interest in the topic.

Having a positive attitude toward STEM courses may determine whether a student will choose to major in and complete a STEM degree. Interventions to help create a positive attitude between women and STEM may contribute to the number of women willing to major in and complete a STEM degree. Machina & Gokhale (2010) conducted a study to focus on the attitude constructs relevant to female engagement with science and technology. Feminine attitudes towards science and technology were measured among first-year female undergraduates after a freshman seminar during the initial semester in college. Students, whose freshman seminar included visits with science and technology professionals (over half of whom were women), plus at least four weeks of science and technology content, had positive attitudes towards science and technology. Students whose freshman seminar included science content but not the visits with science and technology became less accepting of female participation in science and technology with relatively positive attitudes. Students whose freshman seminars did not include any intervention declined significantly in their attitudes towards science and technology (Machina & Gokhale, 2010).

Self-esteem and confidence are critical issues for females in STEM courses. Starting in adolescence, girls tend to have a lower self-esteem than boys due to their perceptions of acceptance and respect from others, adequacy in topics (academics, sports, body image), and experience with relationship problems such as rejection (Perry & Pauletti, 2011). During adolescence, males are overall more content with their gender and have a stronger gender identity; therefore, they can focus on activities related to STEM

fields more so than their female counterparts. In the 1970's a prominent theory, Horner's Fear of Success, suggested that women possess a motive to avoid success, especially if they have to compete against men. They expect that succeeding has negative consequences such as loss of femininity and social rejection (Szymanowicz & Furnham, 2011).

A woman's gender-role self-concept can have an effect on her career choice. A gender-role self-concept refers to the degree to which a person sees herself/himself as having feminine and masculine traits (Wolfram, Mohr, & Borchert, 2009). Women who choose traditionally male-dominated careers rate themselves higher in masculinity than women in traditionally female-dominated careers (Morris & Daniel, 2008). Measures assessing the gender-role self-concept provide a femininity score and masculinity score which come from the individuals' extent of possessing feminine and masculine traits (Wolfram et al., 2009). Students with higher femininity scores tended to major in nursing and education, while those with higher masculinity scores tended to major in the physical sciences (Morris & Daniel, 2008). Females are also more likely to define themselves in terms of interpersonal relationships and are related with social discourse, intimacy, and care-giving, while males define themselves as independent from others and tend to be concerned with their individual attainment and status (Clifton et al., 2008). Women may be pulled by others into gender-appropriate fields while feeling an internal push from personal awareness of gender stereotypes. Female students in traditionally masculine majors reported experiencing more stereotype threat or discrimination, such as sexist jokes and blonde jokes (Oswald, 2008). These experiences may lead to the departure of females from traditionally masculine majors into traditionally feminine majors.



## Occupational Aspirations

Although women are earning more bachelor's degrees than men, they are still underrepresented in many traditionally male-dominated occupations such as engineering, physical science, mathematics, computer science, and chemistry. Many women who once aspired to work in a STEM field changed their major or profession to fields that are more female-dominated with low prestige and low wages. Not only are women less likely to choose careers in the STEM fields, but they are also more likely than males to drop out of the fields.

Parents' beliefs about the world and their child-specific beliefs can have a great influence on their children's occupational expectations and future occupational choices. If parents expected their adolescent children to have prestigious careers, then the children were more likely to meet the expectations and procure a prestigious career during their young adulthood (Chhin, Bleeker, & Jacobs, 2008). In this same study, it was suggested that fathers may play a bigger part in influencing their children's career decisions and choices than mothers, but both mothers and fathers played a significant part in shaping their daughters' gender-typed occupational choices.

Research supports the suggestions that the lack of women in these fields is due to their low self-concept of abilities and lack of positive attitudes towards the STEM subjects. However, it is the lack of flexibility in STEM careers that deters many women from persisting in pursuing and completing STEM degrees (Frome, Alfeld, Eccles, & Barber, 2006). Starting in high school, girls are more likely than boys to expect to make sacrifices in their professional life for the needs of their family, and they become increasingly more traditional from their freshman to senior year (Frome et al., 2006).



Females who believed occupational flexibility was more important in order to have their ideal family and personal life (i.e. affordable childcare and flexible schedule) were less likely than their female college peers to choose a major in science and were more likely to major in nursing or teaching elementary school. In addition to making sacrifices for families, many young women start to emphasize the importance in their careers as being one that helps others and does something worthwhile for society. On the other hand, young men place more value on becoming famous, making a lot of money, and seeking out challenging tasks, often those involving math and computers (Eccles, 2009). Among college graduates who consider having a family a low priority, both men and women are equally likely to complete science degrees and enter the workforce in that field. Young women who value having a family are less likely to complete a science degree as compared to women who do not place a great importance on having a family. Men's chances of completing a science degree do not vary according to their appeal of having a family (Burge, 2006).

Traditionally, women are supposed to support their husbands' careers and raise the children. Men are supposed to compete successfully in their occupational world to confirm their value as human beings and head of the household. Females should rate parenting and spouse support as more important than their own professional career (Eccles, 2009). It is unfortunate that women in dual-career couples are expected to start their "second shift" once they get home from their jobs. Women assume most of the responsibilities for their families and household. The additional duties and responsibilities of family make it difficult for women to attain a degree in a STEM field and eventually a career in that area. By midlife, the failure to attain one's career goals is a

large and significant predictor of depression in females; it lowers the psychological well-being and purpose in life (Carr, 1997).

In a study conducted by Frome, Alfred, Eccles, and Barber (2008), 83% of the female participants who in 12<sup>th</sup> grade had aspirations for a male-dominated occupation, switched to female-dominated or neutral occupational aspirations seven years later. The researchers concluded that their participants desired occupations that would allow them to have a career with a family, and the attitudes toward math and science were factors that influenced whether women would persist in their pursuit of careers in male-dominated fields.

Men and women may have equal desires for career and family, but they may face unequal chances of realizing both desires. Fewer women may be attracted to the sciences, because both sexes perceive that women must work harder than men to achieve equal success, and female scientists are less likely to combine a successful career with family life (Spelke & Grace, 2007).

Even if females do complete a STEM degree and acquire a career in that field, the need for constant retraining and education can impede on their future family plans resulting in attrition in the STEM fields (Preston, 2004). The changing nature of science can be stressful to scientists in the field due to the constant pressures of “keeping up” with all new advancements and developments. Based on economic theory, the human capital theory which suggests that science educated men and women have a certain value when entering their occupation. Over time, the scientist works in his or her job and maintains the skills learned in school, but without further education and training the scientist may fall behind the recent advances and human capital will decrease. Likewise if

the scientist takes time off from the scientific job, especially females who may take a maternity leave, the human stock will become less valuable due to the skills that were previously mastered becoming unpracticed with idle hands (Preston, 2004).

## Summary

Many explanations, such as biological differences, social expectations, and psychological reasons; have been proposed to justify the gap in the number of men and women pursuing degrees in STEM fields, but these explanations do not delve into the experiences that men and women have faced while pursuing their college degree in a STEM field. While research has suggested the male disposition is favorable to majoring in STEM fields due to gender differences, the pro-active stance of engaging females in activities that develop and improve spatial skills show that there may be factors other than gender differences at work. However, females' lack of interest in STEM fields, encouraged by the social and structural backgrounds, can lead to lower performance and perseverance in math and science courses. Society encourages females to choose paths in the 'soft' fields of education and biological sciences; and this choice is promoted by family, teachers, and peers. Especially with a lack of role models in STEM fields, girls are instinctively led into fields that are traditionally female. For the trivial amount of women who dare enter the traditionally male domain of STEM fields, challenges in the chilly classroom environment and lack of female friendly teaching methods make completing the degree almost unattainable. Negative social encounters can diminish the self-efficacy of students. Women may feel less successful and competent in STEM courses due to the social structure. Psychologically, women develop a negative attitude

towards STEM fields and leave the coursework, opting for an easier and more socially acceptable major. Also, women give up in STEM majors due to gender stereotypes. STEM majors are stereotypically male fields and women who are interested and pursue these majors are typically regarded as having higher masculinity traits. Women may be directed into traditionally feminine majors to avoid these stereotypes.

Females may abandon STEM coursework as they start thinking about future aspirations. Girls are typically expected to make sacrifices in their professional life in order to take care of the needs of their family. As undergraduate females work toward their course completion those that consider having a family as a priority will more likely change their majors to those that are more accommodating to family life.

### **Theoretical Framework/Feminist Postmodernism**

A feminist perspective suggests that traditional structural and policy variables in educational institutions associated with programs and faculties, hinder the academic and social success of women (Clifton et al., 2007). Before the 1980's, the number of college-enrolled males greatly outnumbered the females, which created a hostile environment for female students. Those females who did enroll in college faced discrimination from professors and other students, which affected their psychosocial dispositions and academic achievement (Clifton et al., 2007). Feminist postmodernism involves challenging the current society (Creswell, 2007). Gender is the central hub that shapes the lives of feminist researchers, and their goal is to amend the "invisibility and distortion of female experience" by means of leveling the social position of women to be equal with men (Creswell, 2007, p. 26).

Feminist literature has been concerned with the extent to which women and other minorities are underrepresented and why that has come about (Barr & Birke, 1998). It involves looking at groups of people who have been written out of the history of science. Even among feminists, it is difficult to find anyone who can name more than one famous woman scientist, and almost always it is Marie Curie. The most popular scientists among middle school students at a school in California were all men; Benjamin Franklin, Thomas Edison, Albert Einstein, and Bill Nye the Science Guy (Hua, 2011). Females need more role models in the science field, but even in 2011 the general public does not recall famous female scientists.

STEM majors can open the doors to careers with higher occupational compensation and respect. Studying women's lives and the issues they experience can give each individual woman a voice to highlight the struggles she faces and the ways in which she copes. Men and women have different experiences, and the oppression of women is a part of the way the world is structured (Ropers-Huilman & Winters, 2011). The radical feminist perspective highlights the reproductive capabilities and duties, along with the patriarchal control of women's sexuality as a way to regulate their educational opportunities (Maslak, 2005). Stewart (1994) suggests that researchers need to probe into how a woman understands her gender, and recognize that "gender is a social contract" that is distinctive for each person. Some fields, such as STEM and higher education, tend to have a masculine nature, which can lead to the suppression of women in that environment. To enter, persist, and advance in these male dominated careers, women must negotiate gendered expectations rooted in the culture.

Feminist research can offer different interpretations of social interactions and deliver opportunities for change in STEM fields, higher education, and other settings (Ropers-Huilman & Winters, 2011). While the feminist movement has helped to bestow the freedom of women to enter STEM majors and careers, there is still much to be done to provide gender equality. The United States science and technology policies must work to address overlooked aspects of gender issues such as, the research agenda and the recognition of women's achievements in the field of innovation and innovation policy (Cozzens, 2008).

The framework used in this study will demonstrate how individuals negotiate their gender identities while choosing and completing coursework in a STEM field. The research treats gender as if it is a fixed condition, but this will not explain why there is a gap in the number of men and women majoring in STEM fields. Understanding that gender is something that is constructed by individuals and influenced by society may uncover how both men and women negotiate gender in STEM fields. Feminist theory recognizes that the perspectives and experiences of women are unique. By examining both male and female perspectives in this study, the similarities and differences in their gender negotiation will be exposed. Possibly this can provide an inside view into why there is a gap in the number of males and females majoring in STEM fields.

## CHAPTER III

### METHODOLOGY

#### Introduction

The preceding chapter discussed the existing literature on student choice of academic major in college and persistence in STEM fields. The literature suggests gender plays a part in this choice (Karpiak, et al., 2007; Porter & Umbach, 2006; Yazici & Yazici, 2010; York, 2008). The prior chapter also examined current research on possible reasons a gap exists between the number of men and women in STEM fields. These reasons can be categorized into biological differences (Bradley & Caldwell, 1980; Klein et al., 2010; Quaiser-Pohl & Lehmann, 2002; Szymanowicz & Furnham, 2011), social expectations (Bandura, 1997; Morris & Daniel, 2008), and psychological reasons (Eriksson & Lindholm, 2007; Perry & Pauletti, 2011; Varma, 2010).

The purpose of this study is to understand how undergraduate men and women negotiate gender in the STEM fields and to examine their experiences associated with gender awareness as they complete their STEM coursework. This chapter describes the methodology that will be used in the study in order to answer the study's central research question: How do undergraduate men and women who have chosen to pursue STEM fields experience and negotiate gender? Subquestions to the central research question will also be examined:

- Why do men and women choose to major in STEM fields?
- How do men and women understand gender as it impacts their experiences from a young age until college age?

- What obstacles impact the persistence of men and women in the completion of their degree and how do they overcome them?

### **Design of Study**

To answer the central research question, a phenomenological approach was utilized. “Evidence from phenomenological research is derived from first-person reports of life experiences” (Moustakas, 1994, p. 84). According to phenomenological principles, scientific investigations are authentic when the information sought after is discovered through descriptions that initiate understanding of the meanings and essences of experience (Moustakas, 1994). Phenomenologists focus on what the participants have in common as they experience a phenomenon, such as pursuing a degree in a STEM field as an undergraduate. By reducing individual experiences and focusing on the universal essence or very nature of the event, researchers can develop a description of what the participants experienced and how they experienced it (Creswell, 2007).

According to transcendental philosophy, all objects of knowledge must conform to experience (Moustakas, 1994). Through the work and contributions of Descartes and Kant, anything that is within a person as knowledge, actually exists and is unquestionable evidence (Moustakas, 1994). Husserl declared that the world is nothing other than what one is aware of and what appears valid in their thoughts. Meaning and truth are derived from inside oneself (Moustakas, 1994). Phenomenology, which emphasizes on understanding the experiences of individuals, will connect with the purpose of this study- to understand how undergraduate men and women negotiate gender by examining their experiences as they complete their STEM coursework.



## **The Constructivist/Feminist Paradigm**

Within the phenomenological method, this study will be guided by the constructivist/feminist theoretical framework. The paradigm of constructivism indicates that people construct their own understanding and knowledge of the work through experiencing things and reflecting on those experiences (Guba & Lincoln, 1994). There are multiple realities through which one can make sense of the world. Individuals who construct reality from their real-world experiences construct multiple and valid realities (Brown, 2008; Moustakas, 1994; Van Manen, 1990). Accepting that ideas are shared among social groups, constructivists argue that multiple realities exist and are unique because they are formed by individuals who experience the world from their own point of view (Hatch, 2002 ). “Reality exists only in the context of a mental framework (construct) for thinking about it” (Guba, 1990, p. 25).

Supporters of the feminist paradigm believe that there is a reality that has been created by social, political, cultural, ethnic, and gender-based forces (Cohen & Crabtree, 2006). Feminist research focuses on the improvement in the lives of women. The aspiration of this research is to expose bias and inequity in the way women are treated in STEM programs and to discover more about how women and men cope with the challenges in undergraduate STEM programs (Cohen & Crabtree, 2006). By using a constructivist/feminist approach, I aim to compare the experiences of women majoring in STEM fields to men, in order to give a voice to the women who are typically marginalized in STEM fields.

## **Philosophical Assumptions**

The problem with phenomenological inquiry is not always that we know too little about a phenomenon, but that we know too much. One's prior knowledge, "common sense", pre-understandings, assumptions, and existing scientific knowledge, influence the researcher to elucidate the nature of the phenomenon before we have grasped the importance of the phenomenological question (Van Manen, 1990). Another way to state this problem is that everyday knowledge has already had much to say about the phenomenon of male and female undergraduates majoring in the STEM fields in college before understanding what it means to be a male or female in the first place. While carrying out phenomenological research, it is imperative to "bracket" or defer what one knows about the phenomenon, and deliberately place this knowledge outside of one's conscious (Van Manen, 1990). The structure of one's own experience of a phenomenon may provide the researcher with clues for orienting to the phenomenon, and this can be accomplished by reflecting on the researcher's own lived-experience (Van Manen, 1990).

## **Role of the Researcher**

My particular interest in the impact of gender on students' experiences in college is appropriate for this type of phenomenological study, which requires the researcher to "bracket out one's experiences" (Creswell, 2007). Throughout my school career, I was most interested in science. My family encouraged my interests and wanted me to pursue a career in some type of science or medical field. In particular, my mother and father wanted me to have a degree in medicine so that I would obtain a stable job with a significant income. Both of my parents, who never attended college, wanted me to have the economic stability that they never had growing up and raising a family. My mother in

particular wanted me to “never have to depend on a man”. By the time I entered high school, I had directed my goal towards becoming a pharmacist like my aunt. I first attended a junior college because it was close to home and believed that I could complete my core requirements before attending a larger university. This was a comfort, because my high school was a very small and rural school. After completing two years at the junior college, I entered a larger university with the intent of completing the medical technology degree. Due to miscommunications with-in the university’s informational packet, as this was before everything was on the Internet, I did not find out that the medical technology program was discontinued until I showed up for orientation one week prior to starting classes. At this point, I had to rush and choose a program in which to major. Some of the student advisors suggested majoring in biology. I felt that the biology department had a very cold climate towards me. It was difficult to arrange meeting times with professors for advisement, and during advisement I felt as if they were pre-occupied with concerns other than my own. After several setbacks and issues, I decided to change my major. By this time, I was entering my fourth year of college and still felt like I had no direction. Some friends of mine, who were educators, suggested I become a teacher. Being frustrated with the system, I decided to give it a try. The College of Education was a warm and inviting place. The professors made me feel that they actually cared about me completing college and starting a career. They gave me advice and a course path to follow. Here I am today, a science teacher. Sometimes I dream of working in a medical field, whether it is as a pharmacist or a lab technician. As a result of my own experience, I wonder what other female undergraduates pursuing a degree in a STEM field have experienced and how they perceive that experience.

As a science teacher, I observe my students and take particular interests in what subjects female students are interested in and what their career goals entail. It is frustrating to me to watch the girls acquiesce to the boys during labs and class discussions. What can I do to help other females, such as my students, have a more successful time pursuing their degree in a STEM field? By studying both male and female undergraduates majoring in a STEM field, I hope to better understand their experiences and shed some light on how they negotiate gender.

Since the researcher is one who makes up the large percentage of women who failed to complete a STEM degree and is personally connected to the problem being studied, there could be some bias to the analysis. While it is nearly impossible to remove all researcher bias, precautions were taken to make the results reliable. During the interviews, questions were asked in a way that did not lead the participant, and body language remained neutral while encouraging the participant to share his or her experiences and thoughts. The researcher established rapport with the participants to make them feel comfortable about their responses without implying her own thoughts about the topic. This helped ensure that the participants were stating their true feelings and not just saying what they felt would “please” the researcher. In order to obtain further feedback and validation, the researcher also used member checking by restating what the participant said or what the researcher thought he or she meant during the interview. To further establish validity the researcher corresponded with the participants via e-mail to clarify information from the interview. In addition to this the researcher kept a reflexive journal during the research process to be aware of anytime her own opinions started to take control over the research.

## **Study Site**

This research was conducted at a mid-size university in a Southeastern city in the United States with a population of approximately 190,000 people. With an enrollment of approximately 8,300 students, females outnumber males at 60% (NCES, 2011). The site will be referred to as Southeastern University (SEU). This site was chosen because of its high percentage of female undergraduates enrolled, proximity to the researcher, and the ability to access students attending SEU.

The majority of the campus is located in one area in the city, which includes the residence halls, classrooms, library, and dining facilities. The College of Arts is located in the downtown area of the city, a few minutes' drive away. Being in a southeastern city, the college is in an urban setting but surrounded by green spaces including trees, flowers, and other vegetation. In order to go to non-collegiate venues such as restaurants or entertainment, it takes just a short drive or walk.

## **Research Participants**

The participants in this study were full-time undergraduate men and women enrolled in a STEM program. Five undergraduate men and five undergraduate women in at least their third year of study were purposely chosen from all undergraduate students attending the university. The participants were selected from the science, technology, engineering, or math disciplines. They may or may not have selected a secondary major such as a degree in teacher certification. Creswell recommends that researchers interview two to twenty-five participants for a phenomenological study (1998). The sample was targeted to those who have at least begun their third year of study as undergraduates so they have chosen and declared their majors and have experienced coursework in a STEM

program. Any participants selected from the Pre-Engineering course would only have to be in their second year of college due to the short nature of the program at this institution. The type of sampling strategy utilized was criterion sampling. Criterion sampling is used to select cases that have experienced the same condition; in this case all participants were enrolled in a STEM field in college. It was imperative that all participants have experienced the phenomenon of the study; therefore, criterion sampling worked well for this study (Creswell, 2007). The experiences of the participants are likely to be rich in information, and they may reveal major weaknesses in the university or college program that could be improved upon (Patton, 2002).

### **Sampling Method**

With the aim of enlisting participants, I used a convenience sampling method consisting of posting flyers to describe the study and request participants. The flyers were posted in the various buildings that host STEM majors. The flyer was also e-mailed to the student population to try to attract participants. In addition to the flyers, STEM professors were asked to promote the study in their classes and encourage participation. I gathered information about the interested students on the Student Information Sheet (see Appendix A). This information was used to determine if the students were suitable for the study, which means that they were majoring in a STEM field, were in at least their third year of college (except for Pre-Engineering students, and would be available to participate in the interviews. While gathering potential participants, students were presented with the nature of the study, and the assurance that their information would remain anonymous. Students were also informed that they would receive a financial incentive in the form of a

\$10 Visa gift card to compensate them for their time and effort. This incentive was provided by the researcher after the participants completed their interviews and questionnaires.

STEM courses offered at SEU are divided into two different departments. STEM fields available within the College of Letters and Sciences include Biology, Chemistry, Astronomy, Geology, Environmental Science, Pre-Engineering, and Math. STEM fields available within the College of Business and Computer Science include Computer Science and Information Technology. For this study, participants were recruited from only the College of Letters and Sciences in hope that five males and five females were available from among the various programs of Biology, Chemistry, Astronomy, Geology, Environmental Science, and Math.

In order to conduct ethical research, the researcher used informed consent. In the Participant Release Agreement (Appendix C), the following criteria are stated:

- They are participating in research
- The purpose of the research
- The procedures of the research
- The voluntary nature of research participation
- The procedures to protect confidentiality (Groenewald, 2004).

The Participant Release Agreement was explained at the beginning of each interview. If the participants were in agreement with the content, then they were asked to sign the form. The participants were identified by a pseudonym. The researcher will be the only one who will have access to the interviews and questionnaires.

## **Assumptions of the Study**

The study is built upon other research studies on the undergraduate's experience in STEM degree programs. The assumption that participants will provide honest responses to all interview questions is expected. It is also assumed that the participants will commence in the study with sincerity and straightforwardness. The researcher speculates that the participants involved in this study will appreciate the information gathered by this study to further understand the topic. The researcher assumes that women undergraduates in STEM programs will be outnumbered by male undergraduates, and that these women may have experiences specifically because they are females majoring in a STEM field. Likewise males may have experiences specifically because they are majoring in a male-dominated field.

## **Data Collection Procedure**

In order to collect data for this study, the researcher met with five men and five women for an in-person semi-structured interview. The participants were allowed to choose the time and location on campus for the interviews to be conducted for their convenience. A quiet and interruption-free location was encouraged (Groenewald, 2004). Each interview took anywhere from sixty to ninety minutes to complete. All of the interviews were digitally recorded; however, to establish validity the researcher also corresponded with the participants via e-mail afterwards in order to clarify information from the interview or to follow up with any additional thoughts the participants may have had afterwards. This action, known as participant feedback, was used to further establish interpretive validity (Johnson, 1997). The fact that the interview was recorded will help improve reliability (Roberts, Priest, & Traynor, 2006). At the beginning of each



recording, the interview was given a code, for example, “Participant’s Pseudonym, March 1, 2013.” Pseudonyms were used to protect each participant’s identity. In addition to the recording, the researcher took brief notes throughout the interview in order to recollect any initial thoughts and notions. Before conducting formal analysis, the researcher listened to each interview and took additional field notes (Hatch, 2002). Each of the interviews was transcribed in preparation for data coding and analysis.

In phenomenological studies, the interview serves the purposes of investigating and gathering experiential narrative resource to develop a richer and deeper understanding of a human phenomenon, and also to develop a conversational relation with a companion about the meaning of an experience (Van Manen, 1990). Interviews are typically a common and legitimate data source to collect data on the experience (Priest, 2002). As phenomenology is based on the lived experience of a phenomenon, its validity is held within understanding that experience as experienced (Wood, 2011).

## **Interviews**

The researcher conducted one interview with each of the participants of the study following a protocol developed by Goldman (2010) with fifteen main questions followed by follow-up probes (Appendix D). If necessary, the researcher asked any clarifying and relevant probing questions, because it is important to tell the experience as it precisely occurred with concrete examples if available (Van Manen, 1990). The interview was reciprocal: with both researcher and participant being engaged in the dialogue, in order to find out more about the setting of the experience (Groenewald, 2004). Although the researcher was engaged in the dialog, her own norms and values were not imposed. This

interaction allowed the participant to express him or herself with more detail and ease (Kuntjara, 2001).

As mentioned before, the interview protocol utilized was used in a study conducted by Goldman (2010) in which she studied the experiences of females and how they negotiated gender as undergraduates in STEM fields. Her interviews yielded the following themes: “looking the part” of a person pursuing a STEM field, “playing up” or “playing down” their choice to pursue a STEM field, conflicts between having a feminine identity versus a STEM identity, “proving their worth” in STEM fields, empowerment by facing the “realities” of STEM fields, having fears and uncertainties by facing the “realities” of STEM fields, and gender stereotypes are outdated and more relevant to their parents’ and grandparents’ generation. Since the current study involves interviewing males as well as females, the interview protocol will be similar but was modified to gather the experiences from the male point of view. It was expected that the females in the current study may address the same themes from Goldman’s study, but will the males construct new themes or share the same themes as the females?

In order to encourage the participants to express all of their experiences in full and rich detail and not exclude any parts that may be painful or confidential, it is imperative for the researcher to establish rapport with the participants. According to Northrop (2011), the researcher must have an attitude that displays safety, trustworthiness and acceptance. With this approach it is more likely that the participants will be more open with their true accounts (Jasper, 1994). The researcher must develop a positive relationship from the beginning of the interview. Allowing the participants to select the time and place will help establish a safe and comfortable environment for them to share

their personal experiences (Northrop, 2011). The researcher should thank each person for participating in the study, and remind them about confidentiality. In order to get the participant talking, the first interview question will be broad (Can you tell me a little about yourself?) to break the ice and will be non-threatening. As responses are given, the researcher can respond with prompts that repeat the words used by the interviewee in order to continue the conversation without leading the conversation (DiCicco-Bloom & Crabtree, 2006).

The intent of the first question of the interview was to have participants introduce themselves and provide some background information. Then the participants were asked to describe their experiences in college so far, including those in the classroom, social arenas, and in the city. Environments influence people's cognitions and behavior; understanding how college students perceive the environment is important (Morris & Daniel, 2008). Next, the participants were asked to explain specifically how they chose an academic major in the STEM field, including the roles of different individuals and avenues that may have influenced their decision. These individuals and avenues included family, siblings, peers, academic experiences, and knowledge of the career opportunities afforded by that STEM degree.

The researcher also asked each participant about his or her specific experiences with gender and negotiation of gender during childhood, high school, and college. They were asked questions about how gender is defined, and specifically if different majors or skills are "male" or "female". They were also asked broader questions about their choice of major and possible obstacles since enrolling and experiencing college. The participants were also asked about the importance of jobs and careers in determining their major. By

preserving each participant's felt experience from their interviews; the methodology will show both validity and reliability.

## **Questionnaires**

After the interviews, each participant completed an informal open-ended questionnaire (Appendix E). The questionnaire, adapted from Dickinson-Skaggs (2010), focuses on the career and life plans after graduation and at different milestones in their lives. The participants were asked to write how they imagine their idyllic life in the future. Since the research shows that career aspirations and family life are factors in determining whether students will complete a STEM major and follow through with a STEM career, it seemed imperative to collect this data from the undergraduates to compare with the current research.

## **Data Analysis**

“Qualitative research is research that involves analyzing and interpreting texts and interviews in order to discover meaningful patterns descriptive of a particular phenomenon” (Auerbach & Silverstein, 2003, p. 3). Once the interviews were completed, the researcher transcribed the data. Each interview was listened to repeatedly by the researcher in order to study and code the data into themes (Holloway, 1997; Hycner, 1999). The use of participants' original narrative to illustrate themes would provide validity due to the perceived truth of the experiences (Jasper, 1994). In order to find the essence of the phenomenon of gender negotiation as experienced by male and female undergraduates majoring in a STEM field, it will be best to examine the shared stories of what the participants experienced and how they describe the experiences. While

inspecting the transcripts, all statements that seemed relevant were identified and highlighted (Priest, 2002). Statements were deemed relevant if they related to or answered the research questions of the study. The transcripts were reread so that the researcher could become very familiar with the experiences of each participant. Phenomenological data analysis requires total immersion for as long as needed to ensure a pure and thorough description of the phenomenon (Moustakas, 1994). The researcher also considered field notes taken during the interviews. Themes were developed by using any statements or quotes that provided an understanding of how men and women undergraduates experience majoring in a STEM field (Creswell, 1998).

Erickson's (1986) analytic induction was used to analyze the data. Assertions were generated by searching the data in its entirety (interview notes, interview recordings, and questionnaires). This method is based on the researcher's repeated reading of the data as a whole and then arriving inductively at a set of credible assertions. Assertions are statements that the researcher believes to be true based on understanding the data. Next, the researcher conducted a systematic search of the data corpus looking for disconfirming and confirming evidence, while remembering the need to reframe the assertions throughout the analysis process.

A Miles and Huberman (1994) approach was also used to analyze data because researcher entered the study with preconceived expectations of codes based on concepts already well known in the literature. Attention was taken to prevent forcing data into these pre-existing categories by reflecting on the data and personal assumptions. However, having a "start list" (Miles and Huberman, 1994) allowed for new understandings to be derived and built on existing ideas.

In addition to the interviews, the researcher examined the questionnaire completed by the participants about their life plans after graduation. The information acquired by the questionnaire was used by the researcher as she compared the experiences among male and female undergraduates majoring in STEM fields.

In order to account for the problem of bias in qualitative research, the researcher kept a reflexive journal. Keeping a self-reflective journal is a strategy that can facilitate reflexivity, where researchers use their journal to explore personal assumptions and goals and elucidate individual beliefs and prejudices (Ortlipp, 2008). During the data analysis process of transcribing interviews, rereading transcripts, and reflecting upon the data, the researcher would often think of experiences shared by the participants as well as her own experiences. Keeping the journal helped the researcher keep her thoughts, opinions, and data interpretation visible.

In order to determine codes, each research question was examined individually. The researcher listened to the recorded interviews, read the interview transcripts, and wrote a summary of key points from each participant's interview. For the first research question, the data was examined to determine why students chose a career in the STEM fields. Next, codes were developed based on common responses between males and females. Then codes were identified that differed across male and female responses. This approach yielded the following codes: interests in STEM, influence from family and friends, influence from teacher, dissuasion to major in STEM by family, and financial stability. For the second research question, the data was examined to see how gender impacted the experiences of the participants. This approach yielded the following codes: connections with the opposite gender, societal expectations, the belief that males are the

dominant gender, femininity, and psychological stances in which males are more confident and females feel inferior. For the third research question, the data was examined to identify obstacles that impact the persistence of the participants in the completion of their degree and how they overcome those obstacles. The following codes were established: the difficult challenge of coursework, cost of tuition, pressure to be the “breadwinner,” female empowerment, and “bonds” with fellow STEM majors, and encouragement from professors. For the central research question, the data was examined to identify how STEM majors experience and negotiate gender. The following codes were established gender negotiation in STEM, day to day gender influences, and gender stereotypes.

## CHAPTER IV

### RESULTS

The goal of this study was to see how undergraduate men and women negotiate gender in the STEM fields and to examine their experiences associated with gender awareness as they complete their STEM coursework. Specifically, this study sought to answer the following questions:

- Why do men and women choose to major in STEM fields?
- How do men and women understand gender as it impacts their experiences from a young age until college age?
- What obstacles impact the persistence of men and women in the completion of their degree and how do they overcome them?

Each participant disclosed information about his/her path in choosing to major in a STEM field including ways in which family, peers, and teachers, influenced his/her choices. Participants shared academic experiences from elementary school to the current experiences at the university. They also discussed their social experiences with gender throughout their school careers as well as obstacles they encountered along the way.

The participants in this study included five males and five females, and in order to protect their anonymity, they have been given pseudonyms. The male participants were Keith, Jacob, Brandon, Thomas, and William. The female participants were Amanda, Kimberly, Tracy, Janie, and Zoë. A demographic profile of each participant can be seen in Table 1. A more detailed summary of each participant's interview can be found in Appendix G. The summary provided is a combination of the researcher's observations



combined with the students' accounts of their experiences gathered from the interviews and questionnaires.

**Table 1 Participant Demographic Data**

| Pseudonym         | Gender | Age | Year   | Major                               |
|-------------------|--------|-----|--------|-------------------------------------|
| Keith Klein       | Male   | 27  | Junior | Mathematics                         |
| Jacob Watkins     | Male   | 21  | Junior | Biology                             |
| Brandon McCain    | Male   | 22  | Junior | Astrophysics & Planetary<br>Geology |
| Thomas Johnson    | Male   | 23  | Senior | Chemistry                           |
| William Savage    | Male   | 28  | Senior | Chemistry                           |
| Amanda Geeslin    | Female | 21  | Junior | Biology                             |
| Kimberly Chadwick | Female | 20  | Junior | Earth & Space Science               |
| Tracy Simmons     | Female | 20  | Junior | Biology                             |
| Janie Powell      | Female | 34  | Senior | Geology                             |
| Zoë Reese         | Female | 23  | Junior | Environmental Science               |

### **Why Major in a STEM Field?**

The men and women participants in this study chose to major in STEM fields for a variety of reasons. All of the participants expressed a love or interest in the subject in which they are majoring. Also, for the majority of the participants, the decision to major in a STEM field was influenced by the encouragement from family, friends, and/or

teachers. Besides this, many of the participants were looking to gain financial stability in a future job with their STEM degree.

### Interest in STEM

The male participants suggested that their interests helped them make the decision to major in a STEM field. Keith claimed that math has always been his favorite subject. By majoring in mathematics, he felt that he would enjoy the classes; therefore, he would do well in school. Since he performs well in his classes, he is very confident that he will complete his degree. Natural science and animals have always been among Jacob's greatest interests, so it was only natural that he chose to major in biology. Brandon, whose dream was to become an astronaut from the age of 3-years-old, chose to major in astrophysics and planetary geology because of his interest in the field. Thomas decided to major in chemistry due to his childhood interest in his fish aquarium and his experiences of visiting his grandparents in Germany during the summers. The culture of Germany encourages individuals to recycle and conserve finite resources. This push to make the world more sustainable fueled Thomas's interest in majoring in a STEM field. William chose to major in chemistry because he was interested in a challenge. In high school, he felt that he only saw the beginning of the subject. With the idea that chemists do not "venture by the book," William decided that he wanted to "write the book" of chemistry. Two of the male participants became interested in STEM during elementary school, two became interested in STEM during middle school, and one male participant became interested in STEM during high school.

The female participants also revealed their reason for choosing to major in a STEM field was their interest in the subject. Four of the five females have interests in and

enjoy doing outdoor recreational activities, such as hunting, gardening, and kayaking. Amanda and Tracy enjoy hunting and have been participating in this outdoor activity with their families since they were children. Both females are capable of killing and cleaning their game. Amanda recalled “playing in the gut bucket” from the time she was a young child. Due to the interests of being outdoors and working with animals, these two women both chose to major in biology. Kimberly and Zoë enjoy gardening and working outdoors. Zoë is extremely interested in the environment and wants to be able to work outside in nature; therefore, she chose to major in environmental science. Janie’s first choice of major was English. Her interest in geology developed when she took an introductory geology class, which was one of her required science courses. Her interest in the field and its potential opportunities influenced Janie to change her major to geology. One female participant became interested in STEM during middle school, three female participants became interested in STEM during high school, and one female participant became interested in STEM during college. Interest in STEM topics was a commonality among all of the participants as they made decisions to major in these fields.

#### Influence from Family, Friends, and Teachers

The participants also suggested that they chose their major based on the influence from family members, friends, and/or teachers. All five males disclosed that their families, more specifically their parents, strongly advised that they attend college. Four of the five male participants claimed that their families had an impact on their choice of major. Jacob, who is majoring in biology and would like to become either a veterinarian or a plastic surgeon, said that his aunt mentioned “it would be nice if they had a doctor in the family.” Keith’s father was adamant that he choose to major in chemical engineering

or pharmacy due to the financial security from potential jobs. Brandon's father worked at a space science center as a graphic designer. This connection allotted many STEM opportunities for Brandon to become involved with as a young child. The support of Brandon's parents was integral in developing his interest in space and the goal of becoming an astronaut, but they did not require him to choose a STEM field as his major. Like Brandon, Thomas's mother did not require that he major in a STEM field, but her actions influenced his interests. Buying him a fish aquarium and giving him the responsibility of tending to it himself, sparked an interest in chemistry. His German grandparents also instilled in him a sense of conserving the Earth's resources. While his family did not directly influence Thomas's choice of major, the lessons they taught him as a child led him to that field. William is the only male participant who did not credit his family for helping him choose to major in a STEM field. His mother encouraged him to go to college, especially because she did not get the opportunity to do so. William expressed that his father did not care what he chose to do after he graduated high school. His advice to William was "go make money."

Only one of the males mentioned that friends played a part in his decision to major in a STEM field, and that was Jacob. He admitted that many of his friends were majoring in biology. At first he was insecure about his ability to be successful in biology due to the math courses required. He stated, "In order to major in biology, I thought you had to be really good at math. I didn't think I could handle that, but now I am doing just as well or better than the other biology majors." Due to encouragement and support from his friends, he decided to major in biology.

Three of the five male participants suggested that a teacher influenced their decision to major in a STEM field. Brandon credits his third grade teacher, Ms. G., for inspiring him to love science and to major in the topic in college. Brandon spoke of Ms. G.

She truly thought that science was the key to the rest of the world. If you could do something with science you could carry it out through all of the other disciplines. It helped me to see that and I have always carried that with me. (B. McCain, personal communication, April 24, 2013)

Thomas remembered his passionate and challenging high school science teachers. Their passion for the subject further stimulated his interest in the field of science. While William did not receive parental influence to major in a STEM field, his high school chemistry teacher moved him to respect and inquire about the field of chemistry.

Interestingly these three male participants were influenced to major in STEM by female teachers.

The females have a different story when it comes to family influences in their choice of major. All five female participants received encouragement and support from their family members, parents or husband, to attend college. However, none of the females were influenced by family members to choose a STEM field as her major. Three of the five females, Amanda, Janie, and Kimberly, chose to major in a STEM field due to motivation from a teacher or professor. Two of these influential teachers were male and one was female. The other two females, Tracy and Zoë, chose to major in a STEM field due to their self-interests.

Amanda credits her high school science teacher as the inspiration for her choice to major in biology. She now has the passion to work with animals and to study their

environment and habits. Kimberly, like Amanda, was encouraged by her high school science teacher to major in a STEM field. Her teacher made chemistry fun, and she learned a lot at the same time. The balance of challenging work and supportive encouragement developed Kimberly's confidence in the field of science. She remembers, "She did make the class fun even though it was hard. I still had a good time. We did labs at least once a week." Janie started her college career at the age of 31, which is a bit later than the typical college student. Originally an English major, she changed her major after taking an introductory geology class. She acknowledges the professor as the catalyst for her change in major. His passion for geology made her love it too. Being one of his top students in the class also gave her reassurance in her ability to major in and be successful in a STEM field. Janie's husband supports her no matter what her major is. They both realize that more opportunities are available with a college degree, and Janie wants to set an example for her two young children in the importance of completing a college degree.

Zoë chose to major in environmental science mostly because she was interested in it. She really didn't credit anyone for inspiring her to major in this field, but she did mention her respect for her friend's mother who was really passionate about the environment and anything living. Tracy chose to major in biology due to her interest in living things. She loves to take care of her aquarium and enjoys scuba diving. Tracy's parents have not been involved with her college education. They support her in going to college and majoring in biology, but they do not push her to do anything in particular.

## **Dissuasion from Family Members**

Unlike their male counterparts, three female participants suggested that their family members tried to dissuade them from majoring in a STEM field because they felt that it might be too difficult for a female to manage. Amanda's mother, who is an educator, has tried everything in her power to persuade her to become a teacher as well. Amanda claims, "That [teaching] is something females do, but honestly that is not something I would want to do." Kimberly's family has also tried to deter her from working on her earth and space science degree. She is a first generation college student as far as her household family is concerned, and she has only two cousins who have previously earned college degrees, both in the field of education. Kimberly's grandmother tried to convince her to change her major to English or history education. She conjectured, "My grandmother didn't want it to be so hard on me when I got to college. My family didn't want me to major in science, get to college, and then crash and burn." Zoë's mother didn't exactly dissuade her from majoring in a STEM field, but she tried to emphasize the importance of her finding a good man to marry, rather than doing well in her studies. Zoë's mother would say, "Go to college, but make sure you marry someone with a lot of money so that when you have babies he can support you." Zoë pointed out, "Why would I go to college if I am just going to have babies?" Opposing her mother's old school attitude she added, "Maybe that is why I majored in a science field."

## **Financial Stability**

Financial stability was an essential reason for six out of the ten participants in choosing to major in a STEM field. All five males mentioned the opportunity to get a job with financial stability using their STEM degree. The male participants mentioned that

they could provide a stable home for their family. Thomas was the only male to remark that he could possibly make a six-figure salary if he was able to get a job in the chemical industry, and that he likes “nice things.” The other four males were happy with the prospects of getting a job in a field that they love and being able to take care of their family comfortably.

Four of the five female participants claimed that the potential salary was not a motivator at all in choosing to major in a STEM field. Janie said, “The salary was not the main reason for choosing to major in geology.” However, she believes that it will make life much better for her family than it is now. She said, “After living in the real world I realized that science is where the money is at.” Janie’s husband is a mechanic who has had to work extremely hard to provide for the family. She wants to get her degree in geology and then get a job so she can support the family. She added, “When I get my degree, he will not have to work anymore because he has been breaking his back to take care of us for the past ten years. Once I am able to take care of us, he won’t have to anymore.”

In sum, interest in the STEM fields was an influencing factor in both groups’ (male and female) choice to major in these fields. The major differences in choosing to major in a STEM field among the males and females in this study were from whom they received their influences and their outlook on financial stability. Where males received much more encouragement and influence from their families to major in a STEM field, none of the females were influenced by their families. Oftentimes, their families discouraged them from majoring in a STEM field. The male and female participants were influenced evenly by their teachers to major in a STEM field. Both groups had three out



of five who were encouraged by their teachers to choose a STEM major. All of the males agreed that financial stability played a part in their decision to major in a STEM field. Only one female recognized the potential financial stability in earning a STEM degree.

### **How Has Gender Impacted Participants' Experiences?**

The participants in this study were asked how gender has impacted their experiences at different benchmarks in their lives (elementary school, middle school, high school, and college). At the elementary school age, participants did not feel that gender differences were something that was stressed. Thomas recalled that he was taught to treat everyone equally, and the only difference was that girls could wear dresses and skirts, but boys could only wear pants. Three of the five male participants recalled that they were friends with both boys and girls. Two male participants recalled that they only played with boys. Keith admitted that he was “not into girls” because he felt awkward around them. Two of the female participants said that they preferred to play with only boys during their elementary school years. Janie said, “Boys never got in trouble and they had cooler toys.” Kimberly liked to challenge the boys to athletic contests, because she thought she was better than they were. Amanda and Zoë felt that gender differences were not stressed during their elementary school years, and Tracy, who was very shy at that age, did not play with anyone.

### **Connections with the Opposite Gender**

Four of the five male participants suggested that in middle school, the gender groups started to divide. Mostly, the boys cooperated with boys better, and the girls would cooperate with other girls. Thomas was an exception. During middle school, he

befriended mostly females as he was not into “all male” stuff, and he was not interested in sports. On the other hand, four of the five females preferred to do activities with males rather than females. Amanda and Janie commented that girls started acting “catty” in middle school. Zoë was the only female participant who said she could get along with both males and females during that time.

During high school, two of the five male participants started branching out to develop relationships with different groups than they did in elementary and middle school. Jacob, who considers himself shy, commented that girls became more accepting of him so he had both male and female friends during high school. Thomas, who always connected better with females, noticed that he became more sociable with other males, especially those who were interested in academic subjects rather than just sports. Four of the five females still related better with males into their high school years, and again they mentioned the fact that they wanted to avoid the “cattiness” of other females.

In college, all five male participants mentioned that they see a difference in gender based on course enrollment. In high school, students have to take the same courses for the most part, but in college each person chooses his/her own major. Brandon mentioned that the biology classes are packed with females, but there was only one female in his engineering class. Keith, who claims that he is still awkward in talking to girls, admits that he doesn't have to worry about it so much because most of his classes are composed of males. William admitted that it is much easier for him to focus on his classes and grades because there are not many females in his upper level chemistry classes. Thomas claims that he still connects better with females, but he has developed closer relationships with other males because of their similar interest in academic

subjects. All five females admitted that in college they have developed friendships among both males and females, but that the two gender groups are held to different expectations as far as their behaviors in academia and in the social setting.

The relationships of the participants among the different genders, their interests throughout their childhood years, and influences from family members have shaped how they fit in socially as well as their psychological frame of mind. Their accounts of how gender has impacted their experiences can be classified into social expectations and psychological stances.

### **Social Expectations**

Participants indicated that there is pressure to conform to expectations from society. A part of that is fulfilling gender roles as defined by society. Society places higher expectations on males than females as far as academic success and career status (Karpiak, Buchanan, Hosey, & Smith, 2007; Masnick et al., 2010). Parents, especially, have lower expectations of their daughters than their sons. In addition to this, males are typically more dominant than females, who tend to be and are expected to be more passive. Both male and female participants described males as being “independent and strong individuals,” who are “in charge” and described females as “more reserved” and “less scary than men.” The participants also suggested that they feel pressured to display certain behaviors around others of the opposite sex. For example, the male participants felt that they are expected to be chivalrous and mindful of what they say. Female participants believed that they are expected to be more caring and nurturing. The females were also somewhat concerned about displaying their femininity.

As previously discussed, families of male participants held high expectations for them in terms of college attendance and career choice. These high expectations are in hopes that the participants will be successful in order to be the provider for their future lives and families or be the “breadwinner.” Keith’s father wanted him to get a degree in chemical engineering or pharmacy because it was something that would make him successful and earn a lot of money. Neither of Keith’s parents went to college, and they want his life to be better than theirs as far as financial security. After high school, Thomas’s mother gave him an ultimatum. If he agreed to go to college and get a degree where he could support himself, then she would allow him to live with her during his college years; however, if he chose to get a job at a place like a fast food restaurant then he would not be able to live under her roof. Jacob also mentioned that his family expects him to become the “breadwinner.” Being that his family is made of successful business people, they want him to achieve an even higher status, such as becoming a doctor. Jacob recalls that his aunt said, “It would be nice if we had a doctor in the family.” He even discussed the prestige he would feel having the title doctor in front of his name, “Dr. Jacob Watkins sounds good, it has a flow to it.”

Two male participants, Thomas and William, have also placed high expectations on themselves to meet society’s expectations of men. Thomas said because he is a male, he feels that he has to be successful. Most of the pressure he feels comes from himself. He states, “I have always wanted to succeed. I guess guys are the ‘breadwinners.’ Since men have to be the breadwinners, females have more freedom to choose majors like art and English (that don’t have as many job opportunities), because they will be dependent on a man who will bring home the money.” William has also placed high expectations on

himself. He wants to continue his schooling until he earns a Ph.D. in chemistry. By continuing his education, William believes that he will be able to provide a much better life for his daughter. However, he doesn't feel that his high expectations are derived from gender. William believes that whether someone has high expectations or not depends on the individual.

Due to the way males are taught from a young age, they may believe that they should behave around and treat females differently than they would other males. Two of the five male participants expressed how they have to filter what they say and be mindful of their behaviors around females in their classes. Keith mentioned that he has always been awkward with girls. Prior to entering college, he would purposely avoid girls because he was not sure how to communicate with them. He wanted to "be friendly and open" without coming off in "negative ways." Now that he is an adult in college with adult females, he tries not to let that affect how he communicates with others. However, he is more comfortable around other guys and doesn't worry about filtering what he says or does. Keith admitted, "If I am with girls, I am very careful about what I say and do because basically there are a few scenarios; either I am attracted to the girl in some way and I don't want to ruin that possibility, or I am not attracted to her and I just want to be her friend. I don't want to try to navigate that. I just filter what I say with girls." Keith did admit that he will sometimes say something funny in classes or answer a question to seek acknowledgement from the girls and see if they approved of it. Brandon expressed that he is pressured to display more chivalry because he is a male. He attributes this expectation to being located in the southern part of the United States. He said, "I will open the door for anybody, and I always look out for the girls on the trips [geology field

work]. I make sure they can climb up the rocks and if there is a stream, I always look out for them.”

Three of the five females shared that their families displayed lower or different expectations for them and even tried to dissuade them from majoring in a STEM field. Their families believe that other majors and professions may be more suitable for females because they require the characteristics (caring and nurturing) more typically associated with females. Amanda’s mother also expects her to dress up and look presentable. She said, “Females should always have make up on, but I have never been one of those people.” Kimberly commented that her grandmother wanted her to become an educator, like her cousins. Her family wanted college to be easy for her and thought that majoring in a STEM field would be too challenging. Becoming an educator or a mother requires caring and nurturing characteristics, which are typical expectations of females. Kimberly also discussed that she was raised with the traditional family values of the man who works and the woman who cleans the house and takes care of the children.

My dad went to work and mom stayed at home and took care of everything. That is kind of how my boyfriend sees it too. He thinks he should go to work and do everything and I shouldn’t worry about college anymore. I don’t want to do that. I want to get a degree and do what I want to do. This is one of the bad things about living in the South. I feel like people are still living in the olden times. When the man goes to work and the woman stays at home and takes care of everything. I don’t agree with that. (K. Chadwick, personal communication, April 20, 2013)

One male participant, Keith, commented that he believes females have more pressure to conform to society’s expectations. He also said that he has noticed some of the pressures that females majoring in STEM fields experience because they are outnumbered; therefore, there is more pressure for them to do well. He feels that it is the opposite for males. It is acceptable for males not to do well but still fit in socially, where

a female would be shunned. Zoe feels that males in general don't seem to have the same worries and concerns as females. She states, "It may partly be because of their attitude, but males are usually a little less stressed about college in general. They don't seem to have the same worries or the intensity of worries as females have like final exams, grades, and things like that. They are just less stressed than females." The male participants displayed less concern than females about what others may think about their skills and abilities.

Zoë commented that women majoring in a STEM field are automatically at a disadvantage. She feels that most males in some of her classes give off an impression that she "is not quite as smart or that she is just below the male population." She often takes classes with her boyfriend, and she notices that people treat him differently from her and they "expect her to be neater and more organized" than him because she is a female.

## **Males Are Dominant**

Four of the five males and three of the five females described the males as being the dominant gender or the one who takes charge of situations. Kimberly described males as being independent and strong individuals where females are emotional and "girly." She added that females "have less chances" than males to become successful. Amanda stated, "Men are scarier [than women]." She alluded to the fact that her father and male professors were more intimidating than her mother or female professors. Tracy described men as the ones who are usually "in charge." Likewise, Keith described the male gender as one that "takes charge" and is the "more dominant gender." Brandon said, "A general man is one who looks out for family and takes care of everything. Even though I know

that is not required of me, it is engrained in my mind that I want to get a good job and support my future wife.” The first thought that came to William’s mind when asked to describe characteristics of males, was “dominance.” Jacob described the male gender as the “suppliers” and those who do “harder work.” William also spoke of “taking control” during labs. He usually works with male partners because his classes are composed mostly of males. However, he did mention having to work with female partners a few times. He said, “The females were just like, whatever. One of the girls was of western culture, and I don’t know, but I don’t think she wanted to listen to me. If I had anything to say it was not being heard by her. I didn’t let that bother me.” William described another occasion in which he worked with a female lab partner.

She was cool. She was easy going. She just wanted to get it done and get out of there. She was a nice student. When it came to the lab she just let me take over and I would tell her what to do and she would do it. She let me take the lead and we would finish. She just wanted to comply and get it done. She was real cool and we never got into arguments. (W. Savage, personal communication, May 14, 2013)

Brandon spoke about how females are guided into the areas of nursing and teaching because they are expected to be nurturing and helpful. He said, “It’s not that guys don’t want to help others, but there is a stigma of once you get in there men can’t stop at just being a nurse they must become more advanced like a doctor. So the male can be in charge.”

## **Femininity**

Three out of the five female participants discussed their femininity. Amanda and Janie both said they like to dress casual in jeans and t-shirts. They also do not like to wear make-up. Amanda’s mom expects her to dress up and look presentable because she is a



female. Her mother also tells her that “females should always have make-up on.” Janie admitted that she never liked “high heels, makeup, and stuff like that.” Until she was 12 years old, Janie’s grandmother would not allow her to wear jeans. She said that her grandmother was very “old school.” Janie confessed that she got into trouble a lot as a child, because she tried to play like the boys and do things that boys did. Her grandmother would tell her that she was acting “unladylike” and “not pretty.” Janie describes her grandmother as the “perfect woman” who did not work but kept the house clean, cooked three meals a day, and had dinner waiting on the table when her grandfather drove up into the driveway. As a geology student and a mother, Janie doesn’t worry about her femininity. She said, “As far as geology students are concerned, we all dress in jeans and t-shirts. Nobody dresses up unless they have to.” Janie also stated, “I think once you become a mommy you no longer have a gender.” She is too busy tending to the needs of her children, husband, and college requirements to worry about how “ladylike” she is by way of how she dresses or wears makeup. Kimberly spoke of how she likes to hang out with the guys rather than doing “girly stuff.” It was typical for her to be the only female in a group of males to go play paintball or video games. Once she was the only girl who went with the group to see a Star Trek movie. The participants suggested that they can feel comfortable with their femininity as grouped with others majoring in a STEM field, where femininity is different from society’s expectations of being feminine.

In summary, the participants suggested that societal factors define the male gender as being the dominant gender, which represents independence. By being the dominant gender, males are expected to be the breadwinners or providers for their

families. Females are the more subservient gender and are the ones who are more caring and nurturing. Due to those differences males are taught to treat females differently, as those who depend on others. The female participants also mentioned pressures of maintaining their femininity by the way they dressed, their role in the family, and activities in which they participated. It seems that females who major in STEM must have two social roles. One is their identity as a female and the other is their identity as a STEM student, which is associated more with male characteristics.

## **Psychological Stances**

The female participants in this study were more likely to have decreased feelings of competence than the male participants. The self-efficacy of the individual determines whether or not they feel like they can complete their degree (Vogt et al., 2007). With a lack of self-confidence, females may be less likely to complete their degree.

All five of the female participants admitted to having a decreased feeling of competence in at least one subject required while pursuing their STEM degree. The two main culprits were the math and chemistry courses. Zoë did so poorly in her pre-calculus class that she changed her major so that she would not be required to take the course. She believed it would be too difficult to understand the subject and pass. Janie also had difficulties with math. She had to drop her math course (pre-calculus) because it would require too much effort on her part to get a “mediocre grade” as she was taking it in conjunction with several science courses. She also sees pre-calculus and calculus as obstacles that she will have to defeat while pursuing her degree. Amanda, Kimberly, and Tracy have had negative experiences in chemistry classes. Amanda claims that chemistry

is an obstacle because she doesn't understand how to do the math in the subject. She said, "I don't understand how to connect all of those things together and what formulas to use. It goes over my head." Kimberly was upset because she made a grade of C in her chemistry class. She said, "I felt stupid in that class." Even when she went to tutoring, she still did not understand the concepts. She said, "It was a bad experience, but I still want to pursue science." Tracy also had a bad experience in her chemistry class. Her lab partner was an older male who was a chemistry major. Every time Tracy tried to do the calculations in the lab, he would clash with her. She stated, "He made me feel like I wasn't doing anything right. We were mostly fighting against each other." Tracy has challenges with the math and calculations in chemistry. She said, "This is my second time taking chemistry in college, which is sad."

Not only did the female participants express their feelings of incompetence in classes, but three of the five females discussed the classroom environment. Not only are the classrooms composed mostly of males in the math and chemistry courses, but Amanda noticed that when the professor was also male, he tended to favor the male students. She stated, "I feel like the men professors like the males a lot better." On the other hand, Amanda commented that female professors tended to agree with the female students more often. She said, "I guess we can relate better with our own gender." Kimberly stated, "I do feel inferior in the classroom sometimes. I also get intimidated by some of the male teachers." She went on to suggest that gender doesn't impact how well a student performs in the classroom, but the performance is impacted more by the attitude and relationship the teacher has with the students.

Psychologically, males and females have different stances. Females in this study were more likely than the males to admit feelings a lack of competence. Females also indicated that they feel out of place in classrooms that are dominated by males and male professors. The participants suggested that they relate better with their own gender especially in their relationships between student and professor. Female participants were more likely to be intimidated by male professors.

### **What Obstacles Impact the Persistence of Participants in the Completion of Their Degree and How Do They Overcome Them?**

Merriam-Webster dictionary defines persistence as the quality that allows someone to continue doing something even though it is difficult or opposed by other people. Eight of the ten participants commented that majoring in and earning a STEM degree was something that would be difficult and challenging. Another obstacle identified by participants was the cost of attending college. The participants felt pressure to earn a degree without wasting a lot of time and money by having to take the same courses more than once. The participants mentioned that they were able to overcome the obstacles due to “bonds” and encouragement from fellow STEM majors and professors. The males in this study indicated that it is the pressure to be the “breadwinner” that encouraged them to withstand challenges. Female participants felt a sense of empowerment to prove to others that they can earn a degree in a STEM field, which has traditionally been dominated by men. This drive has encouraged them to persist towards the completion of their degree. The females also indicated that majoring in a STEM field is not only difficult, but others may hinder them from completing their degree because it is not traditionally a field sought out by females. Also, the females in this study felt that

women majoring in STEM fields are held to a different and higher standard. Receiving encouragement from their professors was essential for both male and female participants to continue to persevere to the completion of their STEM degree.

## Difficult Challenge of Coursework

Three of the five male participants, Thomas, Brandon, and Jacob, mentioned that they realized majoring in a STEM field would be something difficult and challenging. When Thomas was asked about obstacles affiliated with majoring in a STEM field he immediately replied, “The fact that it is difficult.” However, he claims that one of the reasons he has continued to major in chemistry is due to the challenge of it. He has had several setbacks, such as making low and unacceptable grades in organic chemistry courses, calculus, and physics; this required him to retake several courses. He was able to persevere due to help from fellow classmates. Thomas found his niche with a positive peer support group, and they have pushed and motivated one another to work hard to pass difficult and challenging courses with A’s. Brandon admitted that he feels confident in science courses, but that is not because it is easy. His confidence is backed by “doing a ton of studying.” Jacob was uncertain if he could be successful majoring in biology due to the math courses required. He said, “I have never been great at math. I love learning about organisms and how things work in nature. Anything about science is easy, it is just the math that I am not a fan of.” Jacob was encouraged by his friends who are also biology majors, to continue to major in biology. He states, “I am doing just as well or better than they are. If they can keep up with the pace, then so can I.” Two of the five males, Keith and William, did not admit that majoring in a STEM field would be difficult for them. Keith said, “I am totally confident in my abilities. I will willingly call myself a math prodigy.” William also admitted to having no obstacles with classes, and stated, “If other people are passing then I don’t see why I can’t pass.”

All five of the female participants spoke about the difficulty of the courses required for STEM degrees. Tracy and Kimberly felt that chemistry was the most difficult course that could prevent them from continuing their degree. Tracy cannot take any more biology courses for her biology degree until she completes chemistry with a passing score. Zoë, Janie, and Amanda have all had challenges with required mathematics courses. Both Zoë and Janie have or will have to retake mathematics courses in order to continue with their degree. Zoë, who originally majored in environmental science, changed her major to health administration and completed the two-year degree because she had so much difficulty with pre-calculus. The health administration degree did not require her to take pre-calculus, but it was not what she truly wanted to major in.

Eight of the ten participants stressed that the difficulty of the classes has been an obstacle they have encountered while pursuing their degree. Only three of the eight who admitted having difficulty were male. Math, chemistry, and physics were some of the most difficult courses mentioned by the participants. Amanda jokingly stated, “Chemistry is making me want to shoot my brains out.” Tracy is concerned about not being able to take the rest of her upper level biology courses because she cannot make a proficient grade in her chemistry class. The difficulty of the classes leads to lower or even failing grades, which prompts the next obstacle.

### **Cost of Tuition**

The cost of attending college is also an obstacle discussed by five of the participants. Since several participants have had to retake courses, they are concerned about wasting money for tuition. Tracy expressed that she wants to hurry and make an

acceptable grade in her chemistry class so she can take the rest of the required courses for her degree. She said, “I don’t want to waste credits or money.” Zoë mentioned that she was also concerned about finances in completing her bachelor’s degree. She had to retake pre-calculus, and she completed the two-year degree in health administration. Since she changed her major to environmental science, some of the courses she took previously do not count towards her degree. She also wants to work on her master’s degree but may not be able to do that due to the expense. Keith also mentions that financial aid is an obstacle for him, especially because he went to another university for four years but did not complete a degree. He said, “I have been in school for so long and haven’t really gotten anywhere. You can’t get financial aid indefinitely, so I am hoping I can finish before it runs out.” Both Janie and Thomas mentioned having to retake various math and science courses, either because they did not believe they could pass them, or the grades they made were not proficient enough for their degrees.

### **Pressure to Be the “Breadwinner”**

Four of the five male participants noted that their persistence in completing STEM degrees was due to the pressure they feel to become the breadwinner. The pressure they feel may be from external (their families) or internal influences. With the expectation that they should be the ones supporting themselves and their families, the four male participants continue to work towards the completion of their degrees in hopes that they can secure a job with a good salary to provide for their necessities and leisure activities.



## Female Empowerment

All of the female participants felt empowered to persist in their studies and work towards the completion of their STEM degrees to defy the odds that are against them. Amanda commented, “Many people think we [women] can’t do a lot of things. They think that we are weak and that guys can do a better job.” She continued, “Some people, especially men, believe that females must go into a certain field, because they think females can’t do a lot of things.” Zoë majored in science because her mother underestimated her talents and potential by encouraging her to find a “good man” to marry and to “provide for her and her babies” because she is just a girl. She said, “Maybe that is why I majored in science.” She feels with a STEM degree she can be independent and self-sufficient. Kimberly, who has been daunted by her family members and her boyfriend in her decision to major in a STEM field stated, “I see myself just as strong as some guys, and I can see myself as being just as good, if not better than them. I want to get a degree and do what I want to do.” Tracy commented, “I have the mindset that I can do anything that a guy can do. I may be a bit slower, but I can still do it.” In speaking of majoring in geology, Janie stated, “I know this is a very male dominated field. Which makes me want to go out and show up the boys, and I have been doing it up until recently. It will happen again.” She was referring to the fact that she did poorly in her math course, but she is optimistic about upcoming successes. Amanda’s mother wants her to become a teacher, but she said, “That is something females do, but honestly that is not something I would want to do.” These females want to defy the odds and those who underestimate their abilities. While these females were optimistic on their continuation of

completing a STEM degree, the attitudes of their families could possibly open a door that excuses them from completing their degrees.

The female participants also expressed that women in general are held to a higher standard than males. Kimberly discussed her observations of fraternity and sorority members. She describes the males she has observed as slobs, and the females as perfectionists. Since her boyfriend is in a fraternity, she is exposed to many of the members. Kimberly states, "The guys don't care about their actions. They do care about how they look, their appearance, but not how they act at all. The sorority girls care about their looks and their actions." She believes the different actions of the males and females are due to the ability of "guys getting away with things simply because they are a guy." Kimberly stated, "Girls are held to a different standard." Janie also feels that because she is a female in a male dominated field, she is held to a different and higher standard. She feels that she has to be much better than the guys in order to get acknowledgment. Janie is in constant competition with her closest geology study group peer, who happens to be male. They will ask professors about who did better in geology courses. Her male peer gets really upset if a professor states that she was better in the course. Janie is also concerned about being a female geologist in search of a job. She believes that she must be better than her male counterparts.

Any employer is going to choose a man over a woman, I think. If they are equal they are going to choose a man first because a man doesn't have children, and if he does, he is not the primary care giver. (J. Powell, personal communication, April 30, 2013)

Janie believes because she is a woman she must take on more responsibilities than her husband. When her children get sick in the middle of the night, she will not allow her

husband to take care of them even when he tries. This mentality could possibly allow Janie to put her school obligations on the “back burner” in order to take care of other responsibilities.

I sacrifice because I feel that is what I have to do. I feel that women should be equal to men, but I have to take care of him because I am the woman and he is the man. I put more on myself, but I blame that on the way my grandmother raised me. (J. Powell, personal communication, April 30, 2013)

Despite the obstacles encountered by the participants, they still work towards overcoming them due to the support from their STEM major peers and encouragement from their professors. Since majoring in a STEM field, the majority of the participants mentioned their lack of a social life due to the workload in their classes. Many students also hold jobs in addition to attending college full time. The social life that did exist for them was bonding with fellow STEM majors while studying, completing labs, or working on projects. Six of the ten participants (2 women and 4 men) discussed the “bonds” they have formed with fellow STEM majors. When the going gets tough Janie relies on support from her fellow geology majors. They have a study group that gets together often. If students have children, they will bring them so that they can play together while the adults study. In addition to this group, Janie also has a special “bond” with one of her fellow geology majors. They are each other’s support group, but they are also competitive which makes them push each other to bring out the best in themselves. Janie said, “I need a support group like you would not believe. If I did not have study groups I will be missing something.”

## **“Bonds” with Fellow STEM Majors**

Keith had to figure out where he fit in socially at SEU. Like Janie, he is also a little older than the rest of the traditional students in his major. Keith describes himself as “not a very social person,” but the small size of the mathematics department allows him to interact with the same people each semester. He said, “It is nice in my major because the people who are in my classes are the same people each semester just about.” He feels like he has formed a type of camaraderie with this fellow math majors with “light-hearted and humorous competition.” They talk about “staying together” and “sticking up” for each other because their major is outnumbered.

Zoë discussed that she and her boyfriend participate in many study groups among the Earth and Space Science majors in order to help one another be successful in classes. Brandon not only utilizes study groups among the Earth and Space Science majors, but they go on many field studies together. William credits his participation in the chemistry study group as a part of the reason he has been successful in his classes. Thomas depends on the “bonds” he has made with a couple of fellow chemistry majors. Participating in his chemistry study group has been his secret to success in difficult courses. After two years of classes at SEU, Thomas was not being very successful with his classes. Once he formed strong bonds with others in his major, he noticed a difference and college became a much better experience for him. He has partnered with one main lab partner, a female chemistry major, and he said the following about their experience together.

We have been there for each other throughout the past four years. Any time she has needed anything I have come through and vice versa. We have this really strong bond and we work really well together. We are usually the first group to get done not because we are rushing, but because we work automatically together and have very little issues. (T. Johnson, personal communication, April 29, 2013)

Thomas has a limited social life, like the other STEM majors, but has developed strong relationships with his counterparts at SEU. After finding his niche and fitting into a group of fellow students, he was able to be more successful in his classes.

Knowing that other people are working hard if not harder than you really motivates me [to work hard] rather than if you are around a bunch of slackers and complainers then it really makes you feel, well if they can complain then I can complain too. (T. Johnson, personal communication, April 29, 2013)

The bond that Thomas formed with his fellow chemistry majors made the difference in him being able to persevere successfully in his major.

### **Encouragement from Professors**

Four of the ten participants (1 woman and 3 men) discussed that encouragement from their professors gives them the determination to overcome their obstacles. Keith likes the fact that the math department at SEU is small, so he knows all of the professors. He said, “The classes are usually fun because I like math, and the professors here encourage dialog, which I like.” Brandon admires and credits several of his professors for being an inspiration to him to persevere in his major. Thomas mentioned that his professors really care about the students. He said, “Dr. Smith is very passionate about her subject. Just talking to her in general conversation, I learned about what all she does and how active she is, and she was more than willing to help me.” He continued, “She always makes time for her students, and I never once heard her complain.” Thomas also mentioned the chemistry professors put a lot of energy into their work, and they want each individual to succeed. Since the chemistry department is relatively small, the professors get to know the students more intimately. Thomas commented:

When the professor sees you walking down the hallway and calls your name to say hello, and you have only had them for one semester, and it is a couple of semesters later and they still remember your name, that really leaves an impact. They do remember me, they do care. (T. Johnson, personal communication, April 29, 2013)

Janie spoke about being able to talk to her geology professors whenever she had questions or worries, and since the majority of the professors were older men, they treated her like she was a daughter. She said, “When you go to their office, they soften their voices a little when they are talking to you. They try to put you at ease.”

In sum, both male and female participants continue to pursue their STEM degrees. Even though it is a difficult challenge, they want to overcome and conquer it. The confidence of completing required courses is backed by a lot of work and studying according to six of the ten participants. Both male and female participants continue to persist due to the support from peer study groups. Male participants, in particular, mentioned that they have to persist due to pressure from family and society to be the breadwinner and achieve status in society. Encouragement and support from fellow STEM majors and college professors also helped the participants persevere.

### **How Do Students Who Major in STEM Experience and Negotiate Gender?**

When asked to define the term gender, the participants all mentioned the separate roles and grouping of males and females based on their anatomy and genetic makeup. They went on to describe characteristics of people who fit into the male gender as masculine, rough, independent, strong, enjoys sports, breadwinners, and likes video games and technology. The participants described the characteristics of the female gender as feminine, love shopping and cooking, book smart, fashionable, likes to gossip, patient,

and more likely to sacrifice their time for others. Several participants pointed out that there are exceptions to these rules, such as men who love to shop and women who like to participate in sports. However, these are some of the stereotypes that come to mind.

### **Gender Negotiation in STEM**

Three of the five male participants claimed that gender does not affect their performance in their STEM coursework. Thomas said, “Gender doesn’t affect me in regards to chemistry. I think the playing field is level.” Only Keith insinuated that females are not as smart as males in STEM courses. He stated, “I am more motivated to do better than other males than females. I feel less intimidated if a female does better.” Jacob seemed to think that females have the advantage when it comes to STEM coursework. He said, “Girls always work together and plan together. They meet up to do homework and plan their assignments. They are more prepared and communicate better.” He suggests that males are supposed to be more independent, and it is more acceptable for females than males to be prepared by working together in groups.

Three of the five female participants also claimed that gender does not affect their performance in their STEM coursework. Janie said, “Gender doesn’t affect especially in lectures. Everyone is treated equally in class.” However, she did go on to say that male professors tend to soften their voices when speaking to her in their office, but they tend to joke around with the male students. Tracy also agreed that gender does not affect her performance in class. She stated, “It [the difficulty] would be the same if I was a male.” One of the five female participants, Zoë, commented that she gets the impression from fellow male students in her classes that she and other females are not on the same

aptitude level. She stated, “Males respect me less as far as ability to be successful in classwork, labs, and just in general.” Janie states that the only way gender affected her choice of major was that since geology is a male dominated field, it encourages her to “want to show up the boys.”

All of the participants expressed that gender was not a concern when choosing their major. Amanda stated that her mother wanted her to “become a teacher with everything inside of her because she is a teacher, and that is what females do.” Kimberly noted that her family, especially her grandmother, tried to dissuade her from majoring in ESS. Her grandmother wanted her to go into teaching elementary school or a subject like English or history because it would be easier on her. Her grandmother didn’t want her to go to college and then “crash and burn” while majoring in a challenging field. Clearly the relationship between gender and choice of major is something that was more relevant in the generations of the participants’ parents and grandparents.

Whether or not a person majors in and succeeds in a STEM field is not dependent on one’s gender, but upon the individual drive of a person. Two of the five female participants suggested that the success of a student majoring in STEM is based on the individual. Tracy explained this in her observations of males and females in her classes.

There is a stereotype that girls are better students, but the guys try just as much as the girls in college. I have heard that guys are better at science than girls. As far as lab assignments go they are pretty simple if you follow the directions. Some guys can follow directions, if they follow directions. Some guys will do better and some girls will do better. It mainly depends on the individual rather than the gender grouping.

Janie was familiar with stereotypes of males having a better ability than females in measuring, following directions, and with spatial skills. However, she does not agree with



those stereotypes. Three of the five male participants also suggested that success in the STEM coursework is dependent upon the individual, rather than a gender grouping. William also stated that a person's skill set was not something controlled by gender, but that it is a personalized thing and each individual controls the limits for him/herself. He claimed that chemists should be good at abstract thinking, but they should also be able to research and have intuition about it. He feels that he is unable to talk to many people about those types of things. "I haven't talked about it with many other people. When I do they just stare. Some people can talk about it, some people can't." Gender does not decide whether someone will have those skills or not. Thomas said, "We [STEM students] are trusted as individuals on our own talents and strengths not because we are male or female." Thomas explained how one of his chemistry professors had a female lab assistant who prepared the solutions for the lab. The professor trusted her talents and did not simply look at her gender to determine her ability.

### **Day to Day Gender Influences**

The female and male participants both elucidated that female STEM student and females, in general, are held to higher standards and are expected to conform to societal pressures. Zoë claimed that others have expected her to be neater and more organized than her boyfriend. She also feels that she must act more conservatively because females are viewed with more scrutiny than males. Kimberly also expressed that females are "judged more harshly than males." Brandon feels that he is respected more because he is a male and he doesn't have to worry about his appearance like females do. Likewise, Thomas feels that life is easier for him because females have to deal with more social

pressures. Keith also said, “Males do not feel as much pressure. They don’t have to do as well and they can still fit in.”

## **Gender Stereotypes**

When the participants were asked if there were majors that were “male majors” or “female majors,” all ten participants stated that teaching and nursing are “female majors.” Likewise, all ten participants stated that engineering is a “male major.” Janie joked, “Pre-med, engineering, and astrophysics are male majors. Even the females in astrophysics are pretty much males.” She insinuates that the way these females look, dress, and carry themselves is very much masculine.

Four of the female participants and all five of the male participants suggested that women are expected to be more emotional, compassionate, and patient; therefore, the fields of teaching and nursing are female-dominated majors. Zoë stated, “Other females think that I should be more compassionate than a male, but sometimes I am not.” All ten participants suggested that males are expected to be independent, strong, and hands-on; therefore, the fields of engineering are male dominated. According to Thomas, expectations of society require people “to live up to being a masculine male or a feminine female.” Just because biology determines whether a person is a male or a female, it does not determine whether one will have masculine traits (independent, hands-on, strong) or feminine traits (caring and emotional).

Thomas spoke of his frustration with the stereotype that males are better in sciences than females. He said, “It’s frustrating when people say they can’t do it because they don’t have the gene.” He went on to say that anyone can succeed in STEM, but the

foundations they learn in middle and high school are very important in determining their level of success.

Keith discussed the stereotype that some STEM majors, particularly engineering majors, are inept with social skills. He has observed these students who are not good at socializing with others in a comfortable way. These students could be labeled “geeks” or “nerds.” They seem to be “way more awkward with the opposite gender.” Therefore, if they feel that a female is not on the same intellectual level with them, then she will never fit in to their group.

## Summary

In summary, this chapter looked at why college students decided to major in STEM fields. Among the many reasons, the participants expressed interest in STEM subjects; their family, friends, and teachers encouraged them to major in STEM fields; and they were looking for financial stability. In addition to this, participants described how gender impacted their experiences from their childhood until the present. Some participants expressed that they were uncomfortable with the opposite gender, while others were more comfortable with the opposite gender. Males who were uncomfortable with the opposite gender were drawn to areas such as STEM fields which are male-dominated. Females who are more comfortable with males are also attracted to the STEM fields for that same reason, as four of the five female participants admitted to wanting to associate with males rather than females. Participants also discussed pressures they feel from society and how that affects them psychologically. However, participants persist in their pursuit of STEM degrees for several reasons. Males persist because they have high expectations placed upon them by society as well as themselves. Females persist because they get a sense of empowerment from going against the odds. Male and female participants persist in their quest for STEM degrees in spite of identified obstacles. Among those are the difficulties of required courses, affording tuition, and others trying to dissuade them from continuing coursework towards a STEM degree. Participants recognized that encouragement from their professors and fellow classmates helps them to endure the difficult path of attaining a STEM degree. The majority of the participants did not feel that gender affects their performance in their STEM coursework. Gender was also not a concern when choosing their majors; however, some female students were

dissuaded by family members who suggested they take a more traditional route for females. The participants also indicated that success in STEM is dependent upon the talents and work ethic of individuals rather than their gender grouping. Both male and female participants recognized that females are held to higher societal standards and are expected to conform to expectations. The participants identified gender stereotypes that exist, but they did not agree that they held true for all situations.

## **CHAPTER V**

### **CONCLUSION**

This research study intended to investigate how undergraduate men and women negotiate gender in the STEM fields and to examine their experiences associated with gender awareness as they complete their STEM coursework. This chapter will open with an analysis of themes from the previous chapter. The chapter will continue with implications for future research and a discussion of the study's limitations.

#### **Analysis of Themes**

The findings in Chapter 4 implied several themes among the male and female participants. First of all, the reasons for choosing to major in a STEM field were examined. Next, the impact of gender on the participants' experiences was looked at. Next, the obstacles that impact the persistence of STEM majors in degree completion was investigated, as well as, the solutions for overcoming those obstacles. Lastly, Chapter 5 looks at how students who major in STEM experience and negotiate gender.

#### **Assertions from Data Analysis**

By using Erickson's (1986) analytic induction the following assertions were generated by searching the data in its entirety (interview notes, interview recordings, and questionnaires). Students who major in STEM chose the major due to their interests in STEM. Males were more likely than females to be influenced by their families to major in STEM. Teachers influenced both males and females to major in STEM. Male students, more so than female students, chose to major in STEM for financial stability and job opportunities. Females were more likely to be dissuaded by their family from majoring in

STEM. Females were more likely than males to connect and cooperate better with the opposite gender. Females were more likely than males to admit to feelings of incompetence and lack of confidence. Males and females, both, associated dominance with the male gender. Males were concerned with their masculinity and females with femininity, but females seemed to be held to more and higher standards about their femininity. Females were more likely than males to admit if something was challenging. Males believed that they must be the breadwinner and provide for their family, and females were encouraged by family to be dependent on males. Males seem to “fit-in” to STEM groups easier than females. Being a part of a study group was essential to success in STEM courses.

### **Why Major in a STEM field?**

Reasons participants chose to major in a STEM field were their interests in the subject; influences from family, friends, and teachers; and the desire for financial stability. Table 2 shows a tally of related themes among the participants’ responses to why they chose to major in STEM.

**Table 2 Reasons for Choosing to Major in a STEM Field**

| Related Themes                    | No. of Males | No. of Females |
|-----------------------------------|--------------|----------------|
| Interest in STEM                  | 5            | 5              |
| Influence from family and friends | 5            | 0              |
| Influence from teacher            | 3            | 3              |
| Influence from a male teacher     | 0            | 2              |
| Influence from a female teacher   | 3            | 1              |
| Dissuaded by family               | 0            | 3              |
| Financial stability/job           | 5            | 1              |

Responses from participants in this study suggest that students decided to major in STEM fields because it is something in which they have an interest. For most of the male participants interest in the STEM subjects was developed from elementary and middle school age. Most of the female participants developed an interest in STEM during high school and one participant even developed an interest in STEM during college. This interest came from activities the participants did with their families such as hunting, maintaining a fish aquarium, and participating in extracurricular activities involving STEM. Sparking an early interest in subjects, such as STEM, may lead to lifelong interests and can possibly lead to the desire to pursue a degree and career in that area.

A noticeable difference is that the male participants were more positively influenced by family and friends to major in a STEM field. Male participants were encouraged to major in STEM so they would be able to make a living and gain status in society. Female participants did not receive influence to major in STEM subjects from their family members. In fact, some females were actually dissuaded to major in STEM from their family and encouraged to choose another major that was traditionally more female appropriate, such as teaching. Before female STEM majors enter their coursework they must overcome family perceptions of STEM and STEM careers for women and their families' views of appropriate roles for women. Social structure shows that society has different and higher expectations for males than females. In a study by Eccles (2005), parents of daughters had lower expectations of their child's future performance in math, engineering, and physical sciences than parents of sons. Fathers were found to make more cognitive demands on the child during physics related tasks if the child was a boy (Bhanot & Jovanovic, 2009).



The majority of the participants cited that their interests in STEM fields were sparked by either a teacher in grades K-12 or a college professor. It seems that the gender of the teacher does not have to correspond with the gender of the student. Three of the male participants were all influenced to major in STEM by female teachers. Two of the female participants were influenced to major in STEM by male teachers, and one was influenced by a female teacher. As mentioned male participants were influenced to pursue a degree in the STEM fields by family members, but none of the female participants received encouragement from family members. Chhin et al. (2008) suggested that parents, especially fathers, play a big role in influencing their children's career decisions, but the expectations for females are typically lower than those for young males. Three of the five females in this study were actually dissuaded to major in STEM by their family members. Therefore, it is vital that educators continue to encourage females to pursue STEM fields and expose them to experiences in STEM that will gain their interests.

All five male participants admitted to financial stability as being a reason for majoring in a STEM field. Most of the female participants, contrary to the male participants, did not mention financial stability as a reason for majoring in STEM. Anticipated occupational outcomes can influence a students' selection of college major. Since the male participants in this study felt they needed to be the provider for their family, choosing a major in one of the STEM fields, which are among the top paying careers in the United States, would take care of their financial needs in addition to satisfying their interests in the subject.

## How Has Gender Impacted Participants' Experiences?

Participants' relations with members of the opposite gender suggest that for the females, the degree to which they are comfortable associating with males and participating in activities that are considered to be more for males may be a factor in their decisions to major in and persist in STEM fields. The participants' experiences that have been impacted by gender can be found in Table 3.

**Table 3 Relevant Themes for Experiences Impacted by Gender**

| Related Themes                             | No. of Males | No. of Females |
|--|--------------|----------------|
| Connected better with the opposite gender  | 1            | 4              |
| Society places higher expectations on them | 3            | 0              |
| Society places lower expectations on them  | 0            | 3              |
| Feelings of incompetence                   | 0            | 5              |
| Believe males are dominant                 | 4            | 5              |
| Concerned with femininity                  | 0            | 3              |

### Social Expectations

The participants discussed how gender has impacted different experiences throughout their lives starting with elementary school, continuing into middle school, high school and into college. Four of the five males discussed how they cooperated better with other males throughout their school careers, and some even avoided girls because they did not feel comfortable around them. On the other hand, four of the five female participants discussed how they cooperated with males better than their own gender throughout their school careers. These females seemed to be interested in activities that are deemed to be “male activities” such as playing video games, hunting, and outdoor recreation. Since these females were more open to participating in activities that are traditionally categorized as “male activities”, they may have also been drawn to

STEM subjects for that reason. Contrary to Jacobs et al. (2002), the female participants in this study participated in “male activities” throughout their childhood and into their college years, rather than changing to more gender appropriate interests during middle school years. The group of people a female associates with during high school may influence her advanced-course enrollment especially in the areas of math and science (Shapiro & Sax, 2011). The female participants in this study tended to connect better with males during high school and this may have impacted their interests and decision to major in STEM.

Eccles (2005) suggested that society has different and higher expectations for males than females. Male participants in this study agreed with this view. Three of the five males spoke of having higher expectations placed upon them from family members and society due to their gender. The females in this study seemed to have lower expectations placed upon them, especially by family members. Wells, Seifert, Padgett, Park, and Umbach (2011) found that same-sex parental education influences expectations. A mother’s education has a positive influence on the degree expectations of women and a father’s education has a positive influence on the degree expectations of men. Traditionally, females have chosen majors that may not be deemed as challenging or have the status that is affiliated with STEM majors. If females do choose to major in STEM fields regardless of parental educational influences, they could be more likely to drop out of STEM fields if they find it too challenging and choose a more traditional female major. Since family members and society tend to have these expectations that males should choose a more challenging field and it is acceptable for women to choose

fields that are less challenging students may live up to their expectations. If less is expected of students then they may achieve less.

### **Male Confidence/Female Inferiority**

Male participants displayed more confidence than the females to control whether they are going to be successful in their courses. Females were more willing to admit that they felt inferior in classes or that they doubt their abilities to be successful in STEM courses. All five female participants admitted to feeling incompetent in at least one class; however, none of the males admitted to being incompetent. Females felt especially incompetent in their math courses or courses, such as chemistry, that require a lavish amount of math skills. Shapiro and Sax (2011) reported that women consistently report lower levels of academic and mathematic confidence, even when their abilities are equal to that of men. This is a concern for women may not leave the STEM majors due to their lack of abilities, but they may leave due to a lack of “scientific self-confidence” (Shapiro & Sax, 2011).

The female participants spoke of frustrations and difficulties with their classes as well as an unsupportive atmosphere in the classroom. They also displayed more concern for doing their best in classes, where the male students seemed more at ease with their ability to be successful. The factors combined could result in the attrition of female STEM students (Porter & Umbach, 2006). Women may be more likely to pursue majors and careers that are traditionally associated with them, especially in helping fields, which may have a more supportive climate but less occupational rewards (Morris & Daniel, 2006). Female participants discussed the relationships between professors and students

could be affected by gender. As STEM subjects are filled with male students and professors who relate better with each other, female students may feel outnumbered and that the professor favors the male students. Negative relationships between professors and students could lead to students forming a negative attitude toward the subject as well as perceptions that they may not be competent enough to be successful in a course.

Three of the five males and all five females described the notion of being a male was to take charge, be in control, and be stronger than females, while females should be more conservative. The interviews from both male and female participants also highlighted times where males dominate or take control of the group during labs and class activities. This may contribute to a hostile classroom environment for female students. As noted in the research, females' feeling of inferiority may increase due to these hostile and "male-normed" learning environments (Margolis & Fisher, 2002).

While the workload of a STEM degree itself is challenging and difficult, women are dealing with the fact that society, men and even other women, are judging them based on their actions and what is expected of them. While the males may be undergoing judgment as well, they carry it differently and don't seem to be stressed by it. Women typically use social coping more than men, which is not traditionally supported in the climate of the STEM environment (Morganson et al., 2010). Males typically have a proactive personality which involves active planning and increased participation in coping with stressors (Major et al., 2012). This may explain the perception that males seem less stressed than females. In this study females believed that males in their classes did not seem as stressed as the females. However, male participants in this study did have stress, but may have carried it differently than females. They were confident they would

overcome the obstacles causing the stress and realized that majoring in a STEM field would present challenges. Of the ten participants in this study, the females were more likely than males to admit feeling a lack of competence. According to Schreuders et al. (2009), this lack of competence in females may inhibit their ability to persevere and complete their degree.

### **Males Are Dominant**

Nine out of the ten participants spoke of the male gender as possessing dominance and control. All five females related dominance to the male gender. Even though the females feel that they can achieve whatever a man can achieve and even be better, the society around them has engrained in them that men are in charge. Women can be successful, but they have to work harder than the men around them because females have fewer chances and are held to higher standards, especially when doing something that is deemed to be a “male activity.”

Some of the male participants admitted looking out for the female students in their classes, especially during labs that involve field work. While the males may believe that they are being helpful and courteous, it could give the perception that they are dominant and believe that the females are incapable of doing the same tasks as males.

### **Femininity**

Three of the five female participants and two of the male participants discussed the femininity of STEM majors. The female participants have felt pressures from others due to the way they dressed or activities that they participated in that were not “lady-like” or “pretty.” These participants have ignored society’s standard of looking and acting like

a female because they feel comfortable with the way they are. This attitude may help them continue to major in a STEM area, even though it is seen as a “male-dominated subject”. They may have by-passed, at least partially, the gender intensification period in which boys’ and girls’ interests involve doing gender appropriate activities (Jacobs et al., 2002). As for the male participants who discussed the femininity of women, both commented that they cooperate better with females who are “tomboyish.” Even though the STEM fields aggregate these types of females, the male participants still treat them differently. They feel that females are weaker and must be taken care of when doing male activities such as hiking or doing geology field work.

Are the females who choose to major in STEM areas drawn to the subjects because their characteristics are deemed more masculine? Morris and Daniel (2008) suggested that students with higher masculinity scores tended to major in physical sciences. Could it be that females with those characteristics are more likely to withstand the climate and culture of the STEM fields because they can better relate to males? Though this seemed to be the case in this study, Oswald (2008) reported that females in traditionally masculine majors experience more discrimination and stereotype threat, which can deter them from those majors and into traditionally feminine majors. For example, the stereotype that men are better at math than women can hinder women’s performance in math. If women are worried about performing poorly in a subject that she is not supposed to be good at, then the anxiety could contribute to her actual failure. This failure is possibly a confirmation to the female that she is in a field where she does not belong. In addition to this, women may be concerned about their femininity. Although the women participants in this study did not seem too concerned about the way others

perceived their appearance, scientists and mathematicians are often depicted as being geeky or nerdy. This could also deter many women from while pursuing a STEM degree.

### **What Obstacles Impact the Persistence of Participants in the Completion of Their Degree and How Do They Overcome Them?**

STEM majors encounter several obstacles during the pursuit of their degree. First of all, the coursework for STEM degrees is difficult. In addition to the challenging curricula, the women participants are also breaking through to an area that is a non-traditional field for females. Due to the fact that the female participants are majoring in a non-traditional path, they often find that they are held to higher standards. The male participants face the pressure of degree completion because it is an expectation that they must be the breadwinner to provide for themselves and a family. Some participants revealed that the cost of tuition is also an obstacle. Table 4 shows a gendered tally of obstacles encountered while pursuing a STEM degree and remedies for overcoming them.

**Table 4 Relevant Themes for Obstacles that Impact the Persistence of Participants in the Completion of their Degree**

| Related Themes                 | No. of Males | No. of Females |
|--------------------------------|--------------|----------------|
| Difficult challenge            | 3            | 5              |
| Cost of Tuition                | 2            | 3              |
| Pressure to be the breadwinner | 4            | 1              |
| Empowerment                    | 0            | 5              |
| Bonds with fellow STEM majors  | 3            | 2              |



## Difficult Challenge

Most of the participants recognized that the coursework involved in earning a STEM degree would be a difficult challenge. For some students, the challenge is part of the motivation that drives them to persist in their quest for the degree. However, the prestige of attaining something difficult was a factor for three of the male participants and only one female participant. According to Abuhamdeh & Csikszentimihalyi (2011), the pursuit of optimal challenges increases one's intrinsic motivation. The key is that the challenge must be optimal, not too easy or too difficult. If the challenge is balanced by skills, then the individual will give all of his or her attention to the task at hand. If the challenge exceeds the person's skill level, then he or she may start to worry and become anxious which takes the focus off of the task eventually leading to boredom and disinterest. Since the female participants already feel the additional pressure of being in an area where they do not belong, they already have additional stimuli that take their attention from focusing on an already challenging curriculum. Along with stereotypes that females have a weaker ability in math and science, females are less likely than males to maintain the attentional involvement needed to overcome the challenges.

The male participants viewed the challenge of earning the degree with more confidence than the females. Since the male participants are majoring in a field that is a traditional path for them and with positive stereotypes. Men, in general, tend to be more positive about STEM, and can make higher scores in classes than women who have negative attitudes towards the sciences (Desy, Peterson, & Brockman, 2009). This confidence and positive attitude, or self-efficacy, can help males to map out the procedures needed to reach their goal (Bandura, 2003). Unlike the females, who have

additional stimuli (negative stereotypes and being out of field) to distract them, males may be able to focus on the challenge of the curriculum more than the females.

The female participants also felt that they were being held to a higher standard due to their gender. Since STEM fields are traditionally male dominated and require achievement scores and skills in math and sciences, classrooms can have an “elitist” environment (Vogt et al., 2007). Since females are the underrepresented group, the males are the “elitists,” which make the females feel out of place. It seems that women have to be even better than the men in these classes because they are not in their traditional role or place.

Four of the females expressed that the difficulty of the classes could take a toll on whether they would be able to complete the degree. Some classes are pre-requisites for others, and the women would be unable to continue with coursework if they did not make acceptable grades in these classes. Poor grades can lead to a negative attitude towards the subject and a decreased feeling of competence. Negative attitudes and feelings of incompetence may make these students choose another field to major in (Vogt et al., 2007). Some female participants implied that they may have to choose another field if they could not make the grades needed to complete courses. One participant had already left her original STEM field major to complete a two-year degree in health administration due to losing confidence and developing a negative attitude towards pre-calculus. Incredibly, she decided to come back to major in environmental science because she truly loved it, and was able to tackle her pre-calculus obstacle and redeem her confidence.

## **Cost of Tuition**

Both male and female participants were concerned about the cost of tuition as an obstacle to deal with while pursuing a STEM degree. Since the STEM coursework is difficult and courses may have to be retaken due to low or failing grades, students in this field may end up losing scholarships, if they have them, or use all of the funds allotted to them before completing all of the required courses.

## **Pressure to Be the “Breadwinners”**

The majority of the males expressed concerns that they felt pressure to major in a field where the job could make them the “breadwinners.” Since males experience pressure to be the provider for themselves and their families, they feel that they have to complete their degrees in order to get a secure job with good pay. This pressure does not give them the option of dropping out of the major. Females who start off majoring in a STEM major are more likely to drop out of the field because they do not have as much pressure to be the family provider. In a breadwinner-caregiver family model, if the wife works, it is seen only to help the family in addition to her normal caregiver role. The husband is the one who is responsible for the money making (Fulcher & Coyle, 2011).

Only one of the five female participants in this study mentioned that she will become the “breadwinner” once she completes her degree. However, up until the present her husband has been the sole provider. The majority of the female participants in this study did not feel pressure to be the breadwinner or pressure to make a lot of money. According to a study from Frome et al. (2008), 83% of females who had aspirations to major and work in the male-dominated STEM fields switched to female-dominated fields within seven years after graduating from high school. It seems that throughout development and into early adulthood females are simultaneously furthering their education, yet at the same time planning for a family role that involves caretaking of the home and family (Fulcher & Coyle, 2011). As females prepare for their caretaker role they may be more likely to choose a traditionally gender appropriate major. It is interesting that the one female participant, who wanted to become the breadwinner, was the oldest of the female participants. She was the only one with children, who were

school aged. As she had already experienced her role as the primary caregiver, she planned on becoming the sole provider for the family while her husband reversed roles to become the primary caregiver.

## **Female Empowerment**

Female participants were encouraged to major in STEM programs because they have been told that the odds are against them. Not only do they want to major in and complete a STEM degree, they also want to achieve at a higher level than their male counterparts. The female participants in this study have been exposed to the perception of others that certain tasks are not appropriate for them due to their gender, and if they tried to perform these tasks their results would not be as good as if a male were to complete them. A characteristic of the female participants in this study was that even though they felt discouragement from others to complete these male dominated tasks, they felt motivation to do it anyway and to do it better. They want to “show up the boys,” defy the odds, and challenge those who underestimated their abilities. Arora (2010) stated, “Empowerment of the individual may be achieved when one acquires the ability to recognize his/her own potential in a realistic perspective and capitalize on it, bringing about a fundamental change in the socio-professional fabric”.

## **“Bonds” Among Students**

Since majoring in a STEM field, the majority of the participants mentioned their lack of a social life due to the workload in their classes. Many students also hold jobs in addition to attending college full time. The social life that did exist for them was bonding with fellow STEM majors while studying, completing labs, or working on projects. The

“bonds” formed between STEM majors were often the difference in whether the student passed or not. By forming “bonds” with other STEM majors, students were able to engage in social support coping, which is very important for females to gain emotional support during the difficult challenges presented in STEM coursework (Morganson et al., 2010). However, this study yielded three of five males and only two of five females who spoke of the significance of “bonding” and studying with other STEM majors. The camaraderie that was formed among the students helped to accommodate the different student groups, including those who are underrepresented (Amelink & Meszaros, 2011). Bonding in groups gave the participants support academically and emotionally. The groups helped members find a place where they could “fit in.” The groups provided support when needed, but also gave friendly competition in order to bring out the best in the individual. In the STEM fields, women typically feel out of place and isolated (Vogt et al., 2007); therefore, it is crucial for women to find a group to “bond” with to improve their chances of degree completion.

### **How Do Students Who Major in STEM Experience and Negotiate Gender?**

Table 5 highlights themes of how STEM students experience and negotiate gender. The majority of participants were not concerned about gender when deciding on their major. They also do not believe that it affects their success in STEM coursework. The participants in this study defined gender as a difference among people biologically. They also mentioned that males and females typically may have different interests, characteristics, and emotional feelings from one another; however, in today’s generation individuality is more prevalent. People are choosing majors and career paths based on

their individual interests rather than the group to which they belong. All of the participants expressed that gender was not a concern when choosing their major. Clearly the relationship between gender and choice of major is something that was more relevant in the generations of the participants' parents and grandparents. Whether or not a person majors in and succeeds in a STEM field is not dependent on one's gender, but upon the individual drive and experiences of a person.

**Table 5 Relevant Themes of How STEM Majors Experience and Negotiate Gender**

| Related Themes   | No. of Males | No. of Females |
|--|--------------|----------------|
| Gender does not affect STEM coursework                           | 3            | 3              |
| Gender was not a concern when choosing a major                   | 5            | 5              |
| Success in STEM is dependent upon the individual's drive/ability | 3            | 2              |
| Females are held to higher standards than males                  | 5            | 5              |
| Aware of gender stereotypes                                      | 5            | 5              |

Although the generation of participants in this study do not believe that their choice of major should be dependent upon gender; some have been influenced by their parents and grandparents that there are certain routes or tasks deemed appropriate for either males or females. The participants also suggested that females are held to higher standards than males due to their gender. Females are under more pressure to conform to societal expectations. The males indicated that they have less worries about what society thinks of their appearance and behaviors; therefore, males can focus on their goals a little easier than females who may be sidetracked by what society thinks of them.

All participants were aware of gender stereotypes, but realized that there are exceptions to the rules. Throughout their life and school experiences they may have

unconsciously picked up these “gendered pathways,” but with continued support and encouragement from educators and fellow STEM enthusiasts, they have persisted in their pursuit of a STEM degree. When STEM majors have this type of support, the disparity between male and female majors may subside.

### **Implications for Educators**

It is important for educators, especially those who teach middle and high school, to retain the interests of females in STEM subjects. Since three of the five female participants credit their teachers for influencing them to pursue a STEM degree, it is vitally important that educators keep in mind the influence they wield in a student’s life. This is especially important when possibly the only encouragement for some females to pursue a STEM degree may come from a teacher.

Maintaining a classroom climate where males and females are treated with as much equality as possible is also essential to interest and encourage all young people to pursue in STEM subjects. “Education is a basic human right and a reasonably good indicator of development” (Khandka, Dobhal, & Nasreen, 2012). Females enter the STEM fields with the odds against them, and existing negative stereotypes; they must be empowered by teachers helping to build their confidence, giving them opportunities, and exposure to female role models in STEM.

Interactions between educators and students are important as well. When students feel that the teacher or professor is truly interested in their success, it gives the student encouragement and a socially supportive outlet to utilize. Hopefully this support will help students stay committed to graduating with a STEM degree.



## **Implications for Future Research**

This study provided insights for future research. Among the participants were those raised in a military family setting. The participants mentioned that gender barriers have been broken down as far as the roles of military men and women as they are expected to do the same jobs. It may be significant to study male and female STEM majors who have been raised in the military culture and compare with male and female STEM majors who have not been raised in the military culture of discipline and lack of assigning gender roles. Would the themes raised in this study hold true for STEM majors with a military lifestyle?

It would also be necessary to conduct this research at other sites, more specifically in different regions of the United States. Participants in this study mentioned that experiences with gender roles and certain gender expectations existed due to being located in the southern region of the United States of America. The southern region of the United States is known for being the “Bible Belt” which mostly values a more conservative and traditional way of life. Is there a difference between the experiences of STEM majors raised in different regions of the country?

Because the participants in this study lacked a diversity of ethnicity and solely had the insights from STEM students of the Caucasian race, it may be beneficial to conduct a study on STEM majors of different racial and ethnic backgrounds. Compiling experiences of STEM majors from different cultures and backgrounds could uncover more ideas to bring more variety in the gender and ethnicity of students entering the STEM fields.

A longitudinal study would also be beneficial. Studying male and female students interested in STEM fields during their middle school years (sixth, seventh, and eighth grades) and tracking their experiences throughout high school and into college could reveal more insight to reasons students choose to major or not major in STEM. Following these students throughout their education may shed some light regarding challenges in recruiting students into the STEM fields and arming them with the skills and attitudes to help them persist and complete their degrees.

In order to understand more about the underrepresentation of females in STEM, it would be interesting to study the participants' perceptions of possible reasons for this phenomenon, beyond their own experiences in STEM classes.

### **Limitations of the Study**

There are a few limitations in this study that must be acknowledged, which mostly deal with the data collection. While developing the methodology for this study it was with the intention to interview participants from a variety of STEM majors. Due to the recruitment process this did not happen. Two of the male participants shared the major of chemistry and two of the female participants shared the major of biology which is typically a female STEM major to begin with. The recruitment process did not yield any females in the areas of mathematics or chemistry, which are more male dominated fields.

Another limitation is the small size of SEU's pre-engineering program. The recruitment process also did not acquire any participants from the pre-engineering department. Interviewing a student in this department could shed some light on the

experiences and attitudes that influence one to pursue that field, especially because it is a heavily male dominated STEM field.

Another limitation to this study is that all of the participants are from one ethnic background, white or Caucasian. The perspectives from this study come from participants who have experienced growing up in one culture. It would have been interesting to get the viewpoints from other ethnicities that have experienced being a minority, or have different gender roles than those acceptable in the western society.

### **Closing Remarks**

As an educator, it is important to provide an equal education to both males and females. It may be even more important to encourage females in STEM classes due to the expectations and stereotypes they may experience in their family and other social arenas. From listening to the participants' experiences, it seems that society is more aware of gender equality; however, it is not always demonstrated with actions. The majority of the participants still associated the male gender with dominance. If educators and/or STEM role models have an outlook that males are more dominant and suited for STEM fields, then this can dissuade females from pursuing STEM fields and reinforce the traditional role of women in society. Although it may not be intentional, our actions may speak louder than words.

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**APPENDIX A**

**STUDENT INFORMATION SHEET**

First and Last  
Name: \_\_\_\_\_

Year in College: \_\_\_\_\_

Age: \_\_\_\_\_

Hometown: \_\_\_\_\_

Academic Major: \_\_\_\_\_

High School: \_\_\_\_\_

Gender: \_\_\_\_\_

Country of Birth: \_\_\_\_\_

Highest level of education to plan to achieve (e.g., Bachelor's, Master's, Professional-  
MD or JD, Doctoral-Ph.D. or Ed.D.): \_\_\_\_\_

Preferred e-mail address: \_\_\_\_\_

Phone number: \_\_\_\_\_

Mailing Address (for mailing gift card for participation in study):

\_\_\_\_\_  
\_\_\_\_\_

Preferred Pseudonym (for anonymity during research  
participation): \_\_\_\_\_



**APPENDIX B**

**LETTER TO PARTICIPANTS**

March 15, 2013

Dear \_\_\_\_\_,

Thank you for your interest in my dissertation research on the experience of undergraduate men and women majoring in STEM fields. I value the unique contribution you can make to my study and I am excited about the possibility of your participation in it. The purpose of this letter is to discuss the study and to secure your signature on the participation-release form that you will find attached.

The research model I am using is a qualitative one through which I am seeking descriptions of your experience. In this way I hope to illuminate or answer my question: "How do undergraduate men and women who have chosen to pursue STEM fields experience and negotiate gender?"

Through your participation, I hope to understand the essence of the experience of male and female undergraduates majoring in STEM fields. You will be asked to recall specific episodes, situations, or events that you experienced in choosing your academic major and experiences of gender during your school career. I am seeking vivid, accurate, and complete portrayals of what these experiences were like for you: your thoughts, feelings, and behaviors, as well as situations, events, places and people connected with your experience.

I value your participation and thank you for the commitment of time, energy, and effort. As an incentive for your participation I will send you a Visa gift card at the conclusion of the data collection process. If you have any further questions before signing the release form or if there is a problem with the date and time of our meeting, I can be reached at 706-289-6291.

Sincerely,

Amy Latta-Won  
Columbus State University  
Doctoral Candidate

**APPENDIX C**

**INFORMED CONSENT FORM**

You are being asked to participate in a research project conducted by Amy Latta-Won, a student in the College of Education and Health Professions at Columbus State University. The study will be used in a Doctoral Dissertation supervised by the Doctoral Committee Chair, Dr. Deborah Gober.

**I. Purpose:**

The purpose of this project is to investigate how undergraduates who have chosen to pursue majors in STEM (Science, Technology, Engineering, and Mathematics) fields experience and negotiate gender. The goal of this study is to better understand the experiences of undergraduate men and women who have made the decision to complete a degree in a STEM field, and focuses particularly on their experiences within the STEM fields related to gender and how they negotiate gender. This is a qualitative research study that relies on semi-structured interviews with undergraduate men and women majoring in STEM fields.

**II. Procedures:**

1. The researcher and participant will meet in a quiet location on campus at an agreed upon time to conduct an interview.
2. The researcher will review the informed consent with the participant and have him or her sign the form.
3. The interview is anticipated to last 60-90 minutes and will include questions pertaining to his or her experiences in college; choosing a major; experiences with gender and gender negotiation of gender during childhood, high school, and college; possible obstacles since enrolling in college; and the importance of jobs and careers in his or her major field.
4. At the end of the interview, the participants will complete a short questionnaire which focuses on their career and life plans after graduation and at different milestones in their lives.
5. The participant will receive a \$10 Visa Gift Card after the completion of the interview and questionnaire.
6. The researcher may e-mail participants in order to clarify any details from the interview and questionnaire.
7. The researcher will transcribe and analyze the data to draw conclusions.

**III. Possible Risks or Discomforts:**

Potential risks for participants in the study could be psychological in nature including anxiety or feeling uncomfortable able answering questions during the interview. In order to minimize risks, participants will be identified by a

pseudonym to retain confidentiality. They will be made aware of informed consent and reminded that they can leave the study at any time.

**IV. Potential Benefits:**

Potential Benefits may help us better understand how men and women who are undergraduates in STEM fields negotiate gender and what they experience while majoring in a STEM field.

**V. Costs and Compensation:**

Participants will receive a \$10 Visa gift card upon completion of interview and questionnaire to compensate them for their time and effort.

**VI. Confidentiality:**

Each interview will be digitally-recorded. The recorded interviews will be downloaded and stored on a password protected computer which can only be accessed by the researcher.

**VII. Withdrawal:**

Your participation in this research study is voluntary. You may withdraw from the study at any time, and your withdrawal will not involve penalty or loss of benefits.

For additional information about this research project, you may contact the Principal Investigator, Amy Latta-Won at 706-289-6291 or [lattawon\\_amy@columbusstate.edu](mailto:lattawon_amy@columbusstate.edu). If you have questions about rights as a research participant, you may contact Columbus State University Institutional Review Board at [irb@columbusstate.edu](mailto:irb@columbusstate.edu).

I have read this informed consent form. If I had any questions, they have been answered. By signing this form, I agree to participate in this research project.

---

Signature of Participant

---

Date

## **APPENDIX D**

### **INTERVIEW QUESTIONS**

1. Can you tell me a little bit about yourself?  
Where did you grow up?  
What are your interests, hobbies, experiences?  
How did you end up at this university?
2. How would you describe your experiences in college so far?  
How would you describe your experiences in the classroom?  
How would you describe your experiences with the social life at this university?  
How would you describe your experiences living in this city?
3. Can you describe the experience of choosing your academic major?  
What did this process entail?  
What thought processes did you follow?  
What was the role of your academic experiences so far at the university?
4. Can you describe the different people and experiences that may have influenced this decision?  
What was the role of your academic experiences (e.g., class, faculty, school work, academic peers)?  
What was the role of your family and/or siblings? [pressures]  
What was the role of your peers? [acceptance, pressures]  
What was the role of potential job opportunities and career paths associated with this major?
5. Has your understanding of gender impacted your choice of major?  
Were you conscious of being a male/female when choosing a STEM field?
6. How would you describe your experiences with gender as a young boy/girl at elementary school age?  
What was the role of parents/siblings? Teachers?  
How did gender impact your interests or interactions with friends?
7. How would you describe your experiences with gender during middle school?  
What was the role of parents/siblings? Teachers?  
How did gender impact your interests or interactions with friends?
8. How would you describe your experiences with gender during high school?  
What was the role of parents/siblings? Teachers?  
How did gender impact your relationships with friends?  
How did gender impact your extracurricular involvements?
9. How would you describe your experiences with gender as a college student?

How would you describe your awareness of your gender?  
Do you feel any particular pressure based upon gender?  
What are your experiences with gender stereotypes in college?  
Is there a difference between the “male” college experience and the  
“female” college experience? Explain.

10. When I use the term ‘gender,’ what does that mean for you?  
What are the immediate things that come to mind with this term?  
How would you describe the notion of being male/female? Being a  
man/woman?  
What is the relationship between gender and identity (your identity and  
others’ identities)?
11. How does gender impact your experiences as a college student?  
How would you describe your experiences as a man/woman in the  
classroom?  
How would you describe your experiences as a man/woman in social  
situations?  
Has college made you more or less aware of your gender?
12. What is the relationship between majors and gender more broadly?  
Are there majors that you feel are particularly more “female”? Why?  
Are there majors that you feel are particularly more “male”? Why?  
Are there specific skill sets associated with “male” and “female” majors?  
Which ones?
13. In thinking again about your choice of major, are there any obstacles that you  
perceive now which are associated with this major?  
What are your perceptions about job opportunities associated with this  
major?  
Do you have any concerns about your own ability to compete this major?
14. How do you perceive your experience in choosing a major in relation to the  
experiences of your parents choosing a major?  
Do you feel that you had more or less flexibility than your parents?  
Do you feel that you felt more pressure or less pressure? More stereotypes  
or fewer stereotypes?
15. How important were the jobs and/or careers associated with this major in making  
your choice?  
How important was your understanding of the day-to-day work?



How important was your understanding of the flexibility, work/life balance, challenge rewards, prestige, salary, and etcetera associated with this major?

16. How important was the nature the work associated with this major?  
How important was the nature of the academic work (exams, papers, homework)?  
How important was the level of time commitment? Skills required?

**APPENDIX E**

**LIFE GOALS QUESTIONNAIRE**

Thank you for taking the time to fill out this brief questionnaire. Please answer each question as detailed as you can. The results of this questionnaire will be used within the study of how women majoring in STEM fields experience and negotiate gender. If you have any questions please contact Amy Latta-Won at [amylatta@aol.com](mailto:amylatta@aol.com).

Gender (circle one): Male or Female

Year in college (i.e. Freshman, Sophomore, etc.): \_\_\_\_\_

Major (i.e. Pharmacy, Engineering, etc.): \_\_\_\_\_

What are your plans for the future (i.e. career, marriage, children, graduate school, etc.)?

After graduation:

In 3-5 Years:

In 10 Years:

Your Ideal (Dream) Life:

**APPENDIX F**

**REDSEARCH PARTICIPANTS FLYER**

## RESEARCH PARTICIPANTS NEEDED

- PURPOSE:** The purpose of this study is to investigate how undergraduates who have chosen to pursue majors in STEM (Science, Technology, Engineering, and Mathematics) fields experience and negotiate gender. The goal of this study is to better understand the experiences of undergraduate men and women who have made the decision to complete a degree in a STEM field and emphasize particularly on their experiences within the STEM fields related to gender and how they negotiate gender. This is a qualitative research study that relies on semi-structured interviews with undergraduate men and women majoring in STEM fields.
- ELIGIBILITY:** Participants must be an undergraduate majoring in a Science, Technology, Engineering, and/or Mathematics (STEM) field.
- BENEFITS:** Potential benefits may help us better understand how men and women who are undergraduates in STEM fields negotiate gender and what they experience while majoring in a STEM field.
- COMPENSATION:** A \$10 Visa Gift Card will be given to participants upon completion of interview and questionnaire.
- CONTACT:** Amy Latta-Won  
Columbus State University  
College of Education  
[lattawon\\_amy@columbusstate.edu](mailto:lattawon_amy@columbusstate.edu)  
phone: 706-289-6291

## **APPENDIX G**

### **SUMMARY OF INTERVIEW TRANSCRIPTS**

## Keith

Keith is majoring in mathematics and is a junior at Southeastern University (SEU). He has lived in many different places due to his father being in the Army. He attended military school in various places throughout elementary and middle school. He attended a civilian high school in the South. Originally, Keith attended a larger university in a neighboring southern state where he majored in Chemical Engineering with the intent of going to Pharmacy School. At the time, Keith did not have an idea of what he would like to major in. He felt that he chose that major due to others, including his father, telling him that it was a good decision. His father wanted him to get a degree in Chemical Engineering/Pre-Pharmacy, because it would enable Keith to get “a good job with excellent pay and job security in the future.” After attending classes, Keith realized that while he enjoyed the classes he took, he really did not enjoy engineering itself. He did not want to get a degree and end up in a job he would not enjoy. Keith continued to take his core classes without declaring a major because he did not know what he wanted to do. Due to a plethora of reasons Keith had to drop out of the larger neighboring university. He took a four-year break before enrolling at SEU. He decided to stop thinking about a career and just do what he enjoyed which was to attend school. Math is his favorite subject, so he decided to get a mathematics degree. He likes the fact that the Mathematics degree is flexible because it shows an ability to work with numbers, problem solving skills, and critical thinking skills. However, unlike the support he received from his father and others while majoring in Chemical Engineering, Keith received negative remarks when he told others he was majoring in mathematics. Some commented, “That’s a dumb degree. What are you going to do with it?” Keith didn’t

choose his major based on the role of potential jobs or career paths but because he enjoys the subject. He is very confident in his ability to complete the degree. “If I am doing math, I know I will enjoy it so I will do well, and if I want to do something more specific later, I can come back and do grad school.”

Keith did not even think about gender when making his decision to major in mathematics. He attributes this mindset to the fact that he grew up under military influence. “Gender roles are not nearly as defined in the military as they are in a rural area. As far as the decision [to major in mathematics] itself, gender was never an issue.” Keith went to schools in many different places due to his father being in the military. He was always in advanced classes with students who “were a little ahead of the curve.” In elementary school, he noticed that there were more girls than boys in those classes, and while the boys were more active and were expected to be more active, they were encouraged to play sports. Keith never enjoyed sports, so he would find himself trying to find a group that was not so active. By middle school, Keith realized that boys and girls were supposed to like each other, but he wasn’t interested in the opposite sex. He felt weird talking to girls, and being a jokester, he didn’t know if his humor was appropriate for girls. Keith recalled doing many projects in middle school classes and found that he tended to work better with males than females

“I was awkward with girls. There was always that weird expectation and I tried to navigate that. Even to this day I deal with that. I want to be friendly and open. I don’t want to come off in any negative way.”



The females that Keith related better with were ones who were considered to be “tomboys.” They had short hair and acted differently from girls. He didn’t think of them as girls, even though biologically they were.

Once Keith entered high school, he noticed differences in gender due to it being the first time he was not in military school. He states, “In military school there is inerrant discipline, and gender roles are just not assigned in the military because they are both doing the same jobs. That is just the norm.” Once attending a civilian high school, Keith felt the pressure of doing “guy stuff” such as liking sports and playing video games. Girls were expected to “gossip and do their things.” In high school, Keith mostly associated with other males because he did not know how to handle females. He did mention that the males he hung out with were categorized as “band nerds.” Keith describes himself as an emotional and artistic type of person but is also very logical. The things that he is interested in “may come off as effeminate to other people.”

In college, Keith still filters what he says around girls because he doesn’t want to ruin any chances with them if there could be a possible relationship. In class, he stays focused on the lecture and doesn’t have to worry about filtering what he says, because he finds that most of his mathematics courses are mostly comprised of males. This also reduces the pressure to make better grades due to gender. Although, if he is in a situation where there are a majority of females, he will say something funny or try to answer questions to “seek acknowledgement from the girls” and see if they “approve of what he says.” Not understanding why, Keith feels less intimidated if a female does better than him in a class than if another male performs better than him.

Gender stereotypes exist in college life, and these can pressure both males and females to conform, especially to the lifestyle of fraternities and sororities. Keith feels that females have more pressure to conform and that many females are in college looking for their “Mrs. Degree.” He also stated, “Females in the STEM fields have more pressure to conform to the traditional female lifestyle because they are outnumbered in their field.” Since females are outnumbered, there is “more pressure to do better than males because they are not the majority.” Keith stated that he doesn’t feel as much pressure because he can still “fit in” even if he doesn’t have the best grades, “whereas if a female doesn’t do as well, then she would be shunned.” He also noticed that there are cliques with-in the STEM majors, especially among the engineering majors. The male engineering majors who know what they are doing and what they are learning, would not even let a female contribute to the group unless she was on the same intellectual level. Even then, if the female was on the same “intellectual level” she would most likely be outcast because the males would be intimidated by her. Keith said, “STEM majors tend to be a lot less social, and their social ability is not good. I feel like they are way more awkward with the opposite gender.” Keith feels that this is a stereotype, yet from his experiences and observations he also feels that this is true.

To Keith, being male or female is dependent on a person’s sex, biologically. However, he does associate someone who takes charge, is dominant, and is the provider, with the male gender. He associates someone being concerned with fashion, beauty, and is more subservient in nature with the female gender.

Due to social expectations, Keith feels that he is pressured to be nicer to girls and expected to display chivalry to them. Throughout high school, Keith felt as if he was

constantly told what was appropriate for males and females. Since entering college, he has felt more open minded and understanding about gender and comments, “your gender identity is completely different from your genetic self.” Keith considers nursing to be a “female major” and farming/agriculture, mathematics, and every field of engineering, to be “male majors.” He mentioned that females are now being encouraged to major in STEM fields, and while there has been more female participation in these fields, the mathematics and engineering departments are still lacking in females. Females who enter these male-dominated fields are going to be outcasts and not do as well because “in general males have a better ability to approach things logically” which is a skill needed to excel in mathematics and engineering. Females approach problems “from an emotional standpoint” which leads them to major in nursing and pre-veterinarian programs. There is the stereotype that males want to do things on their own and handle people from a purely logical standpoint. Therefore, many males do not enter majors such as nursing where they would have to relate to people emotionally.

Keith is totally confident in his ability to do well in every course required to complete his degree in Mathematics. In fact, he willingly calls himself a “math prodigy.” The only obstacles he foresees is running out of financial aid and keeping up his GPA. He is on academic probation due to the poor grades he earned at the larger neighboring university he attended first. Since being at SEU, he has maintained a 4.0 average. He also worries that there is a lack of upper level courses at SEU due to the small enrollment in the Mathematics program. Since required courses are not offered each semester, he worries that his time in the undergraduate program could be prolonged.

## Jacob

Jacob is a junior at SEU and is majoring in biology. He has lived in the town where SEU is located his entire life. He was home schooled in elementary and middle school but attended a local public high school. Natural sciences and animals are among Jacob's biggest interests. While he is majoring in a STEM field, chemistry and math are not his favorite subjects and they give him difficulty. He would like to get a biology degree so that he can further his studies and become either a veterinarian or a plastic surgeon. While SEU gives Jacob a lot of work and is more challenging than he thought it would be, overall it has been easy. He credits his high school for preparing him for college. Jacob finds that most of his time is devoted to studying and participating in his fraternity events.

Jacob feels that he is good at biology, and he wants to help people and animals. He chose his major based on these feelings and his future career possibilities. He states, "In your job you should be able to get an outcome not just for yourself, but for others as well. Do something that is helpful and productive." His first choice after attaining the biology degree is to become a veterinarian due to his love of animals and nature. Since he was a child he could not bring himself to kill a fly or bugs, even roaches. He would just put them outside. He sees all living creatures as valuable. If he chooses not to become a veterinarian, he would like to become a plastic surgeon. The women in his family have had procedures such as face lifts and lip injections. He believes he can make people look better without making them look fake.

Jacob was encouraged to pursue biology because a lot of his friends were also majoring in the subject. He states, "In order to major in biology I thought that you had to

be really good at math. I didn't think I could handle that, but now I am doing just as well or better than the other biology majors." Jacob also points out that with a biology degree, he has job opportunities to earn a decent income, and income is important. His family also encouraged him to pursue a degree in biology. Being from a relatively wealthy family, including business owners and real estate brokers, Jacob's aunt mentioned that it would be nice if they had a doctor in the family. His aunt insinuates that status is also important, and he feels as if he has to achieve it to be successful in the eyes of his family.

Jacob says that gender did not play a role in choosing to major in biology in order to become a doctor. He generally thinks of doctors as being males, but the majority of students in his major are females. Throughout his life, he has heard that males are better at math and science, and females are better at English and art.

Obstacles that Jacob foresees in becoming a veterinarian or plastic surgeon include the financial burden of attending graduate school. He is also daunted by taking math courses. Jacob feels that he has never been great at math or anything dealing with equations. He knew that there would be a lot of work associated with majoring in a STEM field and that it would be challenging. He has admitted to going to tutoring sessions because the professor doesn't always have time to help. He doesn't like to ask questions because he doesn't want his classmates to know that he is having a hard time. Jacob mentioned that girls will basically ask any one for help if they are having difficulty.

## **Brandon**

Brandon is a junior astrophysics & planetary geology major. He was born in Seoul, South Korea, but spent most of his elementary school years in Michigan. By

middle school, Brandon moved to the southeast and completed high school in this area. As a child, he was always interested in science. From the age of 3, Brandon had the dream of becoming an astronaut. Being that his father was a graphic designer in 3-D animation he had a choice of jobs, and so the family was located to the South where his father took a job at a space science center in the area. Brandon's love for science grew as he spent time at his father's work place. Brandon always excelled in his classes. He attended a Montessori school while living in Michigan. He describes his teacher, Mrs. Frizzle, as the lovable and eccentric teacher from the Magic School Bus books. She was science oriented and made learning fun. This teacher inspired Brandon to love space and to major in the topic during college. As a college student Brandon, works the sound and video for the local hockey games, is a professional stilter for a clown company, and also works at the space center where he practically grew up.

Academic experiences during the first year of college helped Brandon to decide on the path for his college major and future career plans. After graduating high school, he wanted to know what it takes to become an astronaut. From meeting astronauts at the space center he was advised to go into Aerospace Engineering. So he did and went to a larger university south of SEU. After taking a few courses, Brandon realized that he wanted to do astrophysics and observing. He describes his revelation as follows:

The more I played around the classes of astrophysics and physics classes I learned it was so much fun and interesting, but not what I wanted to do as a job. It would include a lot of computer typing and things like that. The more I took geology courses I found it was more hands-on. So I like working with space rocks to observe them and see what they are made of and how they orbit around the Earth.

I would love to be an astronaut, but I learned that the goal is not to be just an astronaut, but to become a researcher where the level of research requires that you go to space to do it. You have to find the research project that takes you there, not just try to get there. (B. McCain, personal communication, April 24, 2103)

Due to financial reasons, Brandon started his second year of college at SEU so that he could live at home, and entered into the astrophysics & planetary geology major. He likes that the classes at SEU are smaller than his previous university so he can have more personal time with the professors.

For Brandon, gender played no role in choosing his major. He admits that he has noticed that there is a lack of females in his science classes, except for his mineralogy and astronomy classes that were upper level science courses offered to students majoring in education. Brandon points out that the first astronaut he ever met was a woman. He chose his major specifically because he loves it, and feels that it is something anyone can do regardless of gender.

Although Brandon played some sports when he was a child, he was never pressured by his parents to participate in them. He felt that he was not good and coordinated when it came to sports. However, his parents did push his academics and supported his love of space. Growing up Brandon felt that he could cooperate with both boys and girls. He tried many different activities such as theater and band and was the mascot at his high school. Since going to college he admits to seeing the separation of gender roles. In high school, everyone has to take the same classes, but in college he sees the separation. There are a majority of girls in the biology department, but thinking back to classes dealing with aerospace engineering there was only one female in the class.

When it comes to the pressures of being a male, he feels that he must display chivalry. He also thinks this is an expectation due to living in the south. During geology class field experiences, he finds that he always looks out for the girls to make sure they can climb the rocks and don't fall into the stream. He also notices that the girls in his college courses stick together during labs and classes. Brandon comments that there are "a lot of girls in my class, who are hardworking and make good grades and there are some that don't and get bad grades." He mentions that the same is true for the males in his classes. Since some of the professors are female and some are male, "there are no real put downs based on gender." Brandon is very confident in speaking with his professors and unlike females he doesn't have to worry about "what he looks like." He also feels that he has to be cautious when working with a female during a lab or field study. Onlookers may think that he is just working with her because he is "interested in her." He also feels that he has to put up a shield and watch what he says when around the girls. However, he has gotten to know some of the girls in his class better and they can "dish back whatever guy talk is thrown at them."

Brandon feels that he had fewer pressures in choosing a major than his parents did. He was allowed to choose anything as long as he was passionate about it, and was allowed to attend any college he wanted. His mom had to attend a local college because her parents would not let her move far from home. His father chose computer graphics at a time where it was a brand new major. Brandon wants to major in astrophysics and planetary geology because it is fun for him. He was not concerned about what kind of salary he would receive. He says, "I would like a stable income to support a family, but



again if you love your work whatever you're getting paid you will find a way to manage.”

## **Thomas**

Thomas is a senior at SEU and is majoring in chemistry. Being of German and English descent, he is bilingual and spent many summers in Germany visiting his grandparents. He is attending SEU mainly for financial reasons. It is affordable and is located in his hometown. His original plan was to attend his first two years at SEU, and then transfer to a different university; however, his GPA dropped too low during the first two years, so he decided to stay due to losing his scholarship.

Thomas discovered his love for science when he was in middle school. He took a total of eight science courses throughout high school. After researching future careers he found that the sciences offer a wide range of jobs, particularly in chemistry. There is also the possibility of attaining Master's and Doctorate degrees in science fields. At first, he was interested in a degree in environmental science and possible employment at a place like the Environmental Protection Agency (EPA). However, at the time SEU did not offer that degree for undergraduates, so he chose what he felt was the next best thing, chemistry. He knew that this would be a challenging major, but he was up for the task.

Thomas chose his major based on his experience of getting an aquarium. He was in the 6<sup>th</sup> grade when his mother bought him an aquarium and a book that teaches how to take care of the aquarium. He learned about pH, hardness, and the nitrogen cycle from that book. By taking care of the aquarium he was “a step ahead” when he entered middle school science classes. It was motivation for him to see that “science was applicable in

the real world.” Thomas also credits having passionate and challenging science teachers in high school for influencing his decision to major in chemistry. His German background has also fueled his desire for majoring in a science field, because there is a push for recycling in Germany and they drive smaller cars that use diesel fuel. Thomas believes Germany as a whole implements practices that will make the world more sustainable. He perseveres through his classes due to the inspiration given from his college professors. They are “teachers who are passionate about what they do.” “It wasn’t until the upper level chemistry courses when the professors really care.” Thomas says, “I had the biggest change in my academic career when I had Dr. Smith, she teaches physics and she really cares about her students. She wants you to succeed.” Being that the Chemistry Department is relatively small with around 100 students it is easy for the professors to get to know the students and even call them by name even when they are not in the classroom. These experiences help Thomas persevere even though the workload and content is challenging.

Thomas describes his first two years of college as being “really awkward.” Since he was taking core classes he did not see the same people from class to class and was unable to “bond” with anyone. Once he started courses in his field of major he met good friends who he was able to study with and participate in labs with. He has had one main lab partner throughout his fifteen chemistry classes and four physics classes, and she is a female. Thomas described their partnership as “automatic.” They work well together with very few issues and are usually the first group to complete the lab assignment. His social life is very limited due to the workload of being a chemistry major, as well as, being a tutor on campus and participating in the American Chemical Society.

Thomas chose his major of chemistry because science and math have always been his “strong suits.” Gender had no impact on his choice of major; however, he did mention that he feels there is a gender gap in the number of males and females who major in STEM fields but that the gap is getting smaller, especially in biology. In his chemistry courses the number of males outnumber the females.

Thomas, as a boy in elementary school, was pushed by his father to play sports. He was never interested in them. After a quick stint in roller hockey, his father realized that sports was not his forte and dropped the issue. Thomas’s father was not very involved with him after that time. Thomas always associated better with girls than boys and he states that it still holds true till this day. He says, “I was never into ‘all male’ stuff.” Even during high school Thomas felt more comfortable around girls and connected with them better. He states, “Other guys were kind of intimidating by their being macho.” He didn’t talk to the jocks. The only males he associated with were the “academic types” who liked science and math.

Thomas says that he “feels more pressure to succeed academically” so he can get a good job and become the “breadwinner.” He places most of the pressure on himself, although his mother told him if he didn’t attend college, then he could no longer live with her.

Oftentimes while Thomas is tutoring at the university, he becomes frustrated because girls will tell him that they can’t do math or science because they think they have to have the “genes” to succeed. Being that neither of his parents was strong in science or math, he has done very well. He states, “I believe you can develop these traits (being good at math or science) no matter if you are male or female.” While the majority of his

classes are composed of white males, Thomas admits that the few females are “wickedly smart,” and those “who tried could be successful although it does depend on the science foundations they learned during middle and high school.”

Obstacles that Thomas foresees in his major overall are that the classes required are difficult and some required courses are not available each semester. He had to retake Organic Chemistry 1 and 2 due to making a grade of C and D respectively. Finding good friends who help and push him has made the difference in him persevering. Having a peer support group really helps, Thomas says, “Knowing that other people are working hard, if not harder than I am, really motivates me more than if I am around a bunch of slackers and complainers.” He has to be really careful on signing up for classes. Since the Chemistry Department is small at SEU, some courses are not offered each semester and if a student misses signing up for the course, then he/she will have to wait a year to take it.

## **William**

William is majoring in chemistry, and is a senior at SEU. His father is American soldier and his mother is Italian. Until the age of six, he grew up in Italy and attended a private Italian school taught by Catholic nuns. By third grade, William was relocated to the United States and entered into public schools. It was a big culture shock for him because he was not used to speaking English at school, and he did not know the history of America. William still does not identify with an ethnic group. William graduated high school from a school district located in the southeast, just neighboring SEU. Soon after graduating high school, William attended SEU as an engineer major; however, after

completing two years of classes he took a five year break and worked in industry. During that break, he also started a family and has a young daughter. William is currently interested in cosmetics and cosmetic designs. When he is not in classes or studying, he is apprentices at a local lab that produces cosmetics.

William's choice to enter college was mainly encouraged by his mother, who never had the choice to attend college. His father didn't care what William decided to do after high school as long as he could, "go make money." William thinks that he has more pressure to complete a college degree because he has a daughter that he wants to be able to provide for.

The first time William attended SEU he chose the major of engineering. He soon became overwhelmed, especially with the math classes. He states, "I was taking Calculus 2, Linear Algebra, and Physics at the same time. I wasn't able to put it all together and work at the same time. It overwhelmed me." After his five year hiatus, William decided he wanted to come back to SEU and major in chemistry because it was something that he had taken an interest in during high school. This interest in chemistry was fueled by his high school chemistry teacher. She was passionate about her subject and made sure that everyone understood the required concepts before moving on. Her joy for the subject rubbed off on William, which prompted him to change from majoring in engineering to majoring in chemistry. Even after his break from college, he still remembered concepts from the high school AP Chemistry class which helped him to feel comfortable in taking upper level chemistry courses. William's father also worked in the chemical industry, but did not have an education in chemistry. He only had the military training which prepared him for the job. William said, "My father never pushed me to do chemistry."

William is not looking to quickly finish his bachelor's degree so he can jump into the chemistry workforce, but he wants to continue his education and complete a Ph. D. before going into the work community. He says, "I just don't want to sell myself short. I want to get a specialty before going into an industry where I will be just a regular chemist in a four-walled white lab and being capped off early." He has researched and interviewed for placements into Ph.D. programs around the country. It is no secret that his average work week as a graduate student will be around 60 hours per week, which would require working in the lab on the weekends as well. Currently at SEU, the only social time he gets is when he participates in study groups. As a hobby and social outlet he works as a bartender at a local restaurant two weekends a month.

He enjoys the small class sizes at SEU. In the upper level chemistry classes, William is one of about seven students, which allows more individual help from professors. Most of his classmates are males. William has worked with female lab partners, but he did not really enjoy the experience. He stated that, "the females were just like 'whatever' and did not want to listen to what I had to say." The one female he did not mind working with he described as easy going. William said, "She was a nice student. When it came to the lab she just let me take over and I would tell her what to do."

Gender was not an issue in William's decision to major in chemistry. He mainly remembers playing with boys while growing up. While in Italy he did not have many friends due to his language barrier, as he spoke English at home and at school they spoke Italian. In elementary school in the southeast region of the United States, William mainly remembers playing with the boys at school; it wasn't until high school that even thought about girls. He dated a few girls during high school, but mainly concentrated on his

studies. William participated in football and wrestling during middle school. To William gender is just a way to group people, but he associates dominance with the male gender. As far as someone's ability to pursue and complete a major in the STEM field, William believes, "That it is a personalized thing. People control the limits for themselves."

William believes that he will overcome any potential obstacles that could hinder his completion of the B.S. Professional in Chemistry. The first time he attended SEU he was overwhelmed with math courses. Since then, he has taken and passed the math courses and has moved to higher level math courses with no problem. William states, "I will be fine as long as I persevere and am interested. If the interest is not there then it is not for me."

## **Amanda**

Amanda is a junior at SEU and is majoring in biology. Her main interest is in Animal Science and she hopes to work at a zoo or university in the future. She decided to attend SEU because she grew up and attended public school in the same city. It also allows her to live at home with her parents to save money. Amanda describes her class load as difficult. She says, "Professors seem to think that their class is the only one you are taking, but I have lots of other things to do for other classes." Taking a full time course load and working at a local warehouse distributor keeps Amanda too busy to have a social life or spend time on hobbies.

As a child, Amanda dreamed of one day becoming a veterinarian. However, in high school, a teacher introduced her to the field of zoology and since then that has been her passion. She wants to work with wild animals and study their habits. Amanda grew

up in a family that is involved in hunting and being outdoors. She always enjoyed participating in these activities with her family. She has killed game and even cleaned deer and other animals,. Amanda recalls, “I used to get into the gut buckets and play with the hearts and all of that stuff, even if it sounds morbid.” She is motivated by her current college peers to persevere and complete her degree. In high school, she did not have many peers who shared her interest in animal science, but now she is truly happy to have found others with her same interests.

Prior to becoming a biology major, Amanda thought that the majority of the students in the program would be males, but to her surprise she has found that most of the biology majors at SEU are females. She was not conscious of being a female when she chose to major in biology. She chose it because that is what she is interested in. To Amanda gender is just a way to categorize people, but feels that being a female is difficult. During elementary school, Amanda recalls keeping away from the boys, but she would play with both boys and girls if they were around. In middle school and high school, Amanda admitted to “hanging out with the guys because the females were so ‘catty’ at that point.”

Amanda’s mother, who is an educator, has tried with everything in her power to persuade Amanda to become a teacher. She claims, “That is something females do, but honestly that is not something I would want to do.” Her mother always tells her that she “should dress up and look presentable. Females should always have make-up on.” Amanda revealed, “I have never been one of those people. I just do what I want to do, and I don’t really care.” She described how people think that females can’t do a lot of stuff because they are female. For example, the warehouse club at which she works;



customers will request a male employee to help them load televisions on their carts. They think she is unable to do it because she is a female. In her college classes, Amanda expressed that it seems as if the male professors like the male students better than the female students. The professor agrees with the male students more often, but on the other hand the female professors seem to agree with the female students more often. She has observed that all students seem to be more relaxed in classes with a female professor, but are more alert and attentive with a male professor. She expressed that, “Men are scarier so you are more scared to have a male disagree with you than a female. For example, my daddy, I would rather be told to do something by my mom than by my dad.”

Obstacles that Amanda has had to deal with are taking chemistry courses. She is afraid of the math that she will be required to do in chemistry courses. She admitted, “I am okay at math, but I don’t understand how to connect all of those things together, and what formulas to use. It goes over my head.” She is also concerned with physics classes as well. She enjoys the courses of Microbiology and Cellular Biology, but they require a lot studying and time commitment.

## **Janie**

Janie is a senior at SEU and is majoring in geology. She identifies herself as a Caucasian female, who is a little older than the rest of the undergraduates. She is 34-years-old, and is married with two children. She enrolled at SEU because she lives in the same town. Janie decided to major in a STEM field due to financial stability. She said, “After living in the real world, I realized that science is where the money is at.” When she first enrolled at SEU, she was English major, but changed to geology because she did

not see many opportunities for future jobs with a degree in English. In addition to financial gain, Janie admits that she became really interested in geology after taking an introductory geology class, Natural Disasters and Physical Geology, from Dr. Blakely. She was one of the top students in the class, and the professor's passion for the subject inspired her to love it too. Now that she has taken the upper level geology courses, she has found that it is much more challenging than she originally thought. She recalled that her professor told the class, "Everything I taught you in physical geology class was a lie; it was the Fischer-Price version." Even though, the upper level courses are more difficult, the first class she took interested her and "hooked her in till the end." Janie also knows a fellow student, John, who has encouraged her to persevere, and has helped her along the way. He also has children the same age as Janie's. So their children play while they study in their study groups. Janie's husband is also a catalyst for her choosing to major in geology. He is a mechanic who has had to work extremely hard to provide for the family. She wants to get her degree in geology, and then get a job so she can support the family. She admits, "When I get my degree he will not have to work anymore because he has been breaking his back to take care of us for the past ten years. Once I am able to take care of us, he won't have to anymore." Janie revealed that the main reason that she went back to school was for her children. She thought, "I have two kids and no college education. I do not want my children to follow in my footsteps."

While considering her major, Janie did think about gender. She realized that geology is a field that is dominated by males, but that only encouraged her to pursue the degree even more. She admits, "I want to go out and show up the boys, and I have been doing it." She revealed that her grades are usually better than males in her class. Her

friend, John, is a semester ahead of her and they will compare grades made on tests and projects to see who did better. They even ask the professors to compare which one performed the best in the class. John gets really upset if Janie does better on something. Janie also admitted that she can “use a smile to her advantage sometimes.” Admitting that it is wrong to do so, she will ask professors, who are males and are older, to reconsider her answers on assignments to get a couple of points added back on to the grade.

Janie describes herself as a tomboy, especially in her elementary and middle school years. She did not like to play with the girls, and never dressed up. She likes to wear concert t-shirts and jeans all the time. As a young child she wanted to be like the boys. She expressed, “The boys had it easier and had the cooler toys. Boys never get in trouble. They could sit the way they wanted to, eat at the table how they wanted to, and nobody ever said anything to them.” Being raised by a “very old school” grandmother could attribute to the fact that Janie got in trouble a lot. She admits, “Boys could get into fights and receive a pat on the back, but girls could never do that. It is unladylike and not pretty.” In high school, Janie started to like boys “more than just friends”, but she did not have very many girls who were friends.

Now that she is a college student and a mother, Janie does not associate with one gender or the other. She stated, “I think once you become a mommy you no longer have a gender. I am just a mommy now.” Although she does admit that she uses her smile and a little joke to get professors to consider her grade a little more subjectively. Janie points out that she only does this because she is older than the other students. She admits, “I would not even try to get away with that if I was between the ages of 18-21.”

Janie feels that she has more pressure to do better in her classes than her fellow male classmates. She believes that potential employers in the geology fields will choose a man over a woman. If the man and woman are equal in their achievements, the male will be chosen, especially if the woman has children. She feels this way due to influences in society and from reading articles about careers in the field of geology. The obstacles that Janie sees in completing her degree are not gender based. She is concerned about her eyesight, which geology involves looking at rocks and minerals up close. She feels that if she has difficulty with upper level courses then she will just retake them and get a better grade. She is concerned with her math course and physics course since it requires a lot of math skills. When compared to her parents, Janie feels that she has had more flexibility in choosing what to do with her life after high school graduation. Her parents were pressured into getting married right away and they did not have the money to go to college. However, she does feel more pressure than her parents to complete her college degree because no one in her family even finished high school.

### **Kimberly**

Kimberly is a junior at SEU and is majoring in earth and space science. She is from a small town about one hour away from SEU, and she decided to enroll at SEU to get away from home. In high school, Kimberly was a good student in all subjects, but she really enjoyed science the most. She credits her high school honors chemistry teacher with inspiring her to major in a STEM degree in college. Kimberly feels that the teacher made things fun and she and her classmates learned a lot at the same time. Even when she took the next level, AP Chemistry, from the same teacher and it was much

more difficult, Kimberly learned to persevere through the feeling of insecurity and misunderstanding. She continued to take notes and study diligently. She also had a great relationship with her teacher and would talk to her and ask questions. Kimberly chalked it up to learning how to continue through the challenge. She had always been an A-B student, but then she made her first C in AP Chemistry.

Kimberly is a first generation college student as far as her household family. Her family was shocked that she chose to major in earth and space science. She said, "I guess there are not many science nerds in my family." She has two cousins who have attended and graduated college, but they are both educators. One cousin is an Early Childhood Educator and the other is an Art Educator, both are female. Her grandmother tried to convince her to change her major to education and teach either English or history. She conjectured, "My grandmother didn't want it to be so hard on me when I got to college. My family didn't want me to major in science, get to college and then crash and burn." Kimberly admits that she doesn't mind a challenge. Even if it gets too difficult, there is always a way to succeed, the main thing is to never give up. She was crushed in high school when she made her first C in AP Chemistry. Now in college she wants to maintain a high grade point average (GPA) to keep her scholarship, but vows not to worry too much if she makes an occasional C in a difficult class. When she gets discouraged at her grades, Kimberly holds on to advice given to her by one of her male cousins, "C's get degrees."

Gender did play a role in Kimberly being able to choose going to college, but not necessarily in her choice of major. Kimberly's father owns a construction business, and she admits, "If I was a boy I would be working in my dad's construction business. He

wouldn't have sent me to college. He would expect me to take over the business one day." The reason Kimberly chose to major in earth and space science is because she feels that scientists are needed so there is a good chance of getting a job after graduation, plus she loves the subject.

Growing up in elementary and middle school, Kimberly feels that she was one of those girls who thought she was better than the guys. She could do whatever they did and do it better. She liked to play with boys in school and she would challenge them to arm wrestling and anything athletic. She recalls being the only girl in the group playing video games and paintball during high school. Currently in college, Kimberly has a boyfriend and he is of the mindset that the man should work and the woman should stay at home and take care of the kids. Kimberly admits that that is how she was raised, but she doesn't agree with it. She stated, "I don't want to stay at home. I want to get my degree and work. This is the only bad thing about living in the south. I feel like people are living in the olden times."

On the college campus, Kimberly feels that she has experienced different treatment due to gender. Kimberly's boyfriend is in a fraternity, so she is around many fraternity and sorority members. She noted that many of the males in the fraternity "act like slob and don't really care," while the females in the sororities "are all 'prissy-pots' and perfectionists." She pointed out, "Guys can get away with their actions because they are guys, but girls are held to a higher standard." In some classes, Kimberly expressed a feeling of inferiority. Some male professors make her feel intimidated. She realizes that she has entered a STEM field and that females are outnumbered. Kimberly claimed that the only famous female scientist she has heard of is Marie Curie. While she is sure there

are other great female scientists around, they don't get recognition. On the other side of the coin, Kimberly is hoping that because she is a female, and the earth space science field is lacking females, this could be an advantage to get employment after attaining her degree. She doesn't see any obstacles with gender as far as completing her degree. She does worry about the difficult content in upper level science classes, especially chemistry. However, she believes that if she has a good professor who is not intimidating, she will be able to make it.

## **Tracy**

Tracy is a junior who is majoring in biology at SEU. She decided to attend SEU due to its proximity to her home. She notes that she doesn't have much time for a social life because she is too busy going to school, studying, and working two jobs. When she does have spare time she usually spends time with her family. She likes to do outdoors activities such as kayaking, hunting, and yard work.

Tracy first became interested in biology due to her high school science classes. Her interest in living things and biodiversity continued into college when she took the course called Marine Biology. This class was authentic to Tracy who not only has an aquarium, but also enjoys scuba diving. She is the first person in her family to attend college except for her sister who dropped out after majoring in nursing. Tracy would like to get her degree in biology and then move to Florida with her fiancé and work at an aquarium or zoo. If those career choices do not work out, she would like to work for an industry such as a water treatment plant. She admits, "There are tons of biology opportunities."

Tracy did not think of gender when choosing to major in biology. She noted, “Gender really didn’t cross my mind that much. In my chemistry and biology classes the male and female ratios are pretty evenly dispersed.” Tracy admits that her parents are supportive in her decision to major in biology, but they did not push her. Having barely finished high school themselves, Tracy has blazed her own trail into college without a lot of guidance. She admits, “My parents never pushed us toward anything, which is probably why I don’t have that many good grades in college for some of my classes.” She feels that gender doesn’t affect her college experiences. Tracy admits, “I have the mindset that I can do anything that a guy can do. Sometimes I may be a bit slower, but I can still do it, just like with my mowing business. I can do it as well as a guy, but it may take me a bit longer.” She recalled an experience she had with a lab partner in chemistry, “He was a retired military guy who was majoring in chemistry. Since he was a chemistry major, I thought he might be able to help me with the lab, but all he did was tell me I wasn’t doing the calculations right. I thought I was doing them the way the professor told us to, but he made me feel like I wasn’t doing anything right. We mostly just clashed against one another and it ended up not working out.” Tracy wasn’t sure if the negative lab experience was due to her partner being a male showing dominance over a female, or if it was because he was an older person experienced in military, or a combination of both.

Tracy does feel that females are expected to be better students in college, but she observed that many of the guys she knows, study just as much as the girls. Instead of gender dictating how successful a person will become as a student, it is really up to the individual and their mindset. However, she admits “It seems like males are better at



visualizing the whole picture better than females, which would help them with majors like math and engineering.” She continues to say, “Females are too focused on the details so they are better with chores like folding clothes or jobs that require nurturing and compassion, like nursing.”

One major obstacle that Tracy has experienced while majoring in biology is taking the required chemistry classes. She admits to having a difficult time learning the concepts of chemistry, and she is just not that interested in the subject. If she is unable to pass chemistry, she will have to take it again and pass it in order to get to the upper level biology courses required for the degree. She also feels pressured to pass the required courses so that she doesn't waste credits or money while in pursuit of her degree. Tracy stated, “Chemistry is the thorn in my side and I can't move on to what I want to learn about before I get through with and pass chemistry. I will have to put a lot of time and effort into my upper level biology classes too, but I will be more interested in those.”

## **Zoë**

Zoë is a junior who is majoring in environmental science at SEU. She not only moved to the area to attend SEU's environmental science program, but also because the astrophysics program that her boyfriend was interested in, was offered here as well. She attended a college in her hometown for four years, and finally completed the 2-year degree in Health Administration. Zoë admits, “I have had a lot of fun in college, but my first four years were a little lost and misguided.” Now that she is a part of the earth and space science program, she feels that she has found her niche. Zoë, states, “The program in general has a really strong bonds between all of its students. Even outside of that I feel

like the school has a lot of opportunities.” At Zoë’s first college, she toyed with the idea of majoring in environmental science, but all of that changed when she took pre-calculus. She did not do well in the class; therefore, she dropped it so she would not receive a failing grade. Since pre-calculus was a requirement for the environmental science degree she also changed her major. Zoë admitted that she changed her major to Health Administration because she would not have to take pre-calculus. Zoe said, “I have a strong interest in health, but when I got that degree I never intended to use it. I mainly completed the degree there, so more of my credits could transfer when I changed colleges.” In thinking about why she chose to major in environmental science, Zoë recalled, “I knew I wanted to major in something where I could work outside and was research related. I am not a big ‘people person,’ so I don’t want to work directly with people all of the time.” She admits to wanting to help the people and the planet. Since transferring to SEU, Zoë retook the pre-calculus course and passed with an A. She praised her professor at SEU, “He was absolutely fabulous. I feel like I know pre-calculus now, where in the other class I was just lost.” She also took Calculus 1 and passed with an A. Zoë has also decided to take Calculus 2 as an elective. In addition to wanting to help people and the planet, Zoë chose to major in environmental science, rather than biology, because she feels that there is a wider range of jobs available for it.

Zoë’s interest in the environment came from her friend’s mother. Zoë said, “She was really passionate about anything living. Plants or animals, she just wanted to help anything she could, and I respected that about her.” Gender was not a factor in Zoë’s choice of major; however, her mother would tell her, “Go to college, but make sure you marry someone with a lot of money, so that when you have babies, he can support you.”

Zoë pointed out, “Why would I go to college if I am just going to have babies? It’s like she just wanted me to attend college to get an ‘MRS. Degree’.” Opposing her mother’s old school attitude Zoë added, “Maybe that is why I majored in a science field.”

Zoë has noticed that she is sometimes treated differently in college due to gender. She feels pressured to be neater and more organized than the males in her class, and has noticed that male students give more respect to other male students. She states, “Not that they [males] show disrespect by any means, but there is a kind of tension you feel. They think you are not quite as smart because you are a female, or you are just below the male population.” Zoë also feels pressured to show more compassion to others, even when she doesn’t have the feeling. She also points out that males generally have less stress than females or either they don’t show it. She states, “Males are usually a little less stressed about college in general. They don’t seem to have the same worries or the intensity of worries that females have with final exams, grades, and things like that.”

Zoë plans on pursuing her master’s degree after completing her undergraduate degree in environmental science. The only obstacle she mentioned was the financial obligation. Since she had a great experience at SEU with the pre-calculus and calculus class she feels like she can accomplish anything.