The Process of Choosing Science, Technology, Engineering, and Mathematics Careers by Undergraduate Women: A Narrative Life History Analysis

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THE PROCESS OF CHOOSING SCIENCE, TECHNOLOGY, ENGINEERING, AND
MATHEMATICS CAREERS BY UNDERGRADUATE WOMEN: A NARRATIVE LIFE
HISTORY ANALYSIS

By

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I dedicate this to all people who defy the odds, overcome the struggles of stereotypes, and persevere in their dreams, especially the three WSTEM faculty affiliates who spoke with me about their career paths.
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This qualitative study focused on female college seniors and their choices about their science, technology, engineering, and mathematics (STEM) college majors and career choice at the college level. STEM fields have an underrepresentation of women in both the numbers of degrees awarded each year and the number of women participating at the career level (National Science Foundation (NSF), 2007). College is a crucial time to study women’s STEM choices regarding majors and careers because women and men appear to be equally prepared for success in a STEM career when they enter college, but fewer women persist in these majors (NSF, 2007). This decrease in interest and persistence has been a phenomenon that policy makers and college administrators have tried to address. One of the prominent policy initiatives at the college level since 1990, has been single gender living and learning communities where women majoring in STEM fields live together on a dormitory floor. The program of focus in this study will be referred to as WSTEM¹ (Women in Science, Technology, Engineering, and Mathematics).

This study had two purposes: first, to understand the factors that influence women’s persistence in STEM as the women move toward college graduation; second, to determine the role that WSTEM (a single-gender LLC) had on women’s persistence in STEM. To address these, this study focused on twenty six women who attended a Research 1 university in the southeastern United States from 2006 to 2010. Twelve of these women had participated in WSTEM and fourteen came from the general university population. All twenty six women were interviewed using narrative life history analysis to understand the influences on their decisions to stay or leave their original STEM major. At the time of graduation fourteen of these women (eight from the general population and six from WSTEM) graduated with a STEM degree and planned to pursue a STEM career and twelve chose to leave their original STEM major and did not plan to pursue a STEM career (six from the general population and six from WSTEM). The

¹ This name is a pseudonym for the program.
research was guided by the Eccles’ (2007) expectancy-value model related to career choice\(^2\) and Butler’s (1999) conception of gender.

The results of this study indicated that persistence in STEM degrees in highly influenced by three main factors: pre-college and college success in math and science; support from parents, teachers, and college professors; and peer support networks at the college level. The stayers mentioned these factors more than their leaving peers. Many of the participants (both stayers and leavers) identified gender related and non-gender related aspects of the chilly climate within college STEM departments that negatively influenced their STEM career decisions. However, the stayers were able to maintain high expectations of success and see value in their continued participation in STEM fields. This detailed qualitative study will help policy makers and program directors better understand how to increase the number of women in STEM fields by focusing on the factors that affect individual women’s choice of major and early career decisions. As a result, this study will contribute to the literature on improving women’s underrepresentation in STEM fields.

In response to the question of how WSTEM affected women’s decisions to persist in STEM fields, this study found that providing access to a female-friendly support group offers some benefits to persistence. However, a female-friendly environment within WSTEM did not always translate into female-friendly policies within STEM departments. All of the WSTEM leavers reported negative experiences within their STEM majors as factors in their decision to leave. Participants’ comments about WSTEM, however, indicated that the program provided a peer support network with even the leavers (5/6) reporting the positive influence of friendships they made through their participation in the program.

Drawing from these findings, this study concluded that WSTEM met its goals for the women who fully participated in it. Of those women who participated in research opportunities, all but one persisted. And all but one identified the social aspect of WSTEM as a positive influence on their college experience if not their STEM college experience. The findings did not unequivocally support the positive impacts of women-only programs. The study, like others (Mael et al., 2007), found mixed evidence regarding the impact of women-only STEM LLC’s on

\(^2\) “Career choice” in this study refers to women’s career plans after college. This term includes their college majors as well.
women’s persistence in STEM fields. These programs are one part of a multitude of other factors that affect persistence.

The study found that three main areas can positively affect women’s persistence in STEM fields: success in math and science classes before and during college; positive experiences with STEM fields and professionals in college; and peer support networks. The final area included both formal peer support networks such as WSTEM or informal groups composed of peers in one’s major. The results are discussed in detail and contribute to the growing literature on the influences that lead to STEM career choice at the college level. This study can also contribute to practices, theory, and policies related to increasing women’s persistence in STEM fields.
CHAPTER 1

INTRODUCTION

Researchers and policy makers have long recognized an underrepresentation of women in science, technology, engineering, and mathematics (STEM\textsuperscript{3}) fields (T. H. Anderson, 1995; National Science Foundation [NSF], 2007). To improve females’ persistence in STEM fields, policies have been implemented at all educational levels (Rosser, 1995; Spielhagen, 2008). One popular and yet controversial policy approach has been single-gender programs that aim to advance the networking capabilities, confidence, and interest in STEM for women and girls (Gandy, 2006; Spielhagen, 2008). Recent changes to federal policies such as No Child Left Behind (NCLB) and Title IX of the Educational Amendments Act allow schools to create single-gender programs (Ferrara & Ferrara, 2008; Spielhagen, 2008). The changes in policy have been met with suspicion by many women’s organizations including the National Association of Women (NOW) and the American Association of University Women (AAUW), who believe that these types of programs are detrimental because they promote a separate but equal system of education that is often not equal for women (AAUW, 2009; Gandy, 2006). These organizations also feel that these single-gender programs are in violation of the original anti-gender discrimination goals of Title IX. Despite these concerns, single-gender programs have increased at both the K-12 and higher education levels since the changes were made to NCLB and Title IX in 2006 (Spielhagen, 2008). However, the question remains whether these programs increase women’s persistence in STEM fields.

This study focused on college-level STEM decisions because research finds that college is the time during which a higher percentage of women choose to leave STEM fields compared to men. This percentage is even more alarming because in relation to men, fewer women enter STEM majors as college freshmen (NSF, 2007). Because there are many types of single-gender programs across the nation, this study will focus on only one: single-gender STEM-focused living and learning communities (STEM LLCs) on college campuses. Since 1990, more than 25

\textsuperscript{3} For the purposes of this study, STEM career choices or majors will refer to those majors offered by the university in this study. These majors include biochemistry, biological sciences, chemistry, computer science, engineering, geology, mathematics/statistics, meteorology, oceanography, physics, and scientific computing.
colleges and universities across the country have instituted single-gender STEM LLCs to provide support and increase retention for undergraduate women in STEM majors (Inkelas, Johnson, Alvarez, & Lee, 2005; Inkelas, Szelenyi, Soldner, & Brower, 2007). Although these programs vary among campuses, each program possesses common characteristics. Participants live together in a residence hall and engage in common social and educational activities. Participants receive academic and social support. In addition, each program is supported financially by its respective university, its department, donations, or outside funding (such as the NSF). Because these programs have emerged since 1990, few researchers have had the opportunity to study them and their effects on women’s STEM career choices and retention. National studies and survey instruments merely explore the surface of the underlying cultural, social, and individual influences that affect women’s STEM career decisions (AAUW, 2010; Inkelas et al., 2007).

Previous studies suggested that to gain a more informed understanding of these influences, it was necessary to examine how participation in single-gender STEM LLCs influenced women’s persistence in STEM fields (Farmer, 1997; Seymour & Hewitt, 1997). According to these studies, the best way to investigate the underrepresentation of women and the role that single-gender STEM LLCs play in this phenomenon was through qualitative methods. As women enter college and subsequently graduate, the number of women in STEM majors has been significantly less than men (AAUW, 2010). Fewer women choose to stay in STEM majors. This decision-making process is influenced by a variety of external factors (i.e., parental support, success in science and math classes) and internal factors (i.e., reactions to grades, identifying with perceptions of STEM professionals). To understand these factors, this study used a narrative life history methodology to examine the influences that affect undergraduate women’s choices to stay or leave STEM fields. By comparing women who participated in a single-gender STEM LLC to women who did not, this study examined the role that WSTEM played in women’s persistence in STEM fields. The research questions that guided this study were as follows:

1. What influenced women who were interested in STEM fields as freshmen to stay or leave these fields?
2. How did participation in a single-gender living and learning STEM program affect women’s decisions to persist in STEM majors and fields?

4 See Appendix A for a list of colleges and universities and the links to their program Web pages.
Evidence of Underrepresentation

The literature provides details of women’s historic and current underrepresentation in STEM fields (AAUW, 2010; T. H. Anderson, 1995; McGrayne, 2005). In a recent meeting of the Committee on Maximizing the Potential of Women in Academic Science and Engineering, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, members concluded the following:

Women who are interested in science and engineering careers are lost at every educational transition. With each step up the academic ladder, from high school on through full professorships, the representation of women in science and engineering drops substantially. As they move from high school to college, more women than men who have expressed an interest in science or engineering decide to major in something else; in the transition to graduate school, more women than men with science and engineering degrees opt into other fields of study; from doctorate to first position, there are proportionately fewer women than men in the applicant pool for tenure-track positions. (National Academies Press, 2007, p. 3)

This statement has been supported by statistical evidence as well. In 2003, men outnumbered women at all degree levels in science and engineering fields (NSF, 2007). The largest difference occurred at the undergraduate level where 75% of the STEM bachelor’s degrees were awarded to males in 2003. During that same year, women accounted for less than one third of the masters and doctorates awarded for STEM as well. (Figure 1.1 shows the percentage of men and women earning science and engineering degrees at each level in 2003.) Women also represented less than one third of the workforce in STEM careers in this same year. The two fields with the lowest representations of women were physics (11.1%) and engineering (11.1%). (Table 1.1 highlights the percentages of men and women in all STEM occupations compared to the two STEM occupations with the lowest representation of women.)
Figure 1.1: Comparison of women and men in each level of science and engineering degrees in 2003.

Table 1.1: Percentage by gender in science and engineering workforce in 2003.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Percent of Female Participants</th>
<th>Percent of Male Participants</th>
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<tbody>
<tr>
<td>All Science and Engineering Occupations</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td>Physicist/Astronomer</td>
<td>11.1</td>
<td>88.9</td>
</tr>
<tr>
<td>Engineer</td>
<td>11.1</td>
<td>88.9</td>
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To explain how STEM LLCs became the prevailing strategy to address the underrepresentation of women at the undergraduate level (shown in Figure 1.1 and Table 1.1), it is essential to describe the reasons for the gender deficit in STEM. These reasons and the policy response will be discussed in turn.

**Reasons for the Underrepresentation: A Brief Summary**

Before the 1970s, most women were denied access to STEM fields in the United States (T. H. Anderson, 1995). However, the origins of this discrimination in historic documentation can be traced to the Greek philosopher Pythagoras in the 5th century B.C. He proclaimed that science was a masculine venue that required objectivity and rational behavior, traits that women
did not possess (Wertheim, 2006). This stereotype continued into the 20th century. However, during the 1960s, a larger number of women in the United States began to challenge the view that they were inferior and could not participate in male-dominated fields (T. H. Anderson, 1995). In 1972, American women made gains in their fight against gender discrimination when Title IX of the Educational Amendment Act was passed. Title IX mandated the elimination of sexual discrimination in federally funded facilities and programs, which included many colleges and universities (T. H. Anderson, 1995; Carpenter & Acosta, 2005). The original goal of Title IX was to provide access to women so that they could compete on a more equal playing field with men. (A goal that NOW and AAUW currently believe is threatened by single-gender programs.)

Although women have gained access to many STEM fields, there remains a significant difference in the number of qualified women who choose not to continue in the sciences (NSF, 2007; Seymour & Hewitt, 1997). Researchers have identified a number of factors that shape underrepresentation. One controversial explanation for women’s choices to leave STEM fields was based on biological differences between men and women. As recently as 2005, then president of Harvard University, Lawrence H. Summers, claimed that gender discrepancies in the STEM faculty at Harvard University were caused by biological differences that helped men to be more successful in STEM fields (AAUW, 2010; Williams & Ceci, 2007).

The idea of biological causes for gender differences is not new. Some researchers have argued that higher testosterone levels increase a person’s interests in tools and machinery, which has been found to improve one’s abilities in math and science (Berenbaum & Resnick, 2007; Hines, 2007). Other research has suggested that men and women of the same ability levels use different parts of the brain to solve math problems, which might affect abilities (Haier, 2007). However, these studies do not predestine men to be scientists and women to be something else (Hines, 2007; Williams & Ceci, 2007). Comments, such as those made by Larry Summers suggesting that biological differences help men to be more successful in STEM fields, promote the underrepresentation of women by alluding to an idea that it is acceptable and unchangeable, which is not the case (Williams & Ceci, 2007). In fact, female students are closing the gender gap in standardized test scores at the K-12 level (National Science Board, 2008), and male and female high school students are showing similar interest levels in advanced science and math classes (Haier, 2007; National Science Board, 2008; Williams & Ceci, 2007). And yet, fewer
women are choosing to major in STEM fields in college and of those who do continue, a larger percentage choose to leave compared to men (NSF, 2007).

These studies suggest that the underrepresentation of women is caused by influences other than biological ones. Many researchers have identified the cultural and social attitudes that prevail in American society portraying women as inferior to men in science and math (McGrayne, 2005; Williams & Ceci, 2007). Socializers, including parents, teachers, and guidance counselors who play a major role in young women’s career choices, often support this attitude (Carlone, 2004; Dick & Rallis, 1991; Jones et al., 2000; Olitsky, 2006; Sadker, Sadker, & Zittleman, 2009; Zohar & Bronshtein, 2005). Socializers tend to believe that male students are naturally better in science and math classes due to implicit bias affected by America’s cultural attitudes (Nosek, Banaji, & Greenwald, 2002). As a result, parents tend to support sons in their endeavors to pursue science but provide less support to their daughters (Dick & Rallis, 1991; Farmer, 1997; Seymour & Hewitt, 1997) or they are more accepting of their daughters’ decisions to leave STEM fields than their sons’ similar decisions (Mau, 2003; Seymour & Hewitt, 1997).

Classroom observations have indicated that science and math teachers, regardless of their gender, tend to provide male students with more support, opportunities, and praise than female students (Carlone, 2004; Olitsky, 2006; Sadker et al., 2009; Zohar & Bronshtein, 2005). These studies also indicate that female students let male students take over in laboratory experiments, giving them more opportunities to use the laboratory equipment and other tools within the science laboratory (Jones et al., 2000). In one study, Jones et al. (2000) found that the classroom teacher supported this behavior (female students’ lack of use of laboratory materials), which resulted in a lack of practice and preparation for the female students in those classrooms. This lack of practice and the prevailing cultural attitudes that promoted women’s sense of inferiority and marginalization in STEM fields put women at a greater disadvantage when they entered college (Carlone, 2004; Jones et al., 2000; Nosek et al., 2002; Olitsky, 2006).

Once in college, studies find that women continue to experience a sense of marginalization based on the culture of STEM departments. They are outnumbered by their male peers in their science courses (Leggon, 2006), and they encounter few female role models and professors (Leggon, 2006). This lack of women in the field and the isolation that women experience has been called the “chilly climate” (Shakeshaft, 1995, p. 74), which has been
credited as a major reason that female students leave STEM fields once in college (Seymour & Hewitt, 1997; Shakeshaft, 1995).

The language and culture of science can also be a limiting factor to women. Studies have found that female and minority students’ cultural influences make the language of science appear inappropriate (Lemke, 2001; Olitsky, 2006), which can prevent women from excelling in science (Jones et al., 2000; Olitsky, 2006; Ong, 2005). Female students are often forced to make a decision whether to maintain their cultural affinity or to join the science community where there has been historical marginalization for women and minorities (Leslie, McClure, & Oaxaca, 1998). This dilemma suggests the existence of internal choices that young women must negotiate to succeed in STEM fields. Studies have identified how these choices or the culture prevalent in STEM fields often lead women to feel isolated (AAUW, 2010; Ong, 2005; Seymour & Hewitt, 1997).

The isolation that women feel as minorities within certain STEM majors at the college level and beyond is compounded by the weed-out system within these departments. Women tend to internalize grades as representations of their overall abilities, whereas men tend to see them as baseline measurements (AAUW, 2010; Farmer, 1997; Williams & Ceci, 2007). The reaction of the majority of women makes it more difficult for them when they enroll in STEM weed-out courses that are purposely designed to be difficult so that most students fail without a curve adjustment (Seymour & Hewitt, 1997). More women than men tend to be dissuaded by the poor grades they receive in weed-out courses (Williams & Ceci, 2007). Women’s reaction to poor grades has typically been a lower motivation and interest in a subject (Carlone, 2004; Duschl, Schweingruber, & Shouse, 2007; Farmer, 1997; Ferenga & Joyce, 1998). Consequently, the combination of a perceived chilly climate and women’s reaction to this climate lead many women to leave STEM fields (Brickhouse & Potter, 2001; Jorgenson, 2002). The factors that influence women’s STEM career decisions have also been the sources of policy initiatives aimed at improving the underrepresentation of women.

**Alleviating the Problem: Current Policy Context**

The federal government under the Obama administration has been interested in increasing the number of American scientists and engineers to improve the nation’s technological role among other leading first-world countries (AAUW, 2010). The Obama
administration has vowed to make a “renewed commitment” to science and math education in the United States so that American students can move “from the middle to the top of the pack in science and math over the next decade” (Chang, 2009, p. 15). The administration joined with STEM companies and organizations to work toward this goal (Chang, 2009) by pledging to spend over $250 million on initiatives that aim to improve science and math education (Robelen, 2010). One of the focuses of these programs has been the underrepresentation of women in STEM fields.

Even before the Obama administration, from 2004 to 2007, the federal government committed $2.8 billion on educational programs aimed at increasing the participation and retention of minorities and women in STEM fields at both the K-12 level and the college level (Leggon, 2006; NSF, 2007). One federal organization, the NSF, spent $478,567,997 from 1996 to 2006 to help fund higher education programs that pledge to improve the number of STEM graduates, citing that this is one of the crucial educational levels where women are lost (NSF, 2007). Many of these programs included single-gender mentoring or community programs (Spielhagen, 2008). This verbal and monetary support for single-gender STEM-focused programs provides evidence of the federal government’s support for such initiatives.

This support is also evident at the state and local level. According to the National Association of Single Sex Public Education (2010), over 540 schools in 39 states are offering single-gender classes in math and science for boys and girls at the K-12 level. Colleges and universities are also instituting single-gender programs to increase women’s persistence in STEM fields. Since the 1980s, over 50 different programs have been instituted in higher education institutions across the country, including STEM LLCs (Inkelas et al., 2007).

The federal government’s involvement in the underrepresentation of women in STEM fields relates to economic and environmental security in the United States (Chang, 2009; Tessler, 2008). STEM fields not only pay their practitioners well, but they also bring in revenue for successful businesses and governments (National Science Board, 2008). In 1985, the United States’ revenue for all high-technology manufacturing industries was the highest of all countries ($149,692,000,000; National Science Board, 2008). In 2005, this number increased to $414,209,000,000, which was slightly below the revenue for all of Asia combined ($494,490,000,000). Although the United States is still a leader in terms of revenue in high-technology industries, globalization and pacts between nations (e.g., the European Union) are
creating entities that are beginning to surpass the United States in technological revenue. In 2005, the United States imported more high-technology products than it exported, whereas China, one of the United States’ closest competitors for revenue, was exporting more than it was importing and thereby creating more revenue (National Science Board, 2008). The U.S. is beginning to lose larger numbers of the scientists trained in American universities. In 2005, American citizens earned only 49% of all the STEM doctorates awarded that year with females only representing one third of these degrees (National Science Board, 2008). Although in previous decades many of these non-American citizens stayed in the U.S. to work and live, now larger numbers of these scientists are returning to their native countries because these countries have the means to support these scientists and engineers (see Figure 1.2).

![Figure 1.2: Doctorates earned over 20-year period in United States’ higher education institutions.](image)

One strategy that the American government and industries has used to increase the number of U.S. citizens majoring and completing STEM degrees is to focus on increasing the access of minority groups (including women) to these majors. Although researchers, educators, and policy makers agree that more women and minorities are needed in STEM fields, there has been no consensus regarding the best way to attract and retain these groups (Mael, Alonso,
Gibson, Rogers, & Smith, 2005). As discussed earlier, one policy approach that has been instituted at many colleges and universities to retain women in STEM fields is single-gender STEM LLCs.

Living and learning programs exist for majors besides STEM. In these programs, students with common educational majors live together in a college dormitory. According to researchers, LLCs can help students to combine their social and educational worlds and increase the likelihood that students will remain in a particular field or institution (Tinto, 1997). Other research has provided mixed evidence regarding whether these programs and policies improve the retention and performance of minorities and women in STEM fields (Inkelas et al., 2007; Mael et al., 2005). Two comprehensive national studies of single-gender programs have found mixed evidence regarding their benefits for retaining women in STEM fields (Inkelas et al., 2007; Mael et al., 2005).

Many of these studies have ignored the details of each person’s journey and experiences prior to and during college (Inkelas et al., 2007). Surveys and large-scale studies included all women as if they all had similar experiences. This strategy has ignored the unique set of influences and the internalization of these influences that affect each individual’s career choice. Therefore, it is important to study individuals’ lives in depth to better understand their decision process. Because the evidence of past research studies on women-only STEM LLCs has been mixed, there remains a need for more research to address the country’s need for scientists and engineers, especially when the number of these programs is increasing.

As stated earlier, each person has a unique journey to his or her eventual choice to pursue a STEM career. Because STEM fields have historically been, and continue to be, male-dominated, gender can have a major influence on women’s decisions to remain in these fields. Many studies ignore the concept of gender, which is crucial to women’s perceptions of STEM fields and their decisions to remain or leave. Therefore, it is important that the definition of gender be discussed here so that the reader is familiar with the author’s conception and its role in women’s STEM career choices.

**Gender**

Gender is often used in research as simply a term to differentiate between biological sex (i.e., male and female; Glasser & Smith, 2008). However, gender is a much more complicated
and encompassing term that incorporates social and individual phenomena. Each individual’s understanding of gender is both individually and socially constructed (Butler, 1999; West & Zimmerman, 1987). Even behaviors have specific gender designations (i.e., aggression for men and caring for women). As a result, individuals’ decisions to participate in an activity can depend on what gendered behaviors are attributed to it (AAUW, 2010).

This concept is particularly relevant in activities related to the male-dominated STEM fields. This chapter has identified women’s historical marginalization in these fields simply based on their sex. However, the gendered role of science and scientists has also prevented many women from feeling like legitimate participants in STEM fields (Harding, 1997; Heilman & Okimoto, 2007; Kahveci, Southerland, & Gilmer, 2007). Feminist scholars have argued that the unbiased and objective view of STEM fields and the practices inherent within (i.e., argumentation) have prevented women from fully participating (Harding, 1997; Leggon, 2006). For many women, acceptance into STEM fields means giving up part of their own femininity and projecting a more androgynous personality to be accepted and to succeed (Harding, 1997; McGraw, 2005; Ong, 2005).

The concept of gender has important implications for policy initiatives that have been attempting to increase the number of women in STEM fields. Those policies and programs that identify gender as a biological difference are typically aimed at increasing access for women in STEM fields without addressing the underlying causes for that underrepresentation. Opening access merely forces women to fit into the masculine behaviors that dominate specific STEM fields (Harding, 1997). Therefore, an important component of this study is to understand the conception of gender for each participant as well as how this concept has affected the participants’ perceptions of and decisions related to STEM careers.

**Conclusion**

This introductory chapter has explored the current underrepresentation of women in STEM fields (NSF, 2007). This issue has become the focus of policy initiatives at federal, state, and local levels (Leggon, 2006; Spielhagen, 2008). This study focuses on one of these policy responses: single-gender programs, particularly women-only STEM LLCs at the college level. College is a crucial time to study women and programs aimed at retaining women in STEM fields because the retention rates for undergraduate women who enter college with an initial
interest in STEM fields are lower than for men (NSF, 2007; Seymour & Hewitt, 1997), suggesting there is still a need to understand how women’s experiences affect their college STEM choices.

Previous studies on the underrepresentation of women in STEM fields have ignored the unique experience of each individual and how these experiences have affected their career path. Previous studies also ignored the unique effect that gender has on individuals’ perceptions and interpretations. Feminist scholars argue that women, because of their gendered experiences, have different views from men that create “distinctively gendered standpoints on nature” (Harding, 1997, p. 187) or a unique feminist standpoint. Therefore, gender is an important aspect that relates to women’s decisions and views of STEM fields and is one of the central themes of this study.

This study focuses on each individual’s pathway by utilizing a narrative life history method. Each undergraduate woman revealed her own story as it related to her decision to remain in a STEM major or to leave. Twenty-six women who entered a Research 1 University in the southeastern United States as STEM majors were interviewed to understand their eventual STEM career decision to stay or leave their STEM major. Half of these women participated in a women-only STEM LLC (WSTEM) and half were members of the general university population who had originally declared a STEM major. The interview questions focused on their narrative life history as it related to STEM career decisions. These questions sought to identify the factors that affected all the women’s STEM career decisions. For the WSTEM participants, an added portion of the interview asked them to describe how their participation in WSTEM affected their STEM decisions. The results are discussed in detail and contribute to the growing literature on the influences that lead to STEM career choice at the college level.

By focusing on women who participated in a women-only STEM LLC program at a Research 1 University to women who did not, I was able to better study the STEM career decision-making process. Programs such as WSTEM are a relatively new phenomenon that merit study to understand if and how they are improving women’s representation in STEM fields. This study provides more data on the individual paths of each woman and their decisions to remain in STEM fields. This detailed qualitative study can help policy makers and program directors better understand how to increase the number of women in STEM fields by focusing on the factors that affect individual women’s career decisions. As a result, this study can add to the literature on
improving women’s underrepresentation in STEM fields. It can also help the program directors and university administrators at this particular Research 1 University to understand how well they are addressing their goals of improving the underrepresentation of women in STEM fields. This goal can improve the output of these fields by not only increasing the number of practicing STEM professionals but also increasing the number of different (and uniquely gendered) viewpoints within these fields.

**Chapters in the Dissertation**

Including this introduction, this dissertation contains seven chapters. Chapter 2 focuses on the historical marginalization of women in STEM fields that has affected their current underrepresentation. This chapter will include a discussion of the historical policy response to women’s marginalization that has affected current policies, a review of the literature that identifies the influences affecting women’s interest and persistence in STEM fields at each educational phase, and a review of the research focusing on the effects of women-only STEM LLC programs.

Chapter 3 builds on the literature review to establish the conceptual framework. This framework highlights how both the role of gender and each individual’s unique experiences affect her STEM career choice. This framework combines Butler’s (1999) concept of gender, which emphasizes individual’s unique pathways, with Eccles’ (1994; 2007) expectancy value model for career choice.

Chapter 4 describes the methodology and methods for this study. The rationale is provided for this methodology, which builds on both the literature review and the conceptual framework. This chapter also describes the program and individuals that are part of this study and contains a detailed explanation of the proposed data collection and analysis procedures.

The results of the dissertation are centered on the two original research questions. Chapter 5 presents the findings that address the first research question that focuses on the influences that affect stayers and leavers. In this chapter, the factors that affect women before and during college are discussed. These findings are viewed through the conceptual framework outlined in Chapter 4. This guiding framework is highlighted along with how the results fit in with the current literature in the discussion at the end of the chapter.
Chapter 6 addresses the second research question, which focuses on the role that WSTEM played in its participants’ STEM career decisions. In this chapter, the WSTEM stayers’ responses are summarized and then compared to the WSTEM leavers’ responses. This chapter provides an evaluation of the program and its role in each participant’s decision to stay or leave STEM fields.

Chapter 7 discusses the three main findings as they apply to leavers and stayers and to programs like WSTEM in particular. This chapter identifies how these findings contribute to current research, practice, theory and policy.
CHAPTER 2

LITERATURE REVIEW: THE PIPELINE AND THE POLICY RESPONSE

Although researchers have documented the attrition of women from STEM fields and proposed reasons for their departure, there is still little consensus regarding how colleges and universities can impact women’s decisions to persist (AAUW, 2010). The decision process to stay or leave STEM fields is complex and personal because it occurs in a larger historical, cultural, and policy environment (Eccles, 2006; Harding, 1997). This chapter identifies the multiple challenges women face as they make their decision to stay or leave STEM fields. First, the chapter provides the historical context of the marginalization of women in STEM careers, which helps to situate the reader with the past overt discrimination and current subtle forms of discrimination that women have faced. This also helps contextualize the underlying causes for the feminist movement’s response to the role that gender plays in this discrimination. Second, it discusses the policy environment, including the political atmosphere that has led to the current policy initiatives. Third, it shows the influencing factors on women and their STEM career decisions as they go through each stage of their lives: early childhood, adolescence, high school, college, graduate school, and career. The description and review of the research in each of these stages will suggest larger categories of influences that include environmental and individual factors that are part of my conceptual framework. Finally, the fourth section focuses on specific studies that have examined women-only STEM LLCs because this study focuses on one such program at a Research 1 University.

**Historical Marginalization**

As discussed in the first chapter, discrimination has existed within STEM fields for centuries (Wertheim, 2006). The male-dominated atmosphere in many STEM fields has prevented women from participating, and the masculine stereotype of science continues to discourage many women from pursuing STEM careers (Ong, 2005; Shakeshaft, 1995). The lower number of women in STEM fields also makes some women feel that it is a venue in which they cannot succeed (Harding, 1997; Ong, 2005). For example, since Nobel Prizes were awarded...
in chemistry, physics, and medicine/physiology (1901), there have only been 15 women who have received them and three of these were awarded in 2009 (https://nobelprize.org). To fully understand the underrepresentation of women in STEM fields, it is necessary to understand how the discrimination began, how it has become ingrained in American culture, and how it adds to the factors that affect women’s decisions to stay or leave.

The historical discrimination against women in STEM fields can be dated to as early as the 5th century B.C. During this time period, women were seen as biologically inferior to men in terms of their capacity to think objectively and rationally. In the 5th century B.C., Pythagoras, the noted mathematician and scientist, developed the idea that certain traits were inherent in specific sexes (Wertheim, 2006). Pythagoras claimed that the male possessed the traits of objective and rational thought, which included mathematic abilities and thinking. He believed that women possessed the traits of baser instinct and emotion, which were not beneficial in mathematics (Wertheim, 2006).

From the 5th century B.C. until the 19th century, scientists believed that educating women in areas of mathematics and science severely impaired their ability to produce children (McGrayne, 2005; Wyer, 2001). Some middle- and upper-class women were educated in western societies during this time; however, their education was limited to knowledge related to being wives and mothers (Wyer, 2001). Most women who did earn a bachelor’s degree in a STEM field were excluded from many graduate science programs throughout the 18th, 19th, and early 20th centuries in the United States (T. H. Anderson, 1995; Wyer, 2001). Without crucial graduate degrees, women with bachelor degrees in science and an interest in research or higher education positions were restricted to lesser research or teaching positions. The result was typically that few women gained prominence in science circles, because they were not publishing scientific research (Wyer, 2001).

For example, by 1889, only six women had received doctorates in science in the United States. By 1900, this number had increased to 36 (Wyer, 2001). According to Wyer’s (2001) historical analysis of women in science, this increase marked the beginning of women’s entry into the sciences and the “end of men’s exclusive claims” (p. 4) to the sciences. World War II opened doors to many science fields and positions for women; however, this access was taken

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5 Some archaeologists and feminists think that this belief in the inferiority of women began over 10,000 years ago (French, 1992).
away once the troops returned. After World War II, women were told to find satisfaction and happiness in the home with their family (T. H. Anderson, 1995; Friedan, 1963). Colleges and universities set quotas for the number of women accepted to degree programs to create more space for returning troops (Wyer, 2001). By 1954, the number of women receiving science doctorates had increased to 290, which represented only 6% of the total number of science doctorates (Wyer, 2001). Another example of the attitudes of the 1950s is evident in Mead and Metraux’s 1957 study on high school students’ perceptions of scientists, in which they asked men questions regarding a career in science while they asked women questions related to being married to a scientist. Mead and Metraux’s survey suggested that as late as 1957 women were excluded from STEM fields.

A well-known example that occurred during the 1950’s of one women’s exclusion within a science field, is Rosalind Franklin, a chemistry research assistant at King’s College in London. Franklin originally discovered and defined the crystallized structure of DNA. However, when the Nobel Prize for this discovery was awarded, Franklin was not a recipient. The two young male scientists who received that honor, James Watson and Francis Crick, used Franklin’s data without giving her credit (Martin, 1987; McGrayne, 2005). Soon after, Watson published a book about the discovery (Watson, 1968). Although he mentioned Franklin, it was not for her discoveries but rather to complain about her unfeminine appearance and her “difficult” and “belligerent moods” that required her to be “put in her place” (Watson, 1968, p. 58). Other female scientists experienced similar forms of discrimination in their departments during the 1950s as well (McGrayne, 2005; Wyer, 2001).

The discrimination continued into the 1960s, both within STEM fields and within the working environment as a whole. Women’s salaries declined compared to men (T. H. Anderson, 1995). During the 1950s and 1960s, women made on average 60% of what their male peers made for the same career (G. Collins, 2009). Some colleges even set higher standards for women or instituted quotas to maintain male dominance in medicine, dentistry, law, and many graduate schools (T. H. Anderson, 1995). By the end of the 1960s, women represented the following percentages in each of the fields mentioned: 1% of engineers, 2% of dentists, 3% of lawyers, and 7% of physicians. Women were denied jobs based on their sex and were ignored in the government interventions to equalize hiring regulations (T. H. Anderson, 1995).
McGrayne (2005) provided qualitative support for this discrimination in her book where she shared the individual stories of prominent female scientists from 1950 to 2005, all of whom either contributed toward Nobel Prize-winning bodies of work or received one for their work. According to McGrayne, many of the women in her study were denied tenure at their universities, especially those who received their graduate degrees in the 1950s and 1960s because no university was willing to tenure a female scientist. Presidents and faculty members mentioned maternity leave and women’s inability to be both a mother and a scientist as reasons for this discrimination. At least three of the earliest female scientists who received their graduate degrees in the 1950s and 1960s were threatened with losing their job if they married or started a family. Others told stories of not being hired at laboratories because scientists thought they would be a distraction to the men in the laboratory. In two stories, women were permitted to work in their supervisor’s laboratory but only during designated times when no male scientists would be present. The laboratory supervisor felt that this would prevent the male scientists from being distracted from their work by the mere presence of women.

In the 1970s, female scientists continued to experience discriminatory actions within the STEM community. According to McGrayne (2005), female scientists who received their degrees during this decade and even later discussed the difficulties they faced in terms of balancing their career and their family, which they felt was not a concern for their male peers and therefore not addressed by the universities’ policies (McGrayne, 2005). McGrayne’s stories about female scientists from 1950 to 2005 were similar in that each woman had to overcome cultural and organizational gender discrimination within her respective scientific community. The concerns related to the lack of family-friendly policies were an example of the more subtle discrimination that women were facing in the 1970’s and 80’s. This lack of policy forced many women to choose between a STEM career and a family (McGrayne, 2005; Wyer, 2001).

During the 1980s, women began to recognize and articulate the gender discrimination they were experiencing. For example, in 1980, Ruth Hubbard published a book that highlighted the gender bias in her field of biology and medicine (Wyer, 2001). Hubbard explained that previous medical and psychological studies had used only male subjects. She explained that ignoring the uniqueness and different experiences of the female mind and body could be a detriment to women who were being medically treated based on studies conducted only on men. After Hubbard’s book, more female scientists began writing about the gender bias that occurred
both in the field and in the classroom. Scientists such as Sue Rosser published books on female-friendly classroom activities stressing the bias of the classroom techniques in college courses that privileged men (Wyer, 2001). As the 20th century ended and 21st began, women remained outsiders or peripheral observers in the culture of science (Wertheim, 2006; Wyer, 2001).

The historical challenges women have experienced in science continue to occur. Female scientists and faculty continue to experience subtle forms of discrimination (Jorgenson, 2002; Wertheim, 2006). For example, Wertheim (2006) interviewed over 30 female scientists and mathematicians and documented some of these subtle forms. The women that she interviewed described their constant fight against the cultural idea that women are less suited for math and science. Certain fields have demonstrated higher levels of discrimination than others have; for example, university physics departments were some of the last to accept female professors (McGrayne, 2005). Wertheim quoted Gail Hanson, a professor of physics at University of California, Riverside, and the first woman to win the W. K. H. Panofsky Prize in experimental particle physics:

At this point, there seems to be an acceptance of women in science at relatively junior levels. But once we get to senior levels, a kind of antagonism sets in. Men can tolerate a woman in physics as long as she is in a subordinate position but many cannot tolerate a woman above them. (p. D2)

The historical and current marginalization of women in the workforce and higher education provides the necessary context to better understand the political and policy response that occurred over the past five decades in the United States.

**Policy Response**

The previous section revealed the overt and the subtle gender discrimination that exists in STEM fields. According to policy researchers, one of the typical responses to discrimination and its resulting inequities is the demand for a policy response to alleviate the problems (J. E. Anderson, 2006; Wirt & Kirst, 2005). The original policy that addressed gender discrimination in the United States was Title IX of the Educational Amendments Act of 1972. An examination of the political history of Title IX provides important context to better understand the program and policy responses that have occurred at colleges and universities such as women-only STEM
LLCs. Title IX applies to this study, but is also a strong example of the unintended consequences that occur within the policy process, especially during the implementation and evaluation stages.

Title IX was created in response to a series of policy demands occurring during the 1960s. As women began working closely with the civil rights movement, they noticed the gains that minorities were making and became more aware of their own inequities (T. H. Anderson, 1995). In the summer of 1970, Representative Edith Green (D-Oregon) chaired a Special Subcommittee on Education (Stimpson, 1973). The goal of the subcommittee hearings was to amend gender discrimination in federally financed programs including higher education. The speeches and writings presented at the hearings covered inequity grievances that ranged from gender discrimination in the workplace to gender stereotypes that affected hiring procedures. The women who presented these grievances made demands for equality in employment and hiring procedures, salary, federal income tax, educational rights, and social security benefits (Stimpson, 1973). The result of these hearings was Title IX of the Education Amendments Act of 1972, which passed through Congress and was signed on June 23, 1972, by President Richard Nixon (Carpenter & Acosta, 2005). Title IX states, “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance” (Committee on Education and the Workforce of the U.S. House of Representatives, 2001, p. 347). According to the regulations within Title IX, in order for schools or programs to be deemed in compliance and to continue to receive federal funds, they must adhere to one of three options: The number of available opportunities for each gender must be proportional to the number of each gender’s interest and numbers, the program or institution must show a history of program expansion in response to the interests and abilities of each gender, and the program or institution must show that its present programs “fully and effectively” (Carpenter & Acosta, 2005, p. 77) address the interests and abilities of each gender.

The wording of Title IX shows that the original goal was to reduce discrimination in educational programs that received federal financial assistance. However, the interpretation by educational programs, including colleges and universities, directed Title IX’s enforcements to athletics. The reason for this unintended consequence is unclear because it was not one of the major demands from those women who spoke at the 1970 hearings. Some scholars argued that

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6 In the original interpretation, opportunities referred to athletic opportunities, such as teams and sport resources.
this might have been the focus because it was the area where women were experiencing the most inequities (Carpenter & Acosta, 2005; Valentin, 1997). This issue highlights how the interpretation of a policy can affect its implementation and focus. This issue of unintended consequences is also evident in policy responses to the underrepresentation of women in STEM fields.

Since 2000, Title IX has entered the political and policy dialogue as a way to address the underrepresentation of women in STEM fields. In 2000, Debra Rolison, a chemist for the Naval Research Center and prominent proponent of women in science, called for improved enforcement of Title IX in federally funded science departments across the nation, including those within public colleges and universities (Rolison, 2003). In addition to the argument that getting more women into STEM fields would improve America’s science output and consequently the economy, Rolison also argued for a stronger critical mass of women to serve as role models. Specifically she argued that the low numbers of female faculty in mathematics, chemistry, and physics departments are a result of the culture within these fields. In an opinion piece in the Journal of the American Physical Society, Rolison (2003) advocated for the application of Title IX mandates and inducements in college STEM departments. She argued that federal funds should be withheld from departments that remained passive and ignored the discrimination against women in their departments, which mirrored Title IX’s policies as they were originally enforced in athletics.

In 2001, nine top U.S. research universities held a meeting at the Massachusetts Institute of Technology to discuss Rolison’s ideas (Rosser, 2003). Attendees at that meeting argued that specific programs were necessary to increase the number of women in STEM fields at a higher educational level, because the “institutional barriers have prevented women scientists and engineers from having a level playing field in their professions” (Rosser, 2003, para. 2). Soon after the meeting, the research universities lobbied Congress for a federal response. In October 2002, the United States Senate called a hearing on Title IX and science. Following the hearing, amendments were made to the resulting bill that authorized appropriations for the NSF, which required both the NSF and the National Academy of Sciences to examine gender differences on issues such as “faculty hiring, promotion, tenure, and allocation of resources including laboratory

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7 Madill et al. (2007) suggested that critical mass is established after the percentage of the minority population has reached at least 30%.
space” (Rolison, 2003, para. 29). Three years after this hearing, the senators involved concluded, “Title IX in math and science is the right way to start” and “we cannot afford to cut out half our population—the female population” (Sommers, 2008, para. 17). In 2004, policy makers began enforcing Title IX on government STEM offices and institutions by withholding federal funds to those who did not adhere to one of the three options in Title IX (National Coalition for Women and Girls in Education, 2008).

As a result of these events, Congress and other federal agencies have been promoting antidiscrimination policies in science fields under the jurisdiction of Title IX. Many national organizations such as the NSF and the U.S. Department of Energy have “been taking inventories of lab space and interviewing faculty members and students in physics and engineering departments at schools like Columbia, the University of Wisconsin, M.I.T. and the University of Maryland” (Tierney, 2008, para. 2) to identify ways to address gender discrimination in these areas.

In October 2007, a subcommittee of the House Committee on Science and Technology invited multiple speakers to help them understand why women were underrepresented in STEM fields, especially in faculty positions. The goal of this meeting was to explore the role the federal government should have in addressing this underrepresentation. The deputy director of the NSF said, “Ultimately, our goal is to transform, institution by institution, the entire culture of science and engineering in America, and to be inclusive of all—for the good of all” (Sommers, 2008, para. 11). This goal was evident in the funding that NSF provided to higher education institutions that have instituted programs that aim to increase the retention rates of women and minorities in STEM fields (NSF, 2007).

In March 2009, President Obama created the Council on Women and Girls by signing an executive order. He named Valerie Jarrett, his senior advisor, as the head of the council. In his press release statement, President Obama claimed that despite many success stories related to women breaking gender barriers,

Women still earn just 78 cents for every dollar men make; when one in four women still experiences domestic violence in their lifetimes; when women are more than half of our population, but just 17 percent of our Congress; when women are 49 percent of the workforce, but only 3 percent of our Fortune 500 CEOs—when these inequalities stubbornly persist in this country, in this century, then I think we need to ask ourselves
some hard questions. I think we need to take a hard look at where we're falling short, and who we're leaving out, and what that means for the prosperity and the vitality of our nation. (White House, 2009a, para. 7)

He then went on to describe the purpose of the council, which was “to ensure that each of the agencies in which they’re charged takes into account the needs of women and girls in the policies they draft, the programs they create, the legislation they support” (White House, 2009a, para. 14). He also said that providing women and girls equal opportunities in all fields including STEM fields was one of the “priorities of his presidency” (White House, 2009a, para. 18).

On June 23, 2009, Title IX celebrated its 37th anniversary with a panel of women and men who had worked on or benefited from the legislation. At that time, Valerie Jarrett reinforced President Obama’s statement related to women’s opportunities in STEM fields:

Title IX represents a major advance not just for women, but for all Americans and for higher education. I’m especially proud of our [the Council on Women and Girls] efforts to encourage women to pursue their aspirations in fields in which they have been historically underrepresented such as science and technology. The Obama Administration is working closely with all government agencies to understand how we can elevate issues related to girls in this country. Title IX is integral to that effort and that is why it is so fitting to know that any girl can be ready to discover our next cure to cancer, win the next triathlon or become President of the United States. (White House, 2009b, para. 3).

At this celebration, further evidence of the Obama administrations’ support for women in STEM was provided by Education Secretary Arne Duncan’s announcement that the administration pledged to fund $2.4 million in grants that help female high school students to succeed in science and math (Kaya, 2009). Representatives from NASA, including Joyce Winterton, the assistant administrator for education at NASA, pledged to increase funding for math and science programs for women (B. Johnson, 2009).

The ongoing discussion of Title IX highlights the effects and unintended consequences that occur based on policy interpretation. Rolison, Winterton, and other scientists believe that Title IX should be implemented and enforced in STEM departments at federal institutions and colleges. Their interpretation of this policy involves applying the Title IX options to STEM departments, thereby increasing access for women in STEM fields. This increase in access at the
higher educational level corresponds with other gender-focused policy initiatives at the K-12 level.

One of the policy initiatives at the K-12 level has been single-gender schools and classes as a way to improve children’s interest in science as well as their overall education. In 2002, President George W. Bush signed the reauthorization of the Elementary and Secondary Schools Act of 1965, also known as No Child Left Behind (NCLB). NCLB allows “local educational agencies to use Innovative Program funds to support same-gender schools and classrooms” (NCLB section 5131 (a)(23)). This statement appears to be a direct contradiction to Title IX of the Educational Amendments of 1972, which prohibits sex-based discrimination and makes the following statement regarding single-gender classrooms or schools:

A recipient shall not provide any course or otherwise carry out any of its education programs or activities separately on the basis of sex, or require or refuse participation therein by any of its students on such basis, including health, physical education, industrial, business, vocational, technical, home economics, music, and adult education courses. (Committee on Education and the Workforce of the U.S. House of Representatives, 2001, p. 347)

In 2003, to determine whether same-gender schools and classrooms were beneficial, and therefore not discriminatory, the federal government conducted a systemic literature review of over forty quantitative studies on single-gender schools published since 1988 (Mael et al., 2005). The authors used specific standards and criteria, including only studies involving K-12 education with full-time student attendance in an English-speaking or Westernized school comparable to the U.S. public schools. Results of the review showed that while some evidence supported single-gender schooling in terms of academic achievement and aspirations, much of the literature did not show a significant difference between single-gender and coeducational schools in terms of the outcomes listed in the research questions. There were a number of other criticisms of the studies as well. There were very few studies of elementary single-gender schools. Most of the single-gender middle and high schools were private or Catholic affiliated. More studies compared all-girls’ schools to coeducational schools, with fewer comparing all-boys’ schools to coeducational schools. Half of the results showed that single-gender classes or schools were beneficial to student learning and confidence but half indicated no difference. Results were not all comparable because even studies that looked at the same achievement outcome would often
use different statistical controls. Very few studies separated outcomes by race and socioeconomic levels, even though a number of the studies indicated there could be a benefit for single-gender schooling in minority and lower socioeconomic level populations, specifically for males in these categories (Mael et al., 2005).

Although the report provided no definitive evidence that single-gender schools provide better academic results, the U.S. Department of Education in 2006 added regulations to Title IX that allowed public elementary and secondary schools to create single-gender schools or classes as long as they offered the same options to both genders (National Coalition for Women and Girls in Education, 2008). According to a 2006 press release by the U.S. Department of Education, Secretary Margaret Spellings explained the intent of the single-gender school decisions:

Research shows that some students might learn better in single-sex education environments. The Department of Education is committed to giving communities more choices in how they go about offering varied learning environments to their students. These final regulations permit communities to establish single sex schools and classes as another means of meeting the needs of students. They also establish that enrollment in a single sex class should be a completely voluntary option for students and their families and they uphold the prohibitions against discrimination of Title IX. Every child should receive a high quality education in America and every school and district deserves the tools to provide it. (U.S. Department of Education, 2006, para. 2)

This press release showed the federal government’s support of single-gender schools and classrooms despite the mixed evidence regarding their benefits.

Some other studies on single-gender schools and classes have provided positive evidence. Spielhagen (2008) conducted a qualitative study of a rural middle school that offered voluntary single-gender classes in four subjects (language arts, math, science, and social studies) in Grades 6 through 8. After observing and interviewing participants \( n = 100 \) over an entire school year, she found that students who volunteered for these classes on their own accord had increased “cognitive benefits” (Spielhagen, 2008, p. 35). The students claimed to have increased enjoyment, comfort, and confidence in the subjects taught in the single-gender classes.

Researchers who have focused on single-gender science education have found that young women can benefit from a learning environment where the distraction of young men is missing and
interest in science and math is supported by female peers and female role models (Brickhouse & Potter, 2001; Rayman & Brett, 1995). This research, along with the federal policies that promote single-gender schools and classes, has resulted in an increase of these programs since 2000.

Despite these positive findings, many organizations and individuals are critical of the use of Title IX and NCLB to improve gender discrimination. Opponents to the regulation changes in Title IX complain about quota systems and the repercussions of affirmative action policies that hurt both those who benefit from the policies and those who do not. There are also criticisms regarding single gender schools and classrooms. A recent report published by the National Coalition for Women and Girls in Education (2008) argued that the current single-gender school regulations lack “safeguards” that ensure “appropriate purposes and do not perpetuate sex discrimination” (p. 47). The Feminist Majority Foundation has been working to rescind the regulations in Title IX citing that these regulations weaken Title IX by increasing sex segregation (Feminist Majority Foundation, 2009). And the American Civil Liberties Union president claimed that single-gender classes “are inherently unequal and shortchange both boys and girls” (Feminist Majority Foundation, 2009, para. 3).

The Single-Gender Policy Response in Higher Education

The debate regarding single-gender schooling at the K-12 level has begun to permeate higher education as well. As a response to the underrepresentation of women in STEM majors, many higher education institutions have instituted special single-gender STEM LLCs to increase the number of women in STEM fields. These programs have increased in number since the early 1990s (Inkelas et al., 2007). As of 2007, there were twenty five of these programs at colleges and universities across the United States (see Appendix A). No overarching policy advocates that institutions create these programs. The increase in the number of women-only STEM LLCs is based on each institution’s interpretation of research on and the effects of single-gender programs on women’s interest and persistence in STEM fields. Each program has different sources of funding and often different ways of improving women’s retention rates in STEM fields. For example, the STEM LLC in this study, Women in STEM (WSTEM), received its funding from the university based on a line item in the state budget allotted to all universities.

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8 These studies will be discussed in more detail in the next section of the literature review.
within the state to be used specifically for education and general expenditures (State Budget Website). No other university in this state has used its education and general expenditures funding for a single-gender STEM LLC. And in personal communication with program directors at over fifteen of the twenty five single-gender STEM LLCs, I found that none of the programs were funded in the same way as WSTEM.

However, all these programs have university support in that they are given a specific floor or hall within a dormitory where the young women live. Some of these programs were also supported by specific departments within the university that provided classes or volunteers to speak to women within the program about their research and experiences. The common goal of these programs was to provide a supportive all-women environment that provided mentors, research, and networking opportunities that would help them maintain their interest and desire to pursue STEM careers. These programs were evidence of the policy environment at each of the corresponding universities, indicating the university’s desire to address gender issues in STEM majors. The variety among the programs further showed how the interpretation of policy initiatives like Title IX and single-gender programs can affect the implementation and the effects of the specific policy.

These women-only STEM LLC programs were a manifestation of a larger attempt by government and educational organizations to alleviate gender inequities within STEM departments. As of 2008, the federal government and its organizations (NSF) had spent over $3 billion on programs aimed at increasing the participation and retention of minorities and women in STEM fields (Leggon, 2006; NSF, 2008). Women-only programs have been initiated at all levels of the educational system due to changes in NCLB and Title IX of the Educational Amendments Act (Ferrara & Ferrara, 2008; Spielhagen, 2008). The increase in the number of these programs at both the K-12 and the higher education level provides some evidence for the current interpretation of the best way to address the underrepresentation of women in STEM fields. However, the causes for the underrepresentation are complex because a woman’s choice to stay or leave a STEM career is a result of her unique experiences and interpretations of those experiences, as the next section will show.
**The Phases and Influences on Women’s STEM Career Choices**

A career decision is a culmination of experiences and the internalization of those experiences, specifically how the desired career matches with one’s identity and skills (Eccles, 1994). To understand the potential of women-only STEM LLC programs for improving the underrepresentation of women in STEM fields, it is important to describe the complex environmental and individual factors that affect each individual’s college major and career choice. This review will describe how each phase leading up to the undergraduate years affects career decisions. This review will also show that programs such as women-only STEM LLCs are just one part of a much larger set of life experiences that eventually lead to a STEM career choice.

The literature related to women’s STEM career choices can be divided into three phases. The initial phase is early childhood and elementary school, which is when children begin to develop gender roles and stereotypes. These stereotypes can affect their beliefs regarding appropriate careers and behaviors (Spielhagen, 2008). The beliefs can be reaffirmed in the second life phase, which occurs during middle school and high school. Experiences during this phase affect students’ decisions regarding college and often career choices. The third life phase occurs during college. For this study, this period is the final phase, because the study focuses on women who are seniors in college and preparing to graduate and enter their careers.

**Gender Roles in Early Childhood**

The process of gender stereotyping, or the categorization of individuals and objects, occurs as early as infancy as a way for human beings to give meaning to their lives (Ferguson & Bargh, 2008). At this stage, human beings begin to classify people and objects into groups by emphasizing their similarities and de-emphasizing their differences (Zerubevel, 2008). One of the first obvious categories for children besides race is sex, the biological difference between male and female. As children grow older, research shows that they begin to assign roles and behaviors to these categories of sex, thereby engaging in gender stereotyping.

Van Ausdale and Feagin’s (2007) study of prekindergarten children illustrated the process of gender stereotyping. By observing student interactions over 1 year in one preschool class ($n = 20$), the authors found that prekindergarten children adopted the gender, racial, and ethnic identities that others attributed to them. Van Ausdale and Feagin concluded that each
interaction the students had regarding gender, race, or ethnicity influenced their own construction of their identity. Thorne (2007) confirmed this finding regarding gender stereotypes by conducting a yearlong ethnographic study of elementary school children during recess. Her study focused on the interactions between and within genders to examine how elementary school children categorized gender. Thorne found that the children \((n = 50)\) identified gender with specific roles: males as aggressors and females seeking protection. Thorne observed young girls telling the boys that they could not play house because they were boys, and similarly the young boys would claim that the girls could not participate in certain games because they were girls (p. 326). This belief that behaviors are attributed to certain genders denied each gender from specific activities. The effect of these stereotypes on children’s decisions related to careers depends on how these stereotypes are reinforced or contradicted throughout their lives.

Studies of elementary students provided evidence of gender stereotype reinforcement (Losh, Wilke, & Pop, 2007; Shakeshaft, 1995). For example, Losh et al. (2007) asked 206 elementary students to draw pictures of three different occupations: scientist, teacher, and veterinarian. After analyzing over 616 drawings, the authors found that the majority of students drew scientists as a white male or monster-like creature. These results suggested that the masculine connotation associated with science was still evident. These perceptions of science could negatively affect young girls’ interest in science.

Because male and female elementary students have the same levels of achievement on science standardized test scores, the effects of gender stereotyping are often ignored (Williams & Ceci, 2007). For example, Dimitrov (1999) looked at gender differences in fifth graders as it related to science achievement. He conducted a quantitative analysis of the state-mandated science standardized test results of 2,551 fifth graders from 40 schools in a large city in Ohio. After conducting a multivariate analysis of variance of the results, he found that there was no significant difference between gender and science achievement on the multiple choice questions. However, in a study that focused on gender stereotypes, the results were very different. Ferenga and Joyce (1998) focused on levels of motivation, interest, and attitudes related to science in elementary school students. The authors’ sample included 427 students in Grades 4 through 6. Each student completed a Course Selection Sheet, which asked for their reasons for selecting science courses. The results for boys were inconclusive; however, the study found that girls who perceived scientists as male were less likely to choose science courses.
Dimitrov (1999) showed that male and female elementary school students score similarly on standardized science tests. Current standardized test results for elementary school children also supported this result (Williams & Ceci, 2007). However, Ferenga and Joyce’s (1998) study showed that although test scores might be similar, there is a difference in motivation and interest because of gender stereotypes. The next section explores how perceptions related to the masculinity of STEM careers can affect female students’ interests in and choices to pursue them.

**Gender Roles in the Secondary Years (Middle and High School)**

Recent statistics show that male and female middle and high school students are now scoring similarly on math and science standardized tests (NSF, 2007; Williams & Ceci, 2007). High school girls and boys are taking advanced math and science courses (except for physics) at comparable rates and girls on average receive higher grades in these classes (National Center for Education Statistics, 2005; Williams & Ceci, 2007). Despite these improvements, fewer women are pursuing and persisting in science majors in college. Researchers have identified multiple influences in the middle and high school years that might affect this lack of persistence at the college level. These influences can be divided into three main categories. The first category is the role of socializers on women’s science interests (Carlone, 2004; Dick & Rallis, 1991). Second is the lack of practice that women have at this phase with science tools and language, putting them at a severe disadvantage and ultimately leading them to leave STEM fields (Burkam, Lee, & Smerdon, 1997; Jones et al., 2000). The final category is the role of identity, particularly how one’s perceived identity fits with one’s perceptions of science and decisions related to STEM fields (Brickhouse & Potter, 2001; Olitsky, 2006). Each of these will be discussed below.

**Role of socializers.** A quantitative study by Dick and Rallis (1991) highlighted the impact of socializers on female students. The authors surveyed 2,213 high school seniors in nine Rhode Island high schools regarding academic and career choices. They compared survey responses from female and male students with similar backgrounds in advanced science and math classes. The authors found that even when high school students took the same level of

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9 Socializers are individuals such as peers, parents, teachers, coaches, and guidance counselors who affect students’ decisions.
science and math courses, males chose more science and math majors than females. Parents and teachers were credited for this choice. For example, females who chose science reported having a more positive influence from teachers than those who did not choose science.

A more recent study supported the important role of socializers on female students’ interest in science. Carlone (2004) conducted an ethnographic study of an active physics high school course that stressed real-world themes and utilized cooperative learning via laboratory activities, which are strategies considered beneficial to female students. This particular class was taught by an experienced male teacher and composed of 28 students: 14 boys and 14 girls; 26 Whites and two Asians. Carlone focused on the cultural practices that shape girls’ identities and science perceptions. She found that the female students were motivated to take the class because it would improve college acceptance, not because of an actual interest in the subject. None of the girls in the class wanted to pursue science in college. Carlone reported that both the teacher and the students held a perception that males were naturally better at science and consequently would be more successful in science fields and classes. This perception became evident through student and teacher comments. In the class, three girls were receiving the highest grades; however, the teacher reported that this was due to their work ethic and not necessarily to their abilities. Both the teacher and the students explained that the boys who were receiving lower grades had natural science ability and were more successful at science. The teacher reinforced this belief by reaffirming it verbally in class. This idea of natural science abilities promoted the stereotype that the girls would have to work harder than the boys who naturally understood science better. Carlone concluded that in this class, the belief in male natural science abilities negatively affected the girls’ interest in science.

As in Carlone’s (2004) study, many researchers have raised the concept of male teachers and female teachers treating students differently based on gender (Carlone, 2004; Elstad & Turmo, 2009; Jones et al., 2000; Sabbe & Aelterman, 2007). Elstad and Turmo (2009) used survey methods to determine how the sex\textsuperscript{10} of high school students’ science teachers affected their interest and achievement in science ($n = 768$). The authors found that the teacher’s sex had little impact on students. The students instead mentioned the positive effect that hands-on

\textsuperscript{10} I chose to use the term that the authors used in their own study. Anywhere the term “sex” is used, that is because that was the author’s choice of terminology.
teaching techniques and the teacher’s interest in the subject had on student interest and achievement.

Sabbe and Aelterman (2007) conducted a literature review of studies that focused on the effects of teacher’s sex on students’ interest and achievement in science and came to similar conclusions as Elstad and Turmo (2009). Sabbe and Aelterman reviewed over 35 studies that focused on the effect of teacher gender or sex on their teaching strategies and on students’ interest and achievement in science. The authors argued that studies that focus on sex differences often oversimplify the term gender by using the terms sex and gender interchangeably. These studies also tend to disregard the diversity among individuals within each gender. The authors concluded that the theoretical framework through which each set of authors views sex and gender affects their studies. Those researchers, who saw sex as a determining factor in how individuals behave and subsequently teach, tended to find differences in how male and female teachers interacted with students. Those researchers who used a constructivist lens found that sex of the teacher had little effect on students’ interest and achievement in science. Sabbe and Aelterman found that the research they reviewed did not support essentialist views (i.e., the concept that men and women teach differently because of their gender). The authors concluded that researchers should be more explicit in their definition of gender and describe the complexity that gender entails. These studies indicated that there is little evidence to support the idea that a science teacher’s gender can affect students’ achievement and interest in science. However, the studies did indicate that teachers can play an important role in students’ interest in science, achievement, and decisions to pursue science. The support (or lack) of socializers is just one of the many possible factors that affect students’ persistence in science, as the next section will describe.

**Lack of practice.** Women and girls have less practice with laboratory tools and the language of science during secondary school (Jones et al., 2000; Seymour & Hewitt, 1997). This lack of practice puts women at a disadvantage when they reach college. If a young woman enters college with an interest in STEM fields but has had little experience with science tools and language, it will be much more difficult for her to be successful (Seymour & Hewitt, 1997). The following studies provide evidence of students’ lack of practice.
Jones et al. (2000) observed 16 students from five different science classes for 48 observation hours. Results indicated gender differences in language and use of tools. Males attempted more exploratory and inventive uses of the tools whereas females tended to follow the use directed by the teacher. For example, in one observation where students were using a balance, a pair of male students played with the weights by stacking them and observing what they called the “leaning tower of weights” (Jones et al., 2000, p. 770). The authors observed that these two male students were better able to discuss gravity and other fundamental concepts based on their tinkering than those students who followed the directions. In coeducational pairings, the female student typically reverted to a note-taking role, allowing the male student to take over the physical manipulation of the lab equipment. This study showed that the students in these classes were exhibiting signs of the gender stereotypes that portray science as a male realm because the female students let the male students take over the lab equipment. Although this case could not be generalized to all science classrooms, the authors suggested that this extra practice could improve male students’ interest and knowledge in science.

In comparison, Burkam et al. (1997) conducted a quantitative study that focused on 12,120 students (5,907 boys and 6,213 girls) from their 8th to 10th grade years. The authors used the National Education Longitudinal Study of 1988 database to identify factors related to gender differences in 10th grade science performance. The rationale for the study was to better understand why the gender gap in physical science (and to a lesser extent life science) increases from 8th to 10th grade. They found that female participants had less practice with science than their male peers had. Based on their results, they found that many high schools do not offer “hands-on lab activities” (Burkam et al., 1997, p. 299). This issue was more detrimental to girls because many of the male students reported having experience with science tools outside of school such as car batteries and electrical circuits.

Burkam et al. (1997) also found that girls were less responsive to teacher-centered instruction (i.e., lecture). Male students tended to dominate this type of classroom, which often occurs in the STEM courses especially later at the college level. As a result of this domination in the classroom, males had more practice with teacher-centered classroom discourse and were better prepared for it in college. Burkam et al. also found that male students gained more practice discussing science concepts and using science language, which improved their confidence in the sciences as a result of their comfort level with teacher-directed instruction. The authors found
that the gender of the science teacher had no effect on student performance in their model (Burkam et al., 1997). These studies suggested that female students experienced less practice and support in the sciences. Often these environmental factors were then internalized, as the next section shows.

**Identity.** Science education researchers argued that individuals can only be successful in STEM fields if they feel a sense of belonging and an ability to participate (Duschl et al., 2007; Kahveci et al., 2007). This sense of belonging falls into the construct of identity. If science does not fit in with a person’s identity, then that person will not pursue it as a career. For young women, the stereotype of appropriate gender roles that begins as early as preschool can make STEM careers seem inappropriate. The construct of identity is the focus of the next set of studies.

Olitsky (2006) focused on the marginalization of language within an eighth grade science classroom of thirty three students in a large urban public school over an entire school year. Through her participant observations, focus groups, and interviews with students and teachers, she found that certain students in her study would not participate in class for fear of giving the wrong answer or misusing the terminology. These students had a picture of what type of people use scientific language and practice science. She learned that students based this picture on their own perceptions of scientists as male, White, and smart. Therefore, these students felt that only those individuals who fit one or all of these stereotypes could identify with science and eventually participate in science. Many students in the study did not feel that their identity fit with the science stereotype. As a result of this stereotype and their failed uses of science language, they opted out of science fields altogether.

Brickhouse and Potter (2001) observed the internalization of environmental factors (the influence of socializers, gender, and socioeconomic factors) on two African American girls from seventh to tenth grade in an urban vocational high school. Both girls had originally declared an interest in computer science. Data were collected over a 3-year period, including journals, focus group transcripts, and observations in science classes during the seventh, eighth, and tenth grades. The researchers conducted annual interviews with the girls, their teachers, and their parents to understand the point of view of all individuals regarding the girls’ engagement in science and computer science in and out of school. One of the young women in the study began
to receive lower grades in her science classes. Due to her frustration with these lower grades; a lack of parental, teacher, and peer support; and a sense of isolation as the only African American girl in her class, she expressed her sense of marginalization and eventually decided to pursue another non-science area of study.

These two studies showed how stereotypes or perceptions related to science can prevent students from persisting. Middle school and high school students’ interest in science often depends on the level of support from socializers and the amount of practice with science tools and language. Even if these experiences have been positive for students, if their perception of STEM fields does not match with their identity and career or life goals, then they might still choose not to pursue these careers (Eccles, 1994). The studies in this section showed that women tend to have less support and less practice in their science and math classes at this stage of their lives. The next section illustrates how these factors continue to affect women in their undergraduate years.

Gender Roles in the Undergraduate Years

According to the NSF (2007) and the National Science Board (2008), a higher percentage of women left STEM majors in 2005 than men, as indicated by earned bachelor’s degrees. Figure 2.1 shows the comparison based on gender between students’ intention to major in STEM fields and those students who complete a STEM bachelor’s degree. (Percentages are based on the percentage within the particular gender, for instance, in 1985, 34.7% of male students intended to major in STEM fields out of all other male students.)

Men and women with similar grades, test scores, and interest levels enter college with the preparation necessary for a STEM major (National Science Board, 2008), yet fewer women choose to pursue these majors (i.e., 15% of college women planned to major in a STEM degree in 2005 compared to 29% of men). The trend that appears in Figure 2.1 shows that the percentage of female students intending to major in STEM fields has remained the same since 2000. The percentage of male students intending to major in STEM fields declined from 35% in 2000 to 29% in 2005. In 2005, only 11% of the original 15% of women stayed in STEM majors and graduated with these degrees. Almost 4% of the women chose to leave STEM fields compared to only 2% of men for 2005. The literature on STEM majors in college provides some context for this phenomenon and the policies that attempt to address it. The programs that have
resulted from these policies, like women-only STEM LLCs, have been instituted beginning in 1990, a time during which women’s enrollment and graduation rates in STEM majors has remained relatively stagnant. Therefore, this literature review includes only those higher education studies that have been published during that time to highlight current trends in the research (Rolison, 2003).

Seymour and Hewitt (1997) conducted one of the most cited studies of influences on undergraduate STEM majors. The three-year qualitative study of undergraduate STEM majors examined the influences that affect undergraduate women’s and minorities’ decisions related to these majors. They interviewed 335 students and conducted focus groups at seven different institutions in different regions of the United States: three private liberal arts colleges and four larger public universities. Students were chosen based on their SAT scores so that all participants would represent high-achieving students who possessed the academic ability to succeed in

Figure 2.1: Comparison of students by gender: intentions to major in STEM compared to actual completion (Source: National Science Board, 2008).

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STEM majors. The sample was composed of 54.6% leavers (those who left a STEM major) and 45.4% stayers (those who stayed in a STEM major). Seymour and Hewitt highlighted three main reasons for the attrition of female college students from STEM majors. The first two were similar to the factors that were evident in the middle and high school studies: lack of role models (Ong, 2005; Seymour & Hewitt, 1997) and poor preparation (Seymour & Hewitt, 1997). The third factor that Seymour and Hewitt identified as being influential was a chilly academic climate for women (Ong, 2005; Seymour & Hewitt, 1997; Shakeshaft, 1995). Seymour and Hewitt found that women’s abilities to cope with this climate influenced their decision to leave or stay in STEM fields. The three reasons for women’s underrepresentation and the research findings that support Seymour and Hewitt’s (1997) results will be discussed in the next section.

**Lack of role models.** Women often cite the lack of role models as a reason for their decisions to leave a STEM field. A 2002 census of college STEM departments found that the national average of female professors in each department was 20.2% for biology, 12.1% for chemistry, 10.6% for computer science, and 6.6% for physics (Leggon, 2006). The numbers suggest a lack of female role models for women in STEM fields. Because female students do not see or interact with other female or supportive male role models, mentors, faculty, and peers, they often feel isolated and prefer a major in which they are supported and feel that they belong (Seymour & Hewitt, 1997).

**Poor preparation.** Seymour and Hewitt (1997) found that low grades had more of a negative influence on female students’ beliefs about themselves than on male students’ beliefs about themselves. This negative influence often led women to leave STEM majors, which is particularly troublesome because most STEM majors begin with weed-out courses where the majority of the students receive low grades to discourage a large number of students from the major (Leggon, 2006). These weed-out courses appear to affect women disproportionately. Consequently, if this tactic affects female students more than male students, then more females will leave the major. Many of the female and minority students in Seymour and Hewitt’s (1997) study claimed that they were not prepared for the workload within the college STEM majors. These individuals had received high grades in their high school math and science classes and were not prepared for the low grades they were receiving in their college courses. The authors
found that those who persisted had to change the meaning of grades and detach it from their self-worth. This concept of the interpretation of grades has been supported in additional research as well (Williams & Ceci, 2007).

Similarly, Crisp, Nora, and Taggart (2009) found that success in science and math in high school as indicated by high school grade point average (GPA) and SAT math scores were significant predictors of success in engineering majors for students in their quantitative study. For this study, a GPA over 3.0 and a high math SAT score were indications of strong academic preparation in high school. These authors and others found that minority students, specifically Hispanic students, were often placed in lower level science courses despite high GPAs and standardized test scores. This placement lowered their preparation level and their chances of success in subsequent courses that would prepare them for a college STEM major (Crisp et al., 2009; Zuniga, Olson, & Winter, 2005). These studies highlight the unique influence of ethnicity (and race) on students’ STEM career decisions, particularly women who are already in a minority category in STEM fields.

**The chilly climate.** One of the first references to the concept of the chilly climate occurred in a 1982 report on higher education conditions that were affecting women differently from men (Hall & Sandler, 1982). Hall and Sandler reported on the role of the “institutional atmosphere, environment, or climate—both within and outside the classroom—in fostering or impeding women students’ full personal, academic and profession development” (p. 2). This report focused on the role of faculty in sustaining the chilly climate, such as using male students’ names but not female students’ names, providing more praise for men for the same level of work as women, choosing only male students for assistantships, and subtly or overtly using sexist or discriminatory language (Hall & Sandler, 1982). The authors stressed that these behaviors in the classroom often led women to believe that they and their ideas were unwelcome and less important. And the authors outlined how this same behavior from teachers was being exhibited in K-12 classrooms as well.

Hall and Sandler (1982) focused an entire section on women in male-dominated fields such as physics and engineering. In this section, they outlined specific factors occurring in STEM departments that added to the chilly climate, including fewer female role models, feeling like a minority, and overtly discriminatory faculty (Hall & Sandler, 1982). Ten years after this
initial report, the AAUW published a report titled, *How Schools Shortchange Girls*. This report also found the invisibility of female students in K-12 and higher education (AAUW, 1992). Although the authors of the report never mentioned the chilly climate, they identified the same factors that had originally fallen under this title such as female students receiving less attention in classes, sexual harassment by male students, and little information provided on the contributions of women in STEM fields. This study, like Hall and Sandler’s, dedicated an entire section of their article to a discussion of the concept of a chilly or unfriendly climate within science and math classes.

In 2008, AAUW published a follow-up report to their 1992 publication. This report discussed improvements to the chilly climate in many areas; however, the authors argued that the gender gap in science and mathematics still existed. Many researchers believe that this was due to the chilly climate that students encountered in male-dominated STEM majors at the college level. The aspects of the chilly climate at the college level, which was the focus for this study, included a lower number of female role models in STEM fields (Leggon, 2006; Ong, 2005; Seymour & Hewitt, 1997); professors or teachers tending to support male students over female students, believing male students show more natural science aptitude than female students (Allan & Madden, 2006; Carlone, 2004; Sadker & Sadker, 2009; Seymour & Hewitt, 1997); the typical STEM course pedagogy supporting male student learning more than female student learning (Hall & Sandler, 1982; Rosser, 1995); and subtle or overt forms of discrimination from faculty and peers based on stereotypical views of women (Allan & Madden, 2006; Seymour & Hewitt, 1997). These factors combined to add to women’s sense of isolation as a minority in STEM fields, which often led to their decisions to leave the STEM fields (Allan & Madden, 2006; Brainard & Carlin, 1998).

Researchers who have studied retention rates in colleges and universities have found that many women and minorities who leave and even those who stay in STEM majors often describe a sense of isolation and marginalization within their science classes (Franzway, Sharp, Mills, & Gill, 2009; Ong, 2005; Seymour & Hewitt, 1997; Shakeshaft, 1995). The women in Seymour and Hewitt’s study described the chilly climate as a lack of support and praise from faculty, poor teaching styles, grade competition, and overt discrimination. One of the most cited examples of the chilly climate in Seymour and Hewitt’s study was the lack of praise that students received in STEM courses. The authors argued that the women in their study were motivated by praise more
than their male peers. Consequently, this reliance on praise negatively affected women’s ability to persist. This internalization of grades and need for praise was also supported in the secondary school studies (Brickhouse & Potter, 2001; Burkam et al., 1997). Both leavers and stayers in Seymour and Hewitt’s (1997) study mentioned the lack of advice or tutoring. Many said that faculty at their respective institutions were unapproachable. This faculty culture was especially difficult for those students who came from high schools where teachers supported them.

Another source of frustration for the women in Seymour and Hewitt’s (1997) study was the teaching styles they encountered in their science classes. Female students complained about uninteresting teaching styles (i.e., lecture and teacher-centered). The majority of the female students interviewed highlighted this as a reason for their decision to leave their STEM major, whereas male leavers did not. The theory that the type of instruction affects interest in STEM classes has been supported by secondary school studies as well (Brickhouse & Potter, 2001; Carlone, 2004).

The participants in Seymour and Hewitt’s study (1997) complained that the competition instilled by the STEM culture and its weed-out system allowed only individuals with certain types of characteristics, such as aggressiveness and assertiveness, to succeed. The authors reported the weed-out tradition within STEM majors disproportionately affected minorities and women. As a result of the competitive atmosphere and the lack of support perceived, many of the women interviewed cited feelings of alienation, isolation, and loss of confidence more than their male peers did.

Some of the women interviewed by Seymour and Hewitt (1997) mentioned overt discrimination by faculty in their departments. These women also cited discrimination from their male peers. The male students articulated the belief that female students were not naturally gifted in science, similar to situations reported in other studies (e.g. Carlone, 2004). Some of the male students in Seymour and Hewitt’s study credited female students’ high grades to hard work and not to ability, which women reported as devaluing their success. Many women also reported being treated as if they were incapable in labs. For some women, the chauvinism served as a source of motivation. Others responded by keeping silent, changing classes, or leaving the major altogether. Seymour and Hewitt suggested that women’s reaction to this chilly climate best predicted their decision to leave or stay in STEM majors.
In a more recent study, Hartman and Hartman (2009) surveyed over 20,000 male and female engineering students at a mid-Atlantic university over six years (2002-2008). The authors wanted to determine how gender, year in college, and engineering discipline affected students’ attitudes toward engineering; self-confidence in engineering (how well they fit in with the engineering major); satisfaction with major (supportive peers); commitment to engineering as a future career (whether students planned to be working in engineering 10 years later); and expectations for the engineering degree (expectations for career, well-paying job, making a difference, benefiting society). The results supported some of the findings of Seymour and Hewitt’s (1997) study related to the chilly climate. Hartman and Hartman found that female students had a significantly lower self-confidence in their perception of fitting in to the major across all disciplines and experience levels (i.e., first year to fourth year college students). The findings did indicate that male and female engineering students at the university had equally high levels of satisfaction with the peer support that they experienced in their major and with the core courses they took. The authors noted that this reaction, a concept that is discussed in the next section, could be influenced by female students’ decision to assimilate into the masculine culture of engineering rather than challenge it.

**Reactions to chilly climate.** Studies have shown that women’s reaction to the chilly climate often affects their persistence. Typically, women who persist in STEM fields deny the existence of gender discrimination as a way to fit in (Bianchini, Cavazos, & Helms, 2000; Hartman & Hartman, 2009; Jorgenson, 2002; Seymour & Hewitt, 1997) or they alter themselves to fit in (Ong, 2005). Bianchini et al. (2000) conducted interviews with 60 female and male scientists and science teachers and found that women scientists were less likely to claim that the barriers they experienced were related to their gender, whereas their male peers claimed that they recognized the existence of gender discrimination. The female science teachers interviewed cited gender discrimination as the reason for their decision to leave STEM fields. Bianchini et al. (2000) found that women who persist in STEM fields refuse to admit to experiencing gender discrimination and spoke negatively of those women who did admit to it. The authors concluded that these women scientists wanted to feel solidarity with the science community and tried to separate themselves from their gender community. Consequently, by denying the existence of
gender discrimination as a source of the barriers they faced, they could still feel solidarity with their male peers in the science community.

Similarly, many of the women in Seymour and Hewitt’s (1997) study refused to admit that gender played a role in the discrimination and marginalization that they faced. Rather than refer to gender as a source, they preferred to reference natural ability as a source, saying men were better at math like the high school studies showed (Carlone, 2004; Dick & Rallis, 1991). Seymour and Hewitt (1997), like Bianchini et al. (2000), reported that women avoided citing gender as a source for discrimination because it would emphasize the lack of solidarity that they shared with the science community because of their gender. The women interviewed in Seymour and Hewitt’s (1997) study claimed that they did not want to stand out in their classes. They felt that arguing against gender discrimination could bring negative attention or cause them to stand out. Therefore, they decided not to dwell on the gender discrimination that they experienced. Many of the participants described trying to act the same as their male peers in the classroom so the professors would treat them similarly. The adaptation of acting more like their male peers is another reaction to the chilly climate.

Ong (2005) highlighted this type of reaction in her qualitative study of undergraduate and graduate physics majors. Ong chose to focus on ten self-identified minority women physics majors (African American, Chicana, Latina, and Filipina) over eight years, which included their undergraduate and graduate school years and for some their entry into their career. Interviews were conducted annually and explored their interest in physics, their academic performance and satisfaction, educational and career goals, sources of support and discouragement, and perceptions of gender or race-related issues in their educational and career experiences.

Ong (2005) found that women in male-dominated physics programs had to “negotiate [the] three incongruent realms” (p. 598) of gender, race, and physics. In physics especially, she found that the women reported being judged by two contradictory categories, being feminine and being a competent scientist. The women perceived that to be successful in one category they must sacrifice the other. Ong found that minority women had to deny parts of their personality or behavior that could be labeled as feminine or ethnic to fit in with their physics peers. She found that most of her participants felt that they lacked the typical appearance of a scientist because of their gender and their race.
In another study that focused on the incongruent realms of gender, ethnicity, and engineering, Crisp et al. (2009) surveyed 1,925 students who graduated from a southern university from 2006 to 2008. The authors found that Hispanic students in their study were affected more by the poor grades they received in STEM courses than their White and African American peers. A high percentage of Hispanic students chose to leave engineering majors as a result of their low grades compared to their White and African American peers. The Hispanic students mentioned the negative influence of the structure of the weed-out or gatekeeper classes, which they cited as their reasons for leaving STEM majors (Crisp et al., 2009). These students cited the high level of competition in classes and the large class size as two of the major components of the weed-out system that affected their decision to leave.

The concept of incongruent realms and the role of identity as students move through college can be highlighted by focusing on students longitudinally. Ong (2005) chose to follow ten of the minority women in her study through their transition from college to graduate school and their careers. Studies that focus on this transition can highlight changes in individual’s goals and attitudes that could affect their STEM career decisions. These longitudinal changes are evident in the next set of studies.

Gender Role Longitudinal Studies on STEM Career Choice

Thus far, this review has highlighted studies that focus on the elementary school, high school, and college life phases of women’s educational paths. These studies have described the influences on young women’s STEM decisions at distinct points in their lives. However, persistence in STEM is not based on one particular event but on a combination of experiences and interpretations. Two large-scale quantitative studies followed students from high school to college and career (Farmer, 1997) and from college to career (Rayman & Brett, 1995). These studies, like those in the previous section, highlight the importance of role models and socializers (Rayman & Brett, 1995) as well as the role of future family plans in women’s STEM career decisions (Farmer, 1997; Rayman & Brett, 1995).

Importance of role models and socializers. Rayman and Brett (1995) conducted a longitudinal quantitative study in which they highlighted the importance of role models and socializers in women’s STEM career decisions. The authors surveyed three cohorts of women.
science majors \( (n = 369) \) from the same college who had graduated at two-year intervals over an eight-year period. Their goal was to understand precollege and college experiences that affected women’s persistence in science careers. They found that the participants fell into one of three categories: stayers, those who remained in their original science field; changers, those who switched to another science field; and leavers, those who left science fields. The researchers compared the following variables: family background, high school and college math and science grades, perceptions regarding ability, and values and attitudes toward work and family. Then they analyzed the data to determine if any of these could be predictors for staying in or changing a career after graduation.

Those women in the stayers category were the most likely to have received encouragement from teachers and parents (especially mothers), to have a mentor, and to receive career advice from faculty. Compared to stayers, individuals in the changers category were less likely to receive encouragement from mothers and teachers, to have mentors, and to receive career advice from faculty. Leavers were the least likely to have a parent in science, to receive encouragement from parents or teachers, to have a mother who graduated from college, or to receive career advice in college. Individuals in the leaver category also took fewer science and math courses than the other cohorts. These findings support the role of socializers in women’s decisions to remain or leave STEM fields.

**Future family plans.** Studies on college age women and practicing scientists revealed an additional factor that often discourages women from persisting in STEM fields: a perceived conflict between family and career plans (Bianichini et al., 2000; Rayman & Brett, 1995; Seymour & Hewitt, 1997). These studies have shown that women tend to worry more than their male peers do about balancing their family and their career. For example, Rayman and Brett (1995) found that the stayers in their study were the least likely to perceive that their career was incompatible with a family. However, changers were more likely to perceive a STEM career as being incompatible with a family and more likely to believe that women with infants should not work full-time. Over 50% of this group took time off from work, turned down promotions, worked part-time, or changed locations because of family.

A longitudinal study conducted by Farmer (1997) found similar results. Farmer (1997) conducted a mixed methods study that focused on students’ STEM career choices beginning in
high school and then ten years later. Students \((n = 1863)\) were surveyed during high school. Ten years later, 459 of the original sample responded to a follow-up survey. Of these respondents, 105 were interviewed (57 were women and 48 men). Half of these individuals had stayed in their STEM field and half had left. Farmer found that the predictors of persistence were the same for men and women; however, the strengths of these predictors were different. In Farmer’s study, women tended to choose less prestigious science and math occupations than they had originally predicted in high school. (The term \textit{less prestigious} was used by Farmer and referred to choices such as nursing or physical therapy instead of medicine.) During the high school survey, similar numbers of men and women aspired to STEM career aspirations. However, the author found that 46\% of the women in the study (compared to 4\% of the men) chose less prestigious fields such as nursing and health technician. Only 3\% of these women (compared to 35\% of the men) chose the more prestigious field of engineering and only 5\% of the women became physicians compared to 12\% of the men (Farmer, 1997).

During the interview portion of the study, Farmer (1997) found that many of the women who chose nursing said they had done so because of the high degree of flexibility. Most of them reported that their goal of marriage and family made these factors more important than their actual interest in or personality fit to the career. Men were less likely to emphasize family plans over their career, which was a finding that has been supported in other studies as well (Bianchini et al., 2000; Jorgenson, 2002).

The studies in this section have highlighted the factors that influence STEM career choices at the elementary, middle or high school, and college phases. Women appear to have fewer role models in STEM fields and less support from socializers (Carlone, 2004; Dick & Rallis, 1991; Rayman & Brett, 1995; Seymour & Hewitt, 1997). Women tend to have less practice with science tools and language, which can put them at a disadvantage in the competitive college environment (Burkam et al., 1997; Jones et al., 2000; Seymour & Hewitt, 1997). Gender stereotypes portraying men as more suited for science fields such as physics and engineering also can discourage women from pursuing these fields (Brickhouse & Potter, 2001; Carlone, 2004; Ferenga & Joyce, 1998; Losh et al., 2007; Olitsky, 2006; Ong, 2005; Seymour & Hewitt, 1997). And finally, the concern that science careers will force women to make a decision between career and family also affects their decisions to pursue STEM careers (Farmer, 1997; Rayman & Brett, 1995). And yet, not all women follow the same path to their STEM career.
choice. Because each woman has a unique life history, policy initiatives can have varying effects, as the next section will address. This final section highlights studies on specific women-only STEM living and learning programs.

Review of Programs

Women-only STEM LLCs are one of the newest policy initiatives aimed at increasing women’s retention in STEM fields. Consequently, there are few studies of these programs. This section provides a review of five. These studies are divided into a national comparative study (Inkelas et al., 2007) and individual program studies. Each of the studies highlights one or multiple college-level women-only STEM LLCs. The studies look at the effects of these programs on women’s interest and grades in STEM fields during their college years. The review of these studies serves a secondary purpose of highlighting the methodologies that each study utilized and how these methodologies affected the methodological choices for this study.

National Study

Inkelas et al. (2007) conducted the first national study of women-only STEM LLCs. The results of the study came from surveys that were sent to forty universities in 2004 and 2007. The researchers collected survey data from 22,519 student respondents. The colleges and universities chosen represented a variation of institutions in each of the Carnegie Foundation Classification systems. The comparison of the survey responses showed mixed results regarding the effects of LLCs on women’s persistence in STEM fields. The results suggested that parents had the most influence on all women’s choices of majors, which supports the findings in the studies of both secondary school students and undergraduate students (Brickhouse & Potter, 2001; Farmer,

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11 The most recent Carnegie classification has 17 categories of undergraduate institutions ranging from associate’s to research universities. For a full list, please reference the Carnegie Foundation website.
The women in the STEM LLCs had fewer interactions with faculty than the other groups, despite this being a goal of the individuals within these STEM LLCs. This result could have been because the women who lived together were able to help each other with academic questions and therefore did not need to interact with faculty as often (Inkelas et al., 2007).

There appeared to be some positive effects of women-only and coeducational STEM LLC programs on women's confidence in STEM fields. Participants in women-only STEM LLC programs had higher confidence in their engineering abilities and had the highest intention to pursue research internships and leadership positions on campus. Inkelas et al. (2007) stated that their results could indicate self-selection issues that occur when comparing individuals who participate in LLCs because these individuals chose to participate. This could bias their opinions about the positive effects of the program.

One limitation to this study, like many of the studies on LLCs, was that the participants were all underclassmen, with the majority being first-year students (Inkelas et al., 2007). These young people have not had enough time to see the results of their participation in the program. Second, this study raised the issue that it might not be the program that causes positive effects like higher confidence, but the type of individual who gravitates toward it. These limitations are addressed in my study and discussed in Chapter 4.

Individual Programs

After reviewing the literature on women-only STEM LLCs, only four studies were found. Each of the studies focused on an individual women-only STEM LLC. The first of the studies was by Brainard and Carlin (1998). This study was a longitudinal project on the Women in Engineering (WIE) program at the University of Washington. The WIE program is a living and learning program wherein students were provided mentoring opportunities with professional scientists working in each student’s fields of interest. For the study, Brainard and Carlin interviewed and surveyed students each year they were at the university. Students were first interviewed during the first semester of their freshmen year. A follow-up interview was conducted either by phone or in person during the second semester of the freshmen year. Each following academic year, participating students completed surveys. The authors reported the
following sample: 488 freshmen, 218 sophomores, 88 juniors, 100 seniors, and 16 fifth-year students.

The factors that affected retention changed slightly from year to year (Brainard & Carlin, 1998). Students’ reactions to these factors determined whether they stayed or left their STEM major. Freshmen and sophomores discussed a lack of confidence and fear of not being accepted into their desired departments as a factor that caused them to question their choice of majors. Sophomores, juniors, and seniors all discussed a feeling of isolation. All seniors reported experiencing some form or type of barrier to their retention. The barriers mentioned the most were poor teaching, loss of confidence due to poor grades, and unapproachable faculty, which were similar to the results of Seymour and Hewitt’s study (1997). Brainard and Carlin’s study highlighted the importance of focusing on upper classman because they have had more experiences and more time to reflect on these experiences.

Like other studies (Farmer, 1997; Rayman & Brett, 1995; Seymour & Hewitt, 1997), Brainard and Carlin (1998) found no significant difference between the performance levels of stayers and leavers. However, they did find that leavers had lower self-confidence in their math and science abilities than stayers, despite there being no difference in their actual grades. This finding underscored the influence of identity and self-confidence on women’s interests and choices regarding STEM majors.

Brainard and Carlin’s (1998) study also highlighted the unique policies within the university that can affect students’ retention. The University of Washington had a unique situation in that the school did not accept students into their majors until their junior year. The authors found that the critical period to influence retention rates at the University of Washington occurred during the first two years of college due to loss of interest, attraction to another field, or loss of confidence. But the first two years were also when students were unsure whether they would be accepted into their programs of study. In this particular program, the university’s policies played a role in influencing the retention rates. One shortcoming of the study was the lack of understanding regarding how these processes occur, which could improve the strategies and effects of LLC programs.

Allen (1999) compared women from the women-only STEM LLC (WISE-RP) program at the University of Wisconsin, Madison, to female students from the general population. In addition to living on the same floor together as a way to provide networking opportunities, the
LLC program included guest speakers and bonding events chosen by the program directors. These women also participated in a single-gender chemistry course during their freshmen year. WISE-RP, at the time of the study, did not receive any funds from the university; instead they received financial support from a private organization.

Like other research, Allen (1999) identified the reasons for the lower numbers of women in science as isolation, lack of female role models, chilly classroom climate, and low self-confidence (Seymour & Hewitt, 1997; Shakeshaft, 1995). These issues were explored in a survey instrument. WISE-RP participants were asked about their expectations and whether those expectations were met. Allen also administered a 31-item survey to freshmen in multiple residence halls on campus, including WISE-RP. Allen used these survey responses to compare participants in the WISE-RP program who were in their third year of school ($n = 166$) to women in their third year ($n = 126$) in coeducational residence halls who were taking math and science courses. She saw these courses as an indicator of prospective science majors. The two groups’ responses were analyzed using a Pearson chi-square test and analysis of covariance.

The results indicated that WISE-RP students had better average high school ACT scores and better average first-semester college grades than the control group (Allen, 1999). Both groups indicated that they spent the same amount of time studying each week. WISE-RP students who took the single-gender chemistry class had higher average grades than the control group. WISE-RP students had a higher level of satisfaction with college and were less likely to indicate a sense of loneliness or isolation. Results from both a Likert-type survey and an open-ended survey indicated that the women in WISE-RP felt a better sense of community, including the ability to study together and regarding the discussion of academics, than those students from the general population. The shortcoming to this study was that the use of surveys did not allow the author to follow up with the women from the general population to understand how they persisted without this sense of community.

Kahveci, Southerland, and Gilmer (2006) compared thirty five freshmen participants in an all-female science LLC (PWISEM) to thirty four male and twenty nine female students from the general population enrolled in honors general chemistry at a large university in the southeastern United States. The women from PWISEM had to indicate an interest in a science or engineering major to be accepted into the program. The groups were compared via a pretest administered during the first two weeks of their freshmen semester and a posttest administered at
the end of the second semester. Both tests measured interest and confidence in science, determination to pursue a science major, views of science and scientists, interest and understanding of science technology, GPAs, and intended major.

Kahveci et al. (2006) found that all three groups had similar GPA scores and the same level of interest and confidence in science on the pre-and posttest. Like Brainard and Carlin (1998), Kahveci et al. found that all groups had a slight decrease in their interest and confidence levels from the pretest to the posttest. However, the results of the posttest indicated that significantly more PWISEM students remained in a STEM major than either of the other groups. The largest percentage of leavers occurred in the female general chemistry group. This finding supported the results of Allen’s (1999) study.

Kahveci et al. (2006) showed that students in the single-gender science LLC had better retention rates\(^\text{12}\) than those students from the general population. Second, the study indicated that women who did not participate in PWISEM had a higher likelihood of leaving STEM fields altogether. Yet, the authors were not able to fully show why or how this difference in retention rates occurred.

Kahveci, Southerland, and Gilmer (2007) published a study on the qualitative portion of their previous quantitative study (Kahveci et al., 2006). In the later study (Kahveci et al., 2007), the authors conducted a two and a half year case study on women who had participated in PWISEM. The authors surveyed all participants in the program and then focused on three cases. The three women chosen were interviewed during their freshmen and sophomore years. All members of PWISEM lived together in a dorm as freshmen and attended a colloquium series throughout the semester during which they would meet members of the science community. The first-year students reported that they enjoyed the program and would do it again if given the opportunity (Kahveci et al., 2007). They felt that it was influential in their decision to continue their major. The participants claimed that one important factor was that they saw how women in the science community balanced their personal and professional lives. Also, the first-year members were able to share both their academic and their social lives by living together.

Like Farmer’s (1997) study, the interviews in Kahveci et al.’s study (2007) revealed that participants identified the difficulty of being a female in a male-dominated field. The three women described the benefits of the sense of community and support they received from their

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\(^{12}\) Retention rates refer to the number of individuals still in the STEM major at the conclusion of the course.
experience in PWISEM. These young women highlighted the positive role of the peer leaders, who were upperclassmen who had participated in PWISEM and volunteered to live on the floor to provide mentoring to the first-year students. The support from the older, experienced peers was credited as keeping the three women in the program. Kahveci et al. (2007) indicated the importance of socialization on women’s choices to remain in STEM fields and showed how the PWISEM program was different from other single gender LLC programs. These differences can influence the effects of each program on the participants’ STEM major decisions. And finally, this study reveals the importance of interviews for learning more information from the participants.

These studies illustrated the positive influences of women-only STEM LLCs; however, they do have some limitations. First, Allen (1999) and both of Kahveci et al.’s studies (2006, 2007) only focused on underclassmen. Studies have shown that retention rates of female STEM majors tend to decrease later in college after they have been exposed to both the chilly climate and the effects of the weed-out system (Leggon, 2006; Seymour & Hewitt, 1997). Brainard and Carlin (1998) make the point that upperclassmen were better prepared and had more experiences from which to draw on to discuss barriers and their choices regarding STEM majors. During the first two years of college, women would not have been exposed to many STEM classes or to the culture of their particular STEM field. Their decisions regarding intended majors would be based on one year or one semester of classes. Second, most of these studies focused on survey results (Allen, 1999; Brainard & Carlin, 1998; Kahveci et al., 2006) or a limited number of cases (Kahveci et al., 2007). Previous studies have shown how important interviews can be in understanding participants’ rationale for STEM career decisions (Bianichini et al., 2000; Farmer, 1997). In these studies, interviews provided more information regarding participants’ perceptions and rationalization for career decisions than surveys alone.

**Conclusion**

This chapter has highlighted the historical marginalization, denied access, and overt and subtle discrimination that women have experienced in STEM fields. The policy response to this discrimination showed the unintended consequences that resulted in changes to Title IX. This policy environment provides the context for colleges’ and universities’ current program response
aimed at increasing the number of women in science. However, programs can be ineffective if they do not address the individual influences that affect women’s STEM career choices.

Career choice is affected by experiences at each phase of a person’s educational path. These influences for women include stereotypes regarding gender appropriate roles, the role of socializers, lack of practice or preparation, lack of role models, and a chilly academic climate. Programs such as women-only STEM LLCs attempt to support women’s interest and persistence in STEM fields by providing a community of women interested in science, opportunities for these college students to interact with practicing scientists, tutoring in STEM-related classes, and awareness of gender barriers.

The studies of particular women-only STEM LLCs provide evidence for the benefits of these programs. However, these studies ignore the unique path each woman has to her ultimate decision to remain in or leave STEM fields. Women’s unique life histories can affect how they interpret experiences, including policies and programs aimed to improve persistence. The focus on individuals and the influences that affect their STEM career decisions affected my choice of a conceptual framework. This is described in the next chapter.
CHAPTER 3

CONCEPTUAL FRAMEWORK

As the previous chapters have discussed, there are many influences that affect women’s STEM career choices. One of the most prominent influences is gender. As early as preschool, young children begin to develop gender stereotypes (Thorne, 2007; VanAusdale & Feagin, 2007). These stereotypes continue into adolescence, where they are supported or challenged by socializers and experiences (Carlone, 2004; Jones et al., 2000). For women, the historical marginalization of females in STEM fields adds to the gender stereotypes that often prevent them from persisting in STEM careers (McGrayne, 2005; Wertheim, 2006).

As women progress through their life phases (childhood, elementary school, secondary school, and college), their conception of gender is molded by their own experiences. This conception influences women’s identity and the type of career they will choose. If one’s perception of STEM fields conflicts with one’s perceived idea of appropriate gender roles, then he or she might not participate in them. Therefore, it is important that the conceptual framework of this study incorporate the influences that affect individual women’s decisions at each life phase, including gender. This chapter provides a detailed explanation of the conceptual framework that guided this study.

Gender

Women are lost in STEM fields at every transition in their educational journey in significantly larger numbers than their male peers (National Academies Press, 2007). Part of the reason for this loss is gender, particularly gender stereotypes. Feminist theorists contend that the underrepresentation is not simply a historical lack of access but a result of ingrained cultural and social stereotypes that prevent women from pursuing or persisting in STEM fields (T. H. Anderson, 1995; Bianchini et al., 2000; Harding, 1997; Rosser, 2003; Wertheim, 2006). The sociocultural stereotype of scientists as masculine and male gender bias in science instruction and tools contributes to the marginalization of females (Carlone, 2004; Lemke, 2001; Shakeshaft, 1995). However, not all feminist theorists agree on the meaning of gender.
Therefore, this section identifies the definition of gender for this study and the role it has in the subsequent research.

Gender is a complex concept that entails social construction as well as biological manifestation. It is also a concept used to establish differences between groups: masculine versus feminine. Many feminists argue that power is inherent within the concept of gender since feminine is typically defined in opposition to masculine, the stronger of the two (Butler, 1999; P. H. Collins, 1998; DeBeauvoir, 2006). This argument is reminiscent of Pythagoras’s view that men were more rational and women possessed the more inferior emotional characteristic (Wertheim, 2006). Consequently, the two concepts are typically seen in opposition. Individuals often internalize the resulting stereotypes, which creates tensions in other aspects of their lives, like STEM career choice.

Throughout the latter part of the 20th century, feminists stressed the need for equal access for women in STEM fields (Wertheim, 2006; Wyer, 2001). As a result, many programs and policy initiatives have attempted to increase access for women to STEM fields as a way to promote women’s interest and persistence. However, simply opening STEM majors to allow more women in has not addressed the underlying masculine connotation of science that continues to prevent women from persisting in certain STEM fields such as physics and engineering (Wyer, 2001). Current feminist scholars contend that simply opening access to women enforces the idea that women must conform and take on the dominant androgynous or male traits to be accepted (Harding, 1997; Lorde, 2006; Wyer, 2001).

The conformity that women exhibit in science requires them to hide their feminine traits. P. H. Collins (1998) used the term “double consciousness” (p. 15) to describe this feeling wherein a person must negotiate between different personalities that fit in particular instances. In the case of women in STEM fields, some might have an androgynous personality at work to fit in with their male peers and another personality at home or in their community to fit in with society’s expectations of their gender.

There have been two major feminist reactions to the idea that women must exhibit an androgynous personality (and resulting masculine conformity) to be accepted in STEM fields. The first is feminist standpoint theory. According to feminist standpoint theory, each individual’s perceptions of an event, person, or picture are based on his or her own unique experience (Gilligan, 2006; Harding, 1986, 1997). This theory has often been used to argue for increased
access for women in STEM fields. Because women have unique experiences different from men that create “distinctively gendered standpoints on nature” (Harding, 1997, p. 187), they can provide alternate solutions or ideas that can benefit the entire field.

One of the prominent proponents of this theory, Harding (1986) made three arguments regarding the importance of using feminist standpoint theory in the context of science. First, she contended that “women as a social group are more likely than men as a social group to select problems for inquiry that do not distort human social experience” (p. 162). Second, she asserted that because women have been in the unique position of being marginalized in science, they can better recognize bias and are therefore in a better position to eliminate this bias. Finally, she argued that science is often politically motivated by those in the majority in the science community. As a result, women and women’s issues (i.e., pregnancy, differences in body shape that affect how equipment, like seat belts, affects women and men) have historically been ignored by male scientists.

Feminist standpoint theory raises some key issues regarding the role of gender in STEM fields; however, it has also been criticized by other feminist scholars (Butler, 1999; Lorde, 2006). For instance, some scholars argued that feminist standpoint theory reinforces the gendered stereotype of certain fields. If women’s unique viewpoint is related to children and giving birth, as Harding (1986, 1997) often posited, then women will congregate to science fields that specialize in those areas, (i.e., gynecology and pediatrics). Also, Harding (1997) seemed to counter her own argument by listing areas where women would be better or more understanding than men (i.e., pacifism over military or industrial sciences). These comments indicate a high level of stereotyping regarding women’s behavior and interests. Harding’s (1986, 1997) argument that women would be better than male scientists at understanding nature and social life could create two gendered types of science, which could simply continue the underrepresentation of women in male-dominated fields rather than address it.

Despite these shortcomings, feminist standpoint theory does offer an explanation of the inadequacies of simply opening access for women. This theory recognizes that women have a unique viewpoint compared to men that affects how they perceive and relate to science concepts. However, the theory indicates that all women share a common viewpoint because of their gender, which is not the case, especially regarding STEM career decisions. Because each person
has unique experiences that lead to unique perceptions of gender and identity, each person also
has a unique path to his or her career decision.

The feminist theorist, Judith Butler, best articulated this concept of unique experiences
that are affected by gender. Butler (1999) questioned the definition and understanding of gender
as a “natural fact” versus a “cultural performance” (p. xxviii). She defined gender as a discursive
formation shaped by the culture that creates it, specifically the male-dominated system. There
may be no institutions or fields where this male dominance has been more prominent historically
than in STEM (McGrayne, 2005).

Butler (1999) denied the existence of categories in her theory of gender. For Butler,
woman is “a term in process, a becoming, a constructing that cannot rightfully be said to
originate or to end. [It is] an ongoing discursive practice” (p. 43). According to Butler, there is
no common female or woman identity that all women share. Identity is a discursive process in
which it “becomes impossible to separate our gender from the political and cultural intersections
in which it is invariably produced and maintained” (p. 6). Butler considered terms like gender to
be categories imposed to create a sense of nonexistent solidarity, a category of woman which is
simply filled with other aspects of race, class, age, ethnicity, and sexuality (p. 21).

Butler (1999) admitted that individuals have agency in the process of identity
construction; however, she questioned how much of this identity construction is purely chosen
by the individual rather than influenced by cultural norms. Butler further explained that this
cultural understanding of gender is a “shifting and contextual phenomenon” (p. 15), meaning it is
unique to a particular time and place, which can change. Therefore, gender and identity can
change over time within individuals.

Based on this conception of gender, it becomes necessary to study individuals’ life
histories as they relate to STEM college major and career choices. Butler’s (1999) definition of
gender stressed that individuals have their own understanding of gender and that this
understanding will evolve over the course of their life. Therefore, the best way to understand
STEM career choice, a decision process that is highly influenced by gender, is to understand
participants’ conception of gender over their lifetime. I drew on Butler’s conception of gender to
understand how each individual’s perception of gender affected their STEM college and career
choices.
Career Choice

Although Butler’s theory provides a conception of gender, it does not account for career choice\(^\text{13}\). A theory that describes the many influences that affect women’s STEM career choice is Eccles’s (1994, 2007) expectancy-value model. According to Eccles (1994), career choices are influenced by a number of cultural and individual concepts. The cultural concepts include the influence of gender role and cultural stereotypes, socializers’ (parents, peers, and teachers) influence, and achievement and abilities in science and math. Eccles (1994) also identified individual concepts, including an individual’s interpretations of these cultural experiences. For example, a child might interpret a parents’ lack of support for his or her STEM interest as an indication of poor abilities or as a reason not to pursue the field if the child is trying to gain the parents’ approval. Therefore, these interpretations can help to shape an individual’s goals and decisions. As children develop, they witness and often internalize the stereotypes around them. Children will also begin to measure and evaluate their own achievement and abilities based on others around them. These factors influence an individual’s perception of gender and cultural stereotypes (Eccles, 1994). (See Figure 3.1).

Figure 3.1: Eccles’s expectancy-value model for career choice (Eccles, 1994, p. 588).

\(^{13}\) Career choice is a reference to the careers that each of my participants planned to join after college graduation.
These cultural influences, combined with the individual’s perceptions and experiences, culminate in the final two parts of the expectancy-value model: expectation of success and the value a person attaches to this success (Eccles, 1994, 2007). According to Eccles, one’s expectation of success is influenced by one’s confidence in his or her abilities. This confidence level is also affected by the estimated difficulty of the tasks required for a STEM career. An individual’s beliefs regarding his or her abilities are influenced by that individual’s performance in science and math courses and by the support he or she receives from socializers (Carlone, 2004; Rayman & Brett, 1995). Even if a person expects to be successful in a career, that person might not choose that career because of the low value he or she places on this success. Eccles (2007) identified four types of value that each individual assesses to make a career choice. The subjective task values are categorized as attainment value, intrinsic value, utility value, and cost. Attainment value indicates how well the career fits in with one’s identity. Intrinsic value is the interest or enjoyment derived from a career. Utility value indicates how well the career fits in with current and future goals. And finally, cost refers to the negative aspects that might be perceived to be associated with the career (Eccles, 2007). Both the expectation of success and the value one places on a particular career are unique to that individual and depend on the individual’s experiences and the individual’s own interpretation of those experiences. This model complements Butler’s (1999) view, which highlights the unique role that gender plays in each individual’s decisions.

There are two shortcomings of Eccles’s (1994) model in the context of this study. First, Eccles’s model has been used mainly in quantitative research (typically surveys). As explained in Chapter 2, surveys often do not provide the full picture of a phenomenon (Farmer, 1997). For example, the interviews in Farmer’s study provided information that was not apparent in the surveys and in some cases contradicted the surveys. Farmer concluded that the interviews provided a fuller picture of the participants’ career decisions. The second shortcoming with Eccles’s (2007) model is that it does not focus on the concept of gender, which many women cite as a source of marginalization within the science community. Butler’s (1999) conception of gender addresses the weaknesses in Eccles’s theory. The combined framework provides a way to recognize that the process of STEM career choice for each woman is uniquely different. Each pathway can be affected by the categories mentioned in Eccles’s (1994, 2007) model. Because
Eccles’s (1994, 2007) model is general, the integration of gender provides a deeper understanding of the unique experiences each woman undergoes in her eventual career decision.

**Conclusion**

Both the literature review and the conceptual framework for this study highlight the multiple and varied factors that affect women’s decisions regarding STEM career choices. The factors change over time and differ by individual. To understand these influences, one must highlight the different pathways to the eventual STEM career choice. And yet, policy and program responses to women’s persistence do not take these individual pathways into consideration. These programs assume that all women have similar gendered experiences with STEM fields that can simply be addressed by providing women access to these fields. Therefore, it is important to identify what role these access programs have on women’s STEM career decisions when each woman’s uniquely different path is recognized. This study is one of the first to recognize these unique paths and to determine how a one-size-fits-all program affects women’s STEM career choices. In the next chapter, the methodology will be described. This methodology was chosen because it best utilizes the conceptual framework by addressing the unique paths that lead to women’s STEM career decisions and the role that one particular single gender program has on these decisions.
CHAPTER 4

METHODOLOGY, PROGRAM DESCRIPTION, DATA COLLECTION, AND ANALYSIS

The previous chapters have identified the need for a better understanding of the factors that influence women’s STEM career decisions at the college level. These career decisions are a personal choice that individuals weigh according to their expectations of success and the value that success has in their lives. Women’s STEM decisions also involve unique factors as a result of their gender, including lack of practice (Burkam et al., 1997; Jones et al., 2000; Seymour & Hewitt, 1997), a chilly academic climate (Bianchini et al., 2000; Carlone, 2004; Ong, 2005; Seymour & Hewitt, 1997), and gender stereotypes enforcing the masculine nature of many STEM fields (AAUW, 2010; Brickhouse & Potter, 2001; Losh et al., 2007; Olitsky, 2007). These factors have an effect on the results of current policies aimed at improving the underrepresentation of women in STEM fields.

Although previous studies have focused on this issue, there are some shortcomings that this study addresses. Some studies have only focused on freshmen and sophomores (Allen, 1999; Kahveci et al., 2006, 2007). These young women have not had time to reflect on the effects of their life experiences on their career decisions (Seymour & Hewitt, 1997). Consequently, this study focuses on female college seniors who entered State University\(^\text{14}\) with a declared STEM major in 2006 and graduated in the spring/summer of 2010. These women were at the point in their lives where they were making their career decisions, could better articulate this process and had time to see the effects of WSTEM and the culture of their particular major on their interest and persistence in STEM majors.

Other studies have relied on survey data (Brainard & Carlin, 1998; Dick & Rallis, 1991; Eccles, 1994; Rayman & Brett, 1995), which do not allow women to fully describe how their experiences have affected their major or career decisions. Studies that have utilized interview data have shown that this method allowed participants to describe their experiences in their own words, which provided a better understanding of STEM career decisions (Farmer, 1997; Ong,

\(^{14}\) State University is the pseudonym for the university where this study took place.
Consequently, this study used interviews as a method to best study the factors that lead women to remain in or leave STEM majors (and eventually careers). (For the remainder of this study, majors will also infer careers.) Some studies on women-only STEM LLCs have identified self-selection issues that could bias the results (Brainard & Carlin, 1998; Inkelas et al., 2007). In these studies, the authors could not explain whether the positive effects cited by the participants were caused by the program or simply the personality of those students who chose to join the women-only STEM LLC. To address this limitation, this study compares the interviews of those who participated in a women-only STEM LLC to those women who did not. This comparison helped to determine if there were any similarities among the WSTEM women that could lead to self-selection issues.

Most of the previous studies also ignored how each woman perceives her gender and how this affects STEM career decisions. The conceptual framework for this study accounts for the role of gender in women’s career decisions along with their expectations for success and the corresponding value they place on these careers. By combining Eccles’ model for career choice with Butler’s (1999) conception of gender, this study provides a more comprehensive insight into the thought processes and the influences that affect women’s decisions regarding STEM fields.

Summary of Purpose, Sample, and Research Questions

The purpose of this study is to understand how individual female college seniors make their career decisions regarding STEM fields and how single-gender programs can impact these decisions. Twenty-six college seniors participated in this study. All the women were declared STEM majors when they entered State University as first-year college students in fall 2006. All the women were also recipients of the state’s merit-based scholarship, which covers 75 to 100% of tuition each semester. The award is based on high school students’ GPAs (3.0-3.5 for 75% scholarship and 3.6 or above for 100%) and SAT scores (970 for 75% scholarship and 1270 for 100%). Students who receive this scholarship must maintain a specific college GPA (2.75 for 75% scholarship and 3.0 for 100% scholarship) and 12 credit hours per semester (State merit based scholarship website). Because all the participants received merit-based scholarships, it makes the comparison samples similar in that both the WSTEM participants and the non-WSTEM participants had similar high school GPAs and SAT scores. Both the leavers and the
By comparing the narrative life histories of twelve seniors who participated in a women-only STEM LLC (WSTEM) at a large southeastern university to fourteen women in their fourth year of the university from the general university population (GP), this study identified the effects of a prominent policy initiative: women-only STEM LLCs. Each of these cohorts (WSTEM and the GP) included women who stayed in their STEM major and planned to pursue a STEM career and women who chose a non-STEM major. The questions examined are as follows:

1. What influenced women who were interested in STEM fields as freshmen to stay or leave these fields?
2. How did participation in a single-gender living and learning STEM program affect women’s decisions to persist in or leave STEM majors and fields?

**General Rationale for Methods**

To explore these research questions, I chose to use qualitative methods. Women’s career decisions are the result of social experiences and influences that occur throughout their lives. Qualitative studies seek to answer “questions that stress how social experience is created and given meaning” (Denzin & Lincoln, 1998, p. 8) by focusing on the process or the how. According to Denzin and Lincoln (1998), “Every qualitative study involves the intersection of public and private lives and biographies” (p. xviii). In this study, I recognized that each individual had a unique set of experiences, which ultimately affected their STEM career decisions; therefore, it was also necessary to have them describe their own story via biographical methods.

According to Creswell (1998), biographies must be written within the broader context of the individual, their life, and the organizations and institutions they participate in. Consequently, this method requires a broad and clear understanding of the “historical, contextual material to position the subject within the larger trends in society or in the culture” (Creswell, 1998, p. 51). This stipulation is important, because each individual’s life does not occur in a vacuum. The conceptual framework identified the influence of socializers and the experiences that have affected women’s STEM career decisions in past research. For this framework, a more specific type of the biographical method known as narrative life history was used, because of its
emphasis on the individual’s life story. The use of narrative life history allowed each person to describe how they internalized and perceived influences throughout their lives as they related to their STEM career choices. Narrative life history allowed the participants to move beyond descriptions of the surface level of everyday activities that a person performs and uncover the deeper level of motivations that led them to participate in STEM. This method also allowed the participants to voice their own interpretations and how these combined to affect their STEM career choices (Denzin, 1989).

In the following section, I describe the broader context in which this study took place, including the global and national climate, the state context, a description of the university context, and a description of the women-only STEM LLC that was part of this study. Then I describe the categories of participants interviewed. Finally I outline the data collection methods and analysis methods used to answer the research questions.

**Descriptions**

**General Context**

Creswell (1998) said that authors must situate the reader in the “historical, contextual material to position the subject within the larger trends in society or in the culture” (p. 51). Because the focus of this study is on undergraduate women who began their college education in the fall of 2006 and graduated in the spring/summer of 2010, it is important to discuss the broader social and political contexts that were occurring during these years. The participants in this study mentioned the influence of two different aspects on their persistence in STEM fields: STEM role models and political role models. Both of these areas remain dominated by men, and yet both saw improvements for women during this time period.

**Gender.** Globally, in 2009, three women were awarded Nobel Prizes in STEM fields, which was the highest number of women to win Nobel Prizes in 1 year\(^\text{15}\). Drs. Carol Greider and Elizabeth Blackburn were awarded the Nobel Prize in physiology/medicine with their colleague Jack Szostak. They won the award “for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase” (Nobel Prize in Medicine, 2010). Ada Yonath shared the chemistry Nobel Prize with her male colleagues “for studies of the structure and function of the

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\(^{15}\) Before 2009, no more than one woman had ever won a STEM Nobel Prize in 1 year.
riboseome” (Nobel Prize in Chemistry, 2010). These three women joined the eleven other females awarded STEM Nobel Prizes since the award was founded (Women Nobel Laureates, 2010).

In national politics, two women were in prominent positions for the 2008 U.S. presidential election, a political race that had only once before, in the 20th century, had a prominent female party candidate. In 2008, Hillary Rodham Clinton ran for the Democratic candidate for president and Sarah Palin was selected as the vice presidential candidate on the Republican ticket. Despite neither of these women gaining access to the presidency, it marked the first time in U.S. history that two women were so close to the office of the president and the vice president of the United States (Sanchez, 2009). Also in 2009, President Obama nominated the third woman in history to the U.S. Supreme Court. The swearing in of Justice Sonia Sotomayor in August 2009 marked another historic occasion for women in the male-dominated Supreme Court. The participants in the study mentioned all three women as role models.

The accomplishments listed above showed that women were making strides in fields previously dominated by men. These individuals were mentioned here because the participants in this study mentioned them as role models or examples of women overcoming barriers. Their accomplishments also highlight that barriers still exist. Both Clinton and Palin dealt with sexist criticism and comments during their campaigns (Sanchez, 2009). Justice Sotomayor experienced criticisms and doubts from the media based on her ethnicity and background (Sanchez, 2009). Feminists and some pundits argued that these women were being judged differently because of their gender.

One of the American Nobel Prize winning female scientists, Carol Grieder, discussed the barriers that she has experienced in her own career. In a New York Times article she explained,

I think there’s a slight bias of women to work for women because there’s still a slight cultural bias for men to help men. The derogatory term is the “old boys’ network.” It’s not that they are biased against women or want to hurt them. They just don’t think of them. And they often feel more comfortable promoting their male colleagues. (Driefus, 2009, para. 17)

The most striking part of Grieder’s comment was the concept that men “just don’t think” of women for positions. This subtle comment highlighted a perception found in the literature regarding the chilly climate and sense of isolation that women have experienced in STEM fields (Ong, 2005; Shakeshaft, 1995). Grieder’s comment provided qualitative evidence to support the
current statistics on the underrepresentation of women in STEM majors and particularly careers (National Science Board, 2008).

**Economic.** Another global and national issue that occurred at the time of this research was a recession that hit many countries, including the United States, and led to record highs in unemployment for all age levels (Norris, 2009). The unemployment rates affected the participants in this study. First, five of the participants noted that one or both of their parents had been laid off during this time. Second, all the students were worried about the job market and what jobs would be available to them upon graduation. All the women discussed funds being limited, which affected the amount of money they had to pay for their undergraduate degree and, for many of them, their graduate degree. Therefore, the recession played a role in the value participants’ placed on the time and money required for a STEM career and whether this resulting career was worth the cost, as Eccles (2007) mentioned in her expectancy-value model for career choice.

The recession also affected the participants on a state and local level. The state where this study took place had an unemployment rate higher than the national average (Harrington, 2009). State University, where this study occurred, declared plans to lay off up to 200 faculty and staff members in 2009 and increased tuition for the 2009-2010 school year (N. Johnson, Oliff, & Williams, 2009). The discussion of the planned layoffs affected some of the participants in this study, in that mentors and professors were leaving the university. Again, this local and state context affected students’ perception of STEM careers since their experience at SU made careers at the university level appear less stable than these individuals had previously believed.

**State University**

As the literature review on women-only STEM LLCs revealed, each program was uniquely affected by the culture of the university where it resided. State University is a large Research 1 University in the southeastern United States with a population of approximately 40,000 students from 2006 to 2010, the period when this study took place. In 2008, 76% of the enrolled students were undergraduates. Most of these students were in-state residents (80%), which further established how the participants in this study were affected by the recession within the state. During the period of this study, STEM majors comprised 15% of the total
undergraduate enrollment, and women represented less than one third of these students (Vice President of Undergraduate Affairs at State University, personal communication, November, 1, 2009). The STEM persistence rate for women who entered State University in the fall of 2006 and graduated in the spring/summer of 2010 was 50%, where 613 women enrolled as STEM majors as freshmen in 2006 and 309 remained in STEM majors (Vice President of Undergraduate Affairs at State University, personal communication, August 31, 2009).

The number of female faculty in each of the STEM departments at State University\(^{16}\) for the 2009-2010 school year matched the national averages of female faculty in STEM departments as calculated by the NSF (2007). (See Table 4.1 for the total numbers and percentages of female faculty at State University by department.) Similar to national statistics, the department with the highest representation of female faculty was Biology with 29% women (NSF, 2007). The lowest number of female faculty at State University were in the electrical and computer engineering department, where there was only one female faculty member out of 20. This department was closely followed by the Physics Department (7%) and the Chemical and Biomedical Engineering Department (7%). State University is an adequate representation for the national issues of women’s underrepresentation in STEM fields, because it mirrored national statistics for female faculty percentages. None of these percentages matched Madill et al.’s (2007) definition of critical mass, which was 30%. Researchers have cited this need for a critical mass as a way to improve women’s retention in STEM fields (Rosser, 2003; Seymour & Hewitt, 1997).

**WSTEM Program**

One of the goals of this study was to identify whether a particular women-only STEM program affected women’s STEM career decisions. The program, Women in Science, Technology, Engineering, and Mathematics (WSTEM) began in 2000 at State University with an average of 36 participants per year. Since 2000, the stated mission of the program has been to increase the retention of women in STEM fields. I focused on a cohort of WSTEM participants who entered State University during the fall of 2006, at which point the WSTEM program had been in existence for six years, which ensured that the program had reached a point where the experiences provided from one year to another were similar and had been evaluated by the

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\(^{16}\) The only year this information was available.
program director. This evaluation process ensured the program activities that remained from year to year were the most influential and successful for participants’ persistence in STEM fields based on six years of program evaluation.

Table 4.1: Female Faculty at State University during the 2009-2010 school year as provided by department websites.

<table>
<thead>
<tr>
<th>2009-2010 Departments</th>
<th>Number of Full Time Female Faculty</th>
<th>Number of Total Faculty</th>
<th>% of women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Sciences</td>
<td>15</td>
<td>51</td>
<td>29</td>
</tr>
<tr>
<td>Chemical Sciences</td>
<td>5</td>
<td>38</td>
<td>13</td>
</tr>
<tr>
<td>Geological Sciences</td>
<td>2</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Mathematics</td>
<td>9</td>
<td>49</td>
<td>18</td>
</tr>
<tr>
<td>Meteorology</td>
<td>3</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Physics</td>
<td>3</td>
<td>45</td>
<td>7</td>
</tr>
<tr>
<td>Chemical and Biomedical Engineering</td>
<td>1</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Civil and Environmental Engineering</td>
<td>3</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>Electrical and Computer Engineering</td>
<td>1</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Industrial and Manufacturing Engineering</td>
<td>2</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>2</td>
<td>24</td>
<td>8</td>
</tr>
</tbody>
</table>

WSTEM, like other women-only STEM LLCs, was a program where college women who are typically freshmen live together with other women who have declared a STEM major. Acceptance into this program was based on each individual’s expressed interest in STEM majors and her reasons for this interest. (See Appendix B for a more detailed description as found on the university website.) The program director and the graduate assistant who worked with the program reviewed applications and purposefully picked students who showed an interest in research careers in STEM fields. Although there was no GPA requirement, the previous program director would usually accept women with high GPAs and SAT scores (Dr. Moriarty, personal communication, July 15, 2008). The current director of the program stressed that individuals who were accepted described in their application essay an interest in and curiosity for STEM majors (Dr. Smith, personal communication, October 8, 2007).

17 Women who are upperclassmen are allowed to apply but they must live on the floor for an entire year once they are accepted. According to the directors of the program, only one upperclassman has ever participated in the program. All of the other participants have been first-year college students.
The program directors believed that the shared living space promoted a supportive environment that was influential in women’s persistence in STEM fields, particularly during their first year in college. The program has always offered free tutoring to participants. Each year previous participants have volunteered to serve as mentors who live on the floor with the underclassmen and help the women with social and academic concerns (Dr. Smith, Current Program Director, personal communication, October 8, 2007). Along with these opportunities, first-year participants also participated in a required one-credit weekly course. The weekly course included a variety of activities, including presentations by guest speakers who were scientists in different STEM fields, readings or assignments related to women in STEM fields, discussions of current topics in STEM fields, and visits to local laboratories and facilities associated with State University. The students were encouraged to become involved in paid research opportunities with professors on campus that they met during their laboratory tours or in their classes. All students majoring in a STEM field at State University could apply for undergraduate research opportunities beginning in their first year; however, the WSTEM program made students more aware of these opportunities and offered monetary support for their participation through WSTEM funds. The program directors encouraged the young women to participate in research and activities beyond the classroom so they would have more exposure to STEM fields and therefore make more informed decisions regarding STEM careers.

In addition to these academic opportunities, the one-credit course also incorporated social activities. Over the years, these have included a semester dinner prepared by all the members, an ice cream outing, a trip to the movies, a trip to the local outdoor recreational facility, a holiday and an end of semester party (Dr. Smith, Program Director, personal communication, October 8, 2007; Dr. Smith personal communication, September 17, 2009). The current program director described all the outings as efforts to bridge the gap between the students’ educational and social worlds and to build a supportive community among these women (Dr. Smith personal communication, October 8, 2007). After the first year, students were welcome to continue to be part of the WSTEM program, including participation in any of the semester activities and the paid research opportunities as long as they were still in a STEM major. The director believed that the networking opportunities provided through participation in WSTEM were important to women’s continued persistence in STEM fields (Dr. Smith personal communication, October 8, 2007).
At the time of this study, WSTEM received its funding directly from the university through a line item in the state budget. This line item was allotted to all universities within the state to be used specifically for education and general expenditures (State Budget Website). Since its first year, WSTEM had received on average $36,126 annually, which according to the current director was one of the less expensive LLCs (Dr. Smith personal communication, October 8, 2007). This money was used to pay for office personnel staff salaries, general office expenses, students’ research opportunities, and travel expenses for the director, students, and in some cases visiting guest speakers. WSTEM also received $500 in vending funds (funds that are collected from the vending machines across campus) that was to be spent on food for social functions and banquets. In 2007, WSTEM received $10,000 to be used over a period of 5 years from an international organization of “executives and professionals working together to advance the status of women worldwide through service and advocacy” (Organizational website).

The university administration supports WSTEM and its goal to increase the number of women in STEM fields. In an e-mail statement, the vice president of the university said,

The University attempts to encourage women to major in the STEM fields and follows up on this in a number of ways. First, it developed WSTEM. Second, it asks about the status of women in the STEM-related Quality Enhancement Reviews. And third, the Provost discusses this issue with relevant Deans in his annual evaluation. (Vice President of SU personal communication, September 23, 2008)

This support from the university indicated the policy of the university to increase the number of women in STEM fields.

**Rationale for Assigning Stayer and Leaver Categories**

Before I describe the sample and the selection methods I used, it is important to provide the rationale for my categories of stayers and leavers. The first research question for this study asks what the influences are on women’s decisions to stay or leave STEM fields. Consequently, I had to decide how I would define STEM fields. The NSF (2007) defined STEM majors as those that fall into the following categories: mathematics, natural sciences, engineering, computer/information sciences, and social/behavioral sciences. However, recent federal reports and policy initiatives that focus on increasing persistence in STEM mainly focus on mathematics, natural sciences, engineering, and computer/information sciences (AAUW, 2010;
Kuenzi, Matthews, & Mangan, 2006). I used this latter categorization for STEM majors in this study because it was also the agreed upon categorization of the WSTEM directors that I spoke to. As a result, individuals who were majoring in any of the following official majors at State University were considered STEM majors: biochemistry, biology, chemistry, computer/information science, engineering, geology, mathematics, meteorology, and physics.

This categorization was not foolproof because of what Seymour and Hewitt (1997) referred to as the postgraduate leavers. Postgraduate leavers are individuals who, despite majoring in a STEM degree, chose a non-STEM career. Consequently, I had to identify each participant’s career plan to further denote her into stayer and leaver categories. The following careers were assigned to the stayer categories: biology fields including working for the state or U.S. Fish and Wildlife Service or the Environmental Protection Agency; medical fields such as medical doctor, dentist, or physician’s assistant\(^\text{18}\); engineer; and veterinarian. Any individuals who planned to attend graduate school in a STEM field were also included in the STEM stayer category.

Leavers were categorized based on their undergraduate degree and, for some, their career goal. Individuals were designated as leavers if they changed their original STEM major to any major that fell outside of mathematics, natural sciences, physical sciences, engineering, and computer/information sciences. I placed three women in the leaver category because despite their college major falling into a STEM category, their career did not. For example, one participant was originally a chemical engineering major who will graduate with a dual major in chemistry and education. She plans to become a high school chemistry teacher. Teaching did not fall under the STEM career definition; therefore, she was placed in the leaver category despite her chemistry major. I also chose to put nursing in the leaver category based on the number of years of specialization required. For example, some nurses can achieve their desired degree in two years (associate’s degree) as opposed to the four-year bachelor’s degree. I defined a physician’s assistant as requiring more years of specialization beyond the bachelor’s degree and therefore separated nursing from physician’s assistant. Finally, one participant switched her major from biology to environmental studies, which could fall under the STEM category if individuals plan to pursue a career that is related to science, such as animal behavior or the effects of

\(^{18}\) Physician’s assistant was included because these individuals attend 2 additional years of school after their bachelor degree. These extra years of required specialized schooling along with the original STEM undergraduate degree were used as part of the criteria for keeping this career in the STEM stayer category.
environmental factors on ecosystems. However, this particular individual planned to become a lawyer who focused on environmental policies. This career did not fall under the STEM definition. Consequently, these three women were identified as leavers because of their career choice and my own rationale for whether the careers represented STEM fields. After I identified my rationale for my stayer and leaver categories, I then began to identify my sample.

Data Collection

Sample

After the WSTEM program was identified and selected, I began to identify the parameters for the participants. The first research question asked what influences individuals to stay or leave STEM fields. To respond to this question, I chose to focus on female college seniors who had originally declared a STEM major in the fall of 2006. I wanted half of these women to be stayers and half to be leavers. Fourteen women were eventually selected who stayed in their STEM major and twelve were selected who left their initial STEM major. (A full explanation of the selection is described in the next section.) The second research question asked how participation in a women-only STEM LLC (WSTEM) affected participants’ STEM career decisions. Therefore, twelve of the participants had participated in WSTEM as freshmen. Six of the WSTEM participants were stayers and six were leavers. As a result, there were four distinct cohorts of individuals in this study, which are highlighted in Table 4.2.

Table 4.2: Cohorts of participants.

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Number of participants</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSTEM Stayers</td>
<td>( N = 6 )</td>
<td>Women who participated in WSTEM and remained in a STEM major</td>
</tr>
<tr>
<td>WSTEM Leavers</td>
<td>( N = 6 )</td>
<td>Women who participated in WSTEM and left the STEM major</td>
</tr>
<tr>
<td>GP Stayers</td>
<td>( N = 8 )</td>
<td>Women from the general population who did not participate in WSTEM, who remained in their STEM major</td>
</tr>
<tr>
<td>GP Leavers</td>
<td>( N = 6 )</td>
<td>Women from the general population who did not participate in WSTEM, who left their STEM major</td>
</tr>
</tbody>
</table>
Participants were assigned a W if they were members of WSTEM or a G if they were members of the general university population. Then they were assigned an S for stayers or an L for leavers. This categorization resulted in the four distinct cohorts that appear in Table 4.2. Then each member of the cohort was assigned a random number. For example, WS6 represents the woman in my study who participated in WSTEM, stayed in her STEM major, and was the sixth member of that cohort.

**WSTEM participants.** After the Institutional Review Board approved the research project and the prospectus was approved by my committee (April 2009), I contacted the WSTEM director to request the names of the first year WSTEM participants for the 2006–2007 school year. That cohort consisted of 38 women who lived on the WSTEM floor and participated in the one-credit course for first-year students. After receiving the names of the participants, I found their contact information on the Student Directory page of the university website and discovered that of the original thirty eight, twenty one were still in a STEM major. Consequently, for this particular WSTEM cohort, there was a 55% retention rate for women in STEM majors.

I e-mailed all of the original WSTEM members from the 2006 cohort. The first e-mail was sent in April 2009. During the summer six WSTEM stayers and six leavers responded affirmatively to the interview request made in the e-mail. Once each individual responded affirmatively, she was sent an e-mail to set up a time and place for the interview with the consent form attached. This e-mail asked a series of questions related to each participant’s high school and college grades in STEM courses, her parents’ education level and careers, and her motivations for choosing her original STEM major. The list of these pre-interview questions can be found in Appendix C. If the respondent did not have time to answer these questions before the interview, I added them to the interview protocol.

**GP stayers.** During the interviews with each of the WSTEM participants, snowball sampling methods were used (Creswell, 1998) to find the names of women who participants

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19 The university’s STEM retention rate for first time female college students (including WSTEM members) was 50%. During the fall of 2006, 613 women first-time-in-college students majored in science and engineering; of these, 309 are still in a STEM major (50% retention).

20 After the first e-mail in April, only two leavers responded; therefore, a second e-mail was sent in June and a third in August. After these two e-mails, four more participants responded.
knew in their own STEM major and could recommend\(^{21}\). Fifteen names were revealed through the sampling methods. The e-mail addresses for these students were again found on the State University Student Directory. Snowball sampling methods were chosen to ensure that that the majors of the WSTEM stayers would correspond to the majors of the GP stayers (Creswell, 1998). Of the 15 identified GP stayers, eight students agreed to participate in the interview. These students, like the WSTEM stayers, were sent the e-mailed questions found in Appendix C and the consent form.

**GP leavers.** For the final group of participants, the snowball sampling methods did not yield positive results. Although eight individuals were identified, none of these women responded to monthly e-mails sent from May to August asking if they would be willing to participate in the study. In August 2009, I contacted the academic advisors in the biology and chemistry departments at State University asking if they could provide names of female students who were originally declared STEM majors but who had since left that major. The academic advisors forwarded these requests to the dean of undergraduate studies. In August, I sent the dean my recruitment letter that had been accepted by the IRB. He forwarded this information to the 304 individuals who had originally declared a STEM major during their first year at State University (2006-2007 school year) and had subsequently switched to a non-STEM major. Six women responded as willing to participate to the interview. After each woman had responded to the e-mail, I sent an e-mail asking her to list convenient times for their interview, with the consent form and list of e-mail questions found in Appendix C. I also conducted a proportion test with the data I received from the dean of undergraduate affairs. I used the numbers of stayers and leavers from the general population, which included WSTEM participants and compared that proportion to the WSTEM stayer/leaver population. This proportion test showed me the retention rate of female STEM majors in the general population compared to the retention rate in the WSTEM population for students beginning college in 2006.

\(^{21}\) Participants were also asked for the names of students who had left STEM majors. The author contacted these individuals but no one responded.
Instruments

Three instruments were used to collect data in this study. Two of these, the e-mail questions and interview protocol, were used for all participants. The WSTEM applications were only applicable to WSTEM participants.

**E-mail questions.** The e-mail questions sent to each individual were basic demographic questions that helped me to tailor the semi-structured interview questions to students’ individual backgrounds. These can be found in Appendix C.

**WSTEM applications.** The WSTEM participants had a second source for triangulation: their original applications to the program. The WSTEM program director maintains copies of participants’ original application that they write during their senior year of high school. The consent form for the WSTEM participants included a line indicating that by signing the form, they were also giving me permission to view their application and reference it in this study.

**Interviews.** I conducted two semi-structured interviews with each of the 26 participants. The first set of interview questions was developed to obtain the life histories of each participant. These interviews took place during the summer and early fall of 2009. Drawing on Eccles (1994, 2007) and Butler (1999), a narrative history storyline was created for each participant to highlight the consecutive phases of their life and the transitions between them: childhood, middle and high school, and college. During the narrative life history interviews, the focus was on specific incidents that contributed to each individual’s interest in STEM fields (or lack thereof) and decisions as they relate to STEM fields. A visual representation of these stages, the varying influences that Eccles (2007) identified, and the accompanying concept of gender can be seen in Figure 4.1. Each participant had her own storyline and accompanying map as pictured in Figure 4.1, which allowed for easier cross-case comparison to identify the similarities and differences among individuals and their career choice decision paths.

The second set of interviews occurred during the spring of 2010 to identify whether any of the participants’ career choices or plans had changed as they approached their graduation from

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22 The applications supported the interview data in all of the WSTEM participants in this study.
23 All interview questions can be found in Appendix D.
college. The second set of interviews served as a source of validation and triangulation by identifying whether individuals were still part of their original leaver or stayer cohort and what each person’s plans were after graduation.

According to qualitative experts, narrative life histories should focus on epiphanies or turning points in individuals’ lives (Creswell, 1998; Denzin & Lincoln, 1998). The semi-structured interviews with participants focused on their narrative life history as it related to their STEM college majors and career decisions. The questions focused on experiences and epiphanies within their lives that they remembered as being highly influential to their decision to work in a STEM field or not. The questions also asked participants to explain how and why they made their decisions. The interview questions delved into these turning points and each woman’s perception of them as they related to her STEM career decisions.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Outside influences*</th>
<th>Influences within individual*</th>
<th>Career goal or interest at each phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood (Including Elementary school)</td>
<td>Socializers, gender roles, family demographics, gender, aptitude, birth order</td>
<td>Interpretations of experiences, affective reactions, Identity development, goals, gender</td>
<td></td>
</tr>
<tr>
<td>Secondary School (Middle and High School)</td>
<td>Previous achievement, socializers, gender roles, family demographics, gender, aptitude, birth order</td>
<td>Interpretations of experiences, affective reactions, Identity development, goals, gender</td>
<td></td>
</tr>
<tr>
<td>High School (If applicable)</td>
<td>Previous achievement, socializers, gender roles, family demographics, gender, aptitude, birth order</td>
<td>Interpretations of experiences, affective reactions, Identity development, goals, gender</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>Previous achievement, socializers, gender roles, family demographics, gender, aptitude, birth order</td>
<td>Interpretations of experiences, affective reactions, Identity development, goals, expectations of success and subjective task value that leads to career choice</td>
<td></td>
</tr>
</tbody>
</table>

Expectation of Success

Current Career Goal

Subjective Task value
1. Attainment
2. Intrinsic
3. Utility
4. Cost

*Based on Eccles’ (2007) model.

Figure 4.1: Conceptual framework for participants’ storylines.
Although interview data, particularly life histories, are based on perception and memories, this does not bias the results of this study. These perceptions are commonly considered the factors that affect women’s STEM career decisions; therefore, it was important to this research that the participants provided detailed descriptions of their perceptions. These perceptions were unique to each person and led to the participants’ decision to stay or leave STEM fields. Consequently, the reality was not as important as the perception of these events that led to each individual’s decision to stay or leave STEM fields.

Narrative life histories also rely on the influence of participants’ surrounding social, historical, and cultural context (Denzin, 1989; L. M. Smith, 1998). The literature review for this study identified the historical marginalization that women have experienced in STEM fields as well as the chilly climate that continues to prevent women’s persistence in these fields (AAUW, 2010; Ong, 2005; Seymour & Hewitt, 1997; Shakeshaft, 1995). Therefore, concepts such as gender conception and gender discrimination were included in the interview questions. The participants’ responses to these questions identified how each woman’s perceptions of gender affected her STEM career choices. (Appendix D shows each of the influences that were discussed in the literature review and identifies which interview question best addressed it.)

The interview questions were also influenced by my own experience as a biology major in college. This experience helped to improve my understanding of the language of STEM majors, including required courses and their difficulty levels. This knowledge helped me to ask more relevant questions about the process that provided more detailed and specific responses.

**Standards**

For any research study, there is always a concern for the standards of research and the protection of the individuals. To address these concerns, I kept a reflexive journal of my thoughts and reactions to the interviews and observations throughout the research study, which allowed me to voice my bias, thereby recognizing its potential effects on the research. The journal also helped me to identify codes throughout the data collection process. Finally, I utilized an audit trail because members of my dissertation committee read the study to determine if the arguments were sound and justifiable based on the data collected (Creswell, 1998).

In addition to these standards of research, Creswell (1998) listed eight standards for qualitative research and suggested that researchers use at least two of these in their own studies.
This particular study utilized three of the standards. First, triangulation occurred throughout the study. I verified information in the interviews with other sources including the Office of Undergraduate Studies at State University, the university’s documentation of students’ major declarations, and interviews with professors identified as mentors by participants and the professors and administrators associated with the WSTEM program. Second, I provided a thick description of each of the young women’s life histories and the historical and social context in which it took place to allow the reader to have some semblance of transferability. Third, member checking occurred at multiple phases of the project, because I provided the participants with interview transcripts and life history summaries to confirm any findings.

Like Creswell (1998), Denzin (1989) listed five assumptions in narrative life histories that researchers must address. First, biographies are “gendered and class products” that reflect the “bias of the author” (Denzin, 1989, p. 180). Because bias is an issue for many qualitative methods, a thick description of the rationale, methods, and analysis is provided throughout the dissertation so that readers are aware of these biases. Second, the family history is “always the starting point” (Denzin, 1989, p. 181). This concept is central to the interview questions in this study. The third concept is that turning points are always present in individuals’ stories. These turning points or epiphanies are present in the conceptual framework and the interview questions for this study. The fourth aspect of narrative life histories is that the researcher is an outside observer, which was true in this study. The fifth aspect was that the research must provide objective markers as “tangible and verifiable facts of a person’s life” (Denzin, 1989, p. 181). In certain cases, and with participants’ consent, I was able to collect GPAs, completed theses, applications, and résumés to serve as tangible and verifiable facts. Throughout the study, the research questions and conceptual framework drove the data collection and analysis, which is described in the next section.

**Data Analysis**

The focus for this project was twofold. First, I wanted to identify the influences that affect women’s decisions to stay or leave STEM fields. Second, I wanted to understand what effect a women-only STEM LLC had on these decisions. To address these questions, I made a series of comparisons. First, I compared stayers and leavers who participated in a women-only STEM LLC (WSTEM) to stayers and leavers from the general population. Consequently, there
were two broad groups of leavers and stayers. The responses from participants in each of these
groups were compared to identify how the life histories of leavers compared to each other and
how the life histories of stayers compared to each other. I focused on similarities and differences
that existed within and across the two groups of leavers and stayers. I also examined whether the
identified factors from the literature were evident as factors in this study or whether new factors
appeared. These factors, along with the conceptual framework, drove the original analysis until
other codes appeared in the data. The results of this analysis are discussed in Chapter 5.

The two broad categories of leavers and stayers were analyzed further to identify
similarities and differences between WSTEM leavers and GP leavers and between WSTEM
stayers and GP stayers. These comparisons were made to understand what perceived effect, if
any, WSTEM had on the stayers and leavers who participated in WSTEM. To determine how an
intervention aimed at increasing retention levels for women in STEM could still produce some
leavers, I compared WSTEM stayers to leavers. The results of this analysis are discussed in
Chapter 6.

During each interview, I wrote down reflective notes, comments, and questions
(Creswell, 1998; Miles & Huberman, 1994). After transcribing each interview, I reviewed the
interview and the notes and combined these documents into memos for each participant
(Creswell, 1998). These memos served as the source for each participant’s corresponding
storyline, which was based on the original themes and factors identified in the literature review
and conceptual framework, which included gender roles, socializers, role models, science
practice and preparation, identity, future family plans, chilly climate, reactions to chilly climate,
policy issues, expectations for success, value of career, and cost of career. These storylines
included quotes from the interviews that supported each summary. Each participant was sent a
copy of her storyline, and its subsequent summary, as a form of member checking and as a
source of validation.

After the first ten interviews, which were completed in May 2009, I had some time to
review the memos, the storylines, and the actual interview transcripts. During this time, words
and concepts that served as open codes were highlighted (Strauss & Corbin, 1990). One new
theme that arose from this highlighting was the participants’ descriptions regarding the influence
that the culture of STEM majors had on their decisions. As a result, this concept was added to the

24 The storyline rubric can be found in Appendix F.
list of possible codes. At this point in the analysis, I also noticed that the order of the interview questions did not flow well, which was affecting the length of participants’ responses. Consequently, the order was changed according to three main categories: self, gender, and culture of major. The self category included questions that asked participants about family, friends, interest in science, experience with science and school, college decisions (if they were a WSTEM major, they were also asked how they found out about WSTEM and what influence it had), attitudes toward majors, career plans, and future family plans. Then the gender category contained questions regarding their definition of gender, the role it has in STEM, their individual experience in STEM, and perceptions of programs like WSTEM. The final category focused on a description of each person’s major(s) in college and how she perceived the culture within that major.

The first set of interviews was completed by October 2009. The storyline memos were continued and reviewed for possible codes and themes. The process of data collection and simultaneous analysis was akin to Creswell’s (1998) metaphor of the spiral for qualitative methods. This spiral avoided what Creswell referred to as “letting the computer do all the work” (p. 154). The notes were taken by hand during the original interviews. Then the audio interview was transcribed into a Microsoft Word document and the notes were added using the “new comment” function. The memos were written in a separate Word document. The themes and codes that appeared in the data were kept in a Microsoft Excel document with the corresponding descriptions and evidence of each (Creswell, 1998, p. 155). A matrix was created for all the participants with the original codes and emerging themes and categories as rows in Excel.

After the original interviews with all twenty six participants were completed in October 2009, I reread each participant’s memo, the original interview transcripts, and the applications for the WSTEM participants. During this rereading, I focused on the epiphanies related to STEM career choice and experience with science and math. These were added to the original storyline and reviewed for patterns and meanings that could become axial (categorical) codes (Strauss & Corbin, 1990).

The process of identifying themes occurred throughout the data collection procedures and utilized inductive coding. First, the conceptual framework, research questions, and relevant literature review were used to identify codes before data collection (Ryan & Bernard, 2003). Then I began to identify other themes that came from the data collection and analysis. Memos
were created for each of these themes, similar to what Ryan and Bernard (2003) referred to as codebooks: an organized list of codes with descriptions of each and the inclusion and exclusion criteria.

During the analysis, factors were identified by the participants as influential in their career decision process to stay or leave STEM fields. First I focused on the within-group analysis by studying each life history to identify common themes within each group (Strauss & Corbin, 1990). Data displays and thematic memos were created for each of the four groups (WSTEM leavers, WSTEM stayers, GP leavers, and GP stayers) that summarized the common themes for each group, highlighting specific cases and relating them to the literature. After these memos were created, across-group analyses were conducted. For each of the across-group analyses, a data display was created with thematic memos to summarize the themes. I related these themes to the current literature and identified the influences on women’s decisions to stay or leave STEM fields and the effects of a women-only STEM LLC on women’s decisions. There were five across group comparisons, which are summarized in Table 4.3.

Table 4.3: Description of goals for comparison groups.

<table>
<thead>
<tr>
<th>Goal for Comparison</th>
<th>Groups Compared to Achieve Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>To identify similarities and differences between leavers and stayers</td>
<td>All leavers</td>
</tr>
<tr>
<td>To identify similarities and difference between WSTEM and general population</td>
<td>WSTEM, GP</td>
</tr>
<tr>
<td>To identify similarities and differences between WSTEM leavers and GP leavers; To determine how women who participated in an intervention aimed to increase retention compared to those who did not have this.</td>
<td>WSTEM leavers, GP leavers</td>
</tr>
<tr>
<td>To identify similarities and differences between Stayers</td>
<td>WSTEM stayers, GP stayers</td>
</tr>
<tr>
<td>To identify how an intervention like WSTEM still had students choose to leave</td>
<td>WSTEM stayers, WSTEM leavers</td>
</tr>
</tbody>
</table>

First, all the stayers and leavers were compared to each other to identify what similarities and differences occurred between the two groups that could provide more information regarding STEM career decisions. Second, I compared the life histories and interview transcripts of the WSTEM participants to the GP participants. I focused on the similarities and differences
between WSTEM participants and GP participants to rule out self-selection issues or to at least identify what type of individual chooses to participate in WSTEM. This way I was aware of these issues before making the next set of comparisons.

Third, the life histories and interview transcripts of the WSTEM leavers were compared to the GP leavers to identify similarities and differences between these two groups. The purpose of this comparison was to identify what effect, if any, participation in WSTEM had on the individuals who chose to leave. A second purpose was to understand how this experience affected participants’ ultimate decision to leave their STEM major compared to those leavers who did not participate in WSTEM.

Fourth, the life histories and interview transcripts of the WSTEM stayers were compared to those of the GP stayers to identify what effect WSTEM had. These comparisons showed which factors affect both groups of stayers to understand whether these factors are similar or different based on participation in WSTEM.

The final comparison was made between the leavers and the stayers who participated in WSTEM to better understand how the intervening program affected their decisions. Theoretically it would appear that the WSTEM leavers would serve as a group of negative cases in that the intervention did not help them to stay in STEM fields. However, as Chapter 6 indicates, a number of other factors influenced these decisions. Throughout the study, I focused on cases (including negative cases) that did not fit into the model to determine if the model needed to be changed and I made revisions where necessary.

In addition to the 26 student participants, three female professors who have worked closely with the WSTEM program as either directors or mentors were interviewed. Graduate students who have worked with the program over the past four years were also interviewed. These individuals provided the history and context of the WSTEM program. During interviews with the student participants, many mentioned mentors who had positively influenced their STEM career decisions. Those mentors who were faculty at the university were contacted and served as a source of triangulation for the participants’ stories.

The WSTEM participants had another source of triangulation, which was their original application for the WSTEM program that they wrote in spring of 2005. The responses to the application questions regarding their interest in STEM fields and reasons for wanting to join WSTEM were compared to their interview responses.
Finally, the second set of interviews with each of the student participants was conducted in the spring of 2010. These semi-structured interviews were conducted by phone. The purpose of these interviews was to answer any questions that came up during the first interview and to identify what each of the students was planning to do after graduation. These interviews served as a source of triangulation and validation for the original interviews.

**Individual Bias**

Researchers often make the assumption that research is objective and free of bias; however, with any human endeavor, there is always a level of individual bias (Creswell, 1998; Miles & Huberman, 1994). As I mentioned earlier in this chapter, I kept a reflexive journal to make myself aware of my own bias. First, I chose this topic because of my own interest in college STEM decisions. As a college STEM major, I chose to become a science teacher rather than to continue in my original plan to become a medical doctor. My decision was based on my concern at the time that if I became a doctor, I would not have time to devote to a future family. This decision was a gendered one, since research has found that it is only a concern for female students (Farmer, 1997). Although I was able to stay abreast of scientific advances and concepts as a high school science teacher, I did not see myself as a full participant within the science community. I saw myself as a STEM leaver.

My interest in this topic based on my own decision to leave STEM, motivated my choices for this study. However, it did not bias my research methods, data collection, or analysis. Throughout the study I maintained the standards of qualitative research mentioned by Creswell (1998) and Miles and Huberman (1994). My acknowledgement of bias in my reflexive journal made me aware of the effects it could have on my choices. Therefore, I was able to address these biases in my methods.

**Conclusion**

Throughout the study, the standards of qualitative research as supported by Creswell (1998) and Miles and Huberman (1994) were maintained. To address validity in this study, I presented disconfirming evidence as seen in the results section. I purposely sought out negative examples and focused on these and disconfirming evidence to help restructure the argument and
make conclusions. Member checks for each participant were used at least twice during the study, when the original interview transcript was sent and then again when the storyline was sent. This helped to validate my summary and my observations of each participant’s thoughts.

The next two chapters identify the findings from this study. Chapter 5 addresses the first research question: What influences women to stay or leave STEM fields? Chapter 6 addresses the second research question: How does participation in a women-only STEM LLC affect women’s decisions to stay or leave STEM?
CHAPTER 5

RESULTS: THE INFLUENCES THAT AFFECT WOMEN’S DECISIONS TO STAY OR LEAVE STEM FIELDS

This chapter examines the first research question in this study: What were the influences on women who were interested in STEM fields as freshmen in college to stay or leave these fields? The literature review identified the phases in individuals’ lives that led to their STEM major and career decisions. This chapter presents the results according to these phases. First, I summarize the precollege factors (including their motivations for choosing the major) that influenced each of the participant’s decisions to major in a STEM field in college. I include these pre-college factors because of my guiding framework. Eccles (2007) and Butler (1999) both argue that career decisions are influenced by all related experiences, including those that occur before college. Second, I summarize the college factors that led each participant to either stay or leave STEM. During the summary of the college experiences that affected each woman’s decision to stay or leave STEM fields, I discuss the shared paths of members. Finally, I summarize the experiences of the stayers and then the experiences of the leavers.

Throughout the discussion I will also highlight the results with my guiding framework which includes Eccles’ expectancy value model (2007) and Butler’s conception of gender. Eccles’ model highlights how each person’s career decision is affected by his/her experiences and the internalizations of these experiences. Butler complements this model by emphasizing the unique perspective that one’s conception of gender can have on his/her decisions. This guiding framework required that I describe my participants’ life histories as they relate to STEM. Each one of these participants chose to pursue a STEM degree as they entered college; therefore, their pre-college influences are important to their college STEM decisions. These influences will be discussed next.

Precollege Influences

Research has revealed seven major factors that affect women’s persistence in STEM fields during their precollege years. First, women who persist in STEM identify the positive role
of socializers who support students’ STEM interest (Dick & Rallis, 1991; Rayman & Brett, 1995). Second, persistence has been found to be dependent on positive experience with science and math classes and success in some of these areas (Burkam et al., 1997; Jones et al., 2000). Third, women who persist in STEM must believe that their chosen STEM career fits with their identity (Duschl et al., 2007; Eccles, 1994). The fourth through sixth factors are often discussed by feminist researchers who highlight the negative impact that the following factors can have on women’s persistence: the masculine nature of STEM fields, the lack of female role models, and the historical gender underrepresentation and discrimination (Carlone, 2004; Harding, 1997). These three factors often fall under the umbrella term of “chilly climate\textsuperscript{25},” which is a metaphor used to represent the unwelcoming environment women find once they enter STEM departments in college (Hartman & Hartman, 2009; Shakeshaft, 1995). And finally, some quantitative studies have found that parental education level and career can be used as a predictor of women’s persistence in STEM, particularly when a parent has worked in a STEM field (Eccles, 1994; Rayman & Brett, 1995). The findings from this study support most of the literature above, except for the predictive role of parental educational levels. I will discuss those factors that are supported by the literature first.

\textbf{The Precollege Pieces}

The interview data for these participants highlighted the factors that affected women’s STEM career decisions before college. These factors could be combined together for each participant as a representation of their STEM path. Table 5.2 summarizes each of the individual participant’s precollege paths. During my analysis of the interview data, I found that the participants’ comments fell into seven different experiences that could be grouped into seven codes: five were considered positive influences and two were denoted as negative influences. The positive coded categories were successful experience or competition in math and science classes (C), supportive high school teachers (HST), supportive parents (PPS), experience with STEM career of interest (Ex), and experience with the tools of STEM fields or tinkering (T). The categories that fell under the potentially negative factors were poor grades in math or science classes (PG) and finding math or science classes boring (BC).

\textsuperscript{25}Chilly climate refers to the following categories: large class sizes which are viewed as impersonal, often preventing students from getting to know faculty and peers; not fitting in with other students because of a lack of critical mass; competitive nature of STEM major; and professors perceived lack of excitement for the subject.
Table 5.1: Summary of precollege influences on participants’ persistence in STEM.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Precollege Positive Experiences</th>
<th>Precollege Negative Experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1</td>
<td>C, HST,</td>
<td></td>
</tr>
<tr>
<td>WS2</td>
<td>C, HST,</td>
<td></td>
</tr>
<tr>
<td>WS3</td>
<td>C, HST, PPS, T</td>
<td></td>
</tr>
<tr>
<td>WS4</td>
<td>C, PPS</td>
<td></td>
</tr>
<tr>
<td>WS5</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>WS6</td>
<td>C, HST,</td>
<td></td>
</tr>
<tr>
<td>GS1</td>
<td>C, HST, PPS</td>
<td>PG</td>
</tr>
<tr>
<td>GS2</td>
<td>C</td>
<td>BC</td>
</tr>
<tr>
<td>GS3</td>
<td>C, PPS,</td>
<td>BC, PG</td>
</tr>
<tr>
<td>GS4</td>
<td>C, HST</td>
<td></td>
</tr>
<tr>
<td>GS5</td>
<td>C, HST, PPS, T</td>
<td></td>
</tr>
<tr>
<td>GS6</td>
<td>C, HST, PPS</td>
<td></td>
</tr>
<tr>
<td>GS7</td>
<td>C, PPS,</td>
<td>BC</td>
</tr>
<tr>
<td>GS8</td>
<td>C, HST, PPS</td>
<td></td>
</tr>
<tr>
<td>WL1</td>
<td>C, HST, PPS</td>
<td></td>
</tr>
<tr>
<td>WL2</td>
<td>C, HST, PPS</td>
<td></td>
</tr>
<tr>
<td>WL3</td>
<td>Ex, HST</td>
<td></td>
</tr>
<tr>
<td>WL4</td>
<td>HST, PPS</td>
<td></td>
</tr>
<tr>
<td>WL5</td>
<td>C</td>
<td>PG</td>
</tr>
<tr>
<td>WL6</td>
<td>Ex, PPS, T</td>
<td></td>
</tr>
<tr>
<td>GL1</td>
<td>C, HST</td>
<td></td>
</tr>
<tr>
<td>GL2</td>
<td>C, HST</td>
<td>PG</td>
</tr>
<tr>
<td>GL3</td>
<td>C, HST</td>
<td></td>
</tr>
<tr>
<td>GL4</td>
<td>HST, PPS</td>
<td></td>
</tr>
<tr>
<td>GL5</td>
<td>C, HST</td>
<td></td>
</tr>
<tr>
<td>GL6</td>
<td>C, HST</td>
<td></td>
</tr>
</tbody>
</table>

All 26 participants mentioned at least one of the following: 20 women identified success in math and science classes and competitions (C); 18 women mentioned the positive influence of high school math or science teachers (HST); and 14 women reported the positive influence of parents (PPS). Seven of the participants (five stayers and two leavers) mentioned all three of

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26 Each of the participants was assigned a reference pseudonym based on their participation in WSTEM (W denotes WSTEM participant) or not (G denotes general population participant). Then each participant was assigned an S if they stayed in their STEM field or an L if they left their STEM field. And finally the number was selected at random.
these categories and 13 mentioned at least two of these in combination as having a positive influence on their persistence. Each of these influences is discussed in the next section.

**Success in STEM.** Participants reported success in science and math as having the most positive influence on their original decision to major in STEM in college. It was not surprising that 20 of these women mentioned this success because they all were high-achieving students and recipients of the state merit-based scholarship. This precollege success in math and science helped these women see themselves as succeeding in STEM fields in the future. This perceived ability to succeed also helped these women feel that they could identify with STEM. For example, WS3 commented, “Working in science and doing Science Olympiad for so many years . . . it ceases to be something you do and it starts to be something you are.” These women also described the role that success in math and science had on their confidence in their science and math abilities. This sentiment was stated best by WL4, who said, “I did well, so I was like yeah, I like this.” Similarly, GL2 described the feeling she associated with success: “When I was taking a chemistry course, I remember getting some of the highest grades in the class and I remember being really proud of myself. I just felt like, wow, I must be doing something right here.” These women provided qualitative evidence of the confidence they gained due to their success and experience in STEM classes. These experiences helped them to perceive that a STEM career would be an achievable goal that fit with their identity (Eccles, 2007).

**Supportive teachers.** Participants described supportive high school teachers as approachable, excited about the subject, and providing hands-on activities that made the subject understandable. Ten of the participants described their teachers as approachable. This concept was evident in comments such as teachers were described as “friends” (WS6) who “would help you at any time of the day” (GL4) by “explaining it until you understood” (WL4).

Thirteen of the participants discussed how their high school teachers’ excitement about science would instill that same level of excitement in the students. WL2 stated, “They [my teachers] enjoyed what they did and they found ways to make it interesting to the class.” The concept of teachers being interested in the subject was typically referenced by leavers, who also often compared their high school teachers to their college professors. This comparison was referenced to explain why they were interested in science in high school (i.e., teachers were
interested in the subject) and not college (i.e., professor did not seem interested in the subject). For example, GL5 said that “chemistry was more hands-on in high school I guess, and the teachers made it interesting. It wasn’t just monotonous fact repetition.”

Four of the participants mentioned the positive impact of the hands-on activities that their teachers used. GS4 discussed how her high school chemistry teacher made “everyone, even people who never would have thought about taking another science class, want to learn chemistry because she related it to their lives.” Like the other categories related to precollege teachers, more leavers lamented that they did not have these same experiences in college, which led to their decision to leave STEM.

More leavers (10 of 12) experienced positive relationships and classroom techniques with their high school science teacher than their staying peers (eight of 14). This positive support from precollege teachers served as one of the sources that motivated them to pursue STEM in college. And yet, these individuals chose to leave STEM fields once in college, indicating that positive high school teaching was not enough to sustain STEM interest and persistence for all of these participants.

**Parental involvement.** This study confirmed (Dick & Rallis, 1991; Seymour & Hewitt, 1997) the positive role that parents have on their children’s interest in STEM fields. Fourteen of the 26 participants mentioned this positive role in their interviews. Twelve women discussed the hands-on activities that their parents provided such as science-related toys they received like “bug kits and magnifying glasses” (GS5) that sparked their interest in science. Others, like WL6 whose father was a veterinarian, discussed their parents’ careers in STEM as influencing their own interest. “I would go on calls with my dad, I always helped in surgery, and I rode horses so I just stayed interested that way” (WL6).

The overlap between the stayers and leavers during their precollege experiences was understandable because all the women were interested in STEM careers as freshmen in college. The precollege data supported the positive influence of teachers and parents (Dick & Rallis, 1991; Rayman & Brett, 1995) and the positive influence of success in science and math classes (Burkam et al., 1997; Jones et al., 2000). One factor that research argues can improve students’ success in STEM majors in college is the concept of tinkering or having the opportunity to play with STEM tools and equipment (Jones et al., 2000). Only three of my participants mentioned
having this opportunity, which supported previous literature regarding the lack of tinkering young women have in comparison to men with STEM tools and occupations before college. This lack of practice often puts women at a disadvantage when they enter college (Jones et al., 2000).

**Negative influences.** Participants from both stayers and leavers mentioned some negative precollege factors that affected their perception of STEM fields. Four women (two stayers and two leavers) mentioned receiving poor grades in a math or science class in high school. This lack of success in one or two classes caused them to doubt their ability to succeed in a STEM field. However, the support of their teachers and parents and the success that they had in their other science and math classes convinced them that they could succeed despite the setbacks they experienced. Consequently, these precollege successes outweighed their negative experiences, leading to their choice of a STEM major in college.

**Differences by Cohort**

In terms of the precollege influences, there were only slight differences between the two cohorts (stayers and leavers). For stayers, the three most reported positive precollege factors were: success in math and science, which was mentioned by all 14 stayers; the positive influence of a high school science/math teacher, which was mentioned by eight of the stayers; and the positive support from parents, which was described as influential by eight stayers. For leavers, there was a slight difference in the top three most reported precollege factors were. First, 10 of the 12 leavers mentioned the positive influence of a high school math/science teacher. Only eight leavers discussed success in math and science classes. And only six women described their parents’ support as influential in their STEM decisions.

Fewer leavers reported success in math and science precollege classes compared to stayers. As mentioned before, all the women, both stayers and leavers, had similar GPAs and SAT scores (as evidenced by their merit-based scholarship award); therefore, they would have had relatively high grades in their math and science precollege classes. Yet four women in the leaver group did not perceive these grades as success. Each of these four women had received what they perceived as a low grade in one or two math/science courses in high school. However, they received high grades in the rest of their math and science classes. Once these four women experienced low grades in college they began to see their previous success as unachievable and
they began to doubt their ability to succeed in STEM. Each of these women used their lack of perceived success in precollege STEM classes as evidence to support their decision to leave STEM in college.

Two other categories were different for stayers and leavers. First, only three stayers mentioned being bored by science and math classes in high school. For example, GS7 described her sense of boredom as follows: “Unfortunately in elementary, middle and high school I didn’t really have a passion for science. The public school system kind of lacked in their supplies I guess. Even dissections were scarce and sort of . . . uninteresting.” This was an unexpected finding, in that all three of these women went on to major in STEM in college despite not enjoying the classes in high school. These three women were successful in their math and science classes, but they did not feel that the teachers for these classes or the pedagogy of the classes made science and math interesting to them. Two of them sought information about STEM careers through other sources (the Internet, books, and family friends), which they said instilled them with a personal interest in STEM.

Another category was only identified by the leavers. Two of the leavers reported having some experience in their STEM career during high school (WL3 wanted to be an orthodontist and she shadowed her own for a semester in high school and WL6 wanted to be a veterinarian like her father and she would accompany him on many of his operations and check-ups). This experience motivated both WL3 and WL6 to major in STEM as freshmen in college; however, it was not enough to sustain their interest and consequently their persistence due to negative college STEM influences.

**Precollege Factors That Did Not Match Literature**

In my literature review, I found that feminist researchers discussed three factors that could negatively affect women’s STEM experiences before college. These factors were: the masculine nature of science, the lack of female role models, and the historical gender discrimination that has existed in STEM fields (Carlone, 2004; Harding, 1997). In my study, none of the 26 participants said that they experienced any of these gender related factors before college. As mentioned above, all of these women had supportive teachers and/or parents who made them feel that they could succeed in STEM fields. Before college all of these women had
experienced success in most of their math and science classes which supported their belief that they could succeed in STEM.

Table 5.2: Parental education level for each participant.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Parents*</th>
<th>STEM Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Father</td>
</tr>
<tr>
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<td>M</td>
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<tr>
<td>WS2</td>
<td>A</td>
<td>M</td>
</tr>
<tr>
<td>WS3</td>
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<tr>
<td>WS4</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>WS5</td>
<td>B</td>
<td>B</td>
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<tr>
<td>WS6</td>
<td>B</td>
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<tr>
<td>GS1</td>
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<td>B*</td>
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<td>B</td>
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<td>WL5</td>
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<td>G*</td>
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<td>GL2</td>
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<td>M*</td>
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<tr>
<td>GL4</td>
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<td>G*</td>
</tr>
<tr>
<td>GL5</td>
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<td>HS</td>
</tr>
<tr>
<td>GL6</td>
<td>B</td>
<td>M</td>
</tr>
</tbody>
</table>

*Parent in a STEM field.

B = Bachelor degree; M = Master’s degree; A = Associates degree; HS= High school, G = advanced graduate degree (i.e., PhD or MD).

In terms of parental influences, past studies found that women whose parents worked in a STEM field had a higher likelihood of persisting in these fields (Eccles, 1994; Rayman & Brett, 1995). Having a parent who participated in a STEM career did not appear to have an effect on
the participants in my study. In this study, six participants had a father who worked in a STEM field. Three of these women persisted in their STEM field through college, whereas three left. Based on the data, each woman was just as likely to stay or leave her chosen STEM field even with a parent in the field. This result supports the influence of other factors that affect STEM career decisions besides whether an individual has a parent who works in STEM.

Past research has suggested that the level of education held by parents can affect women’s persistence in STEM fields (Crisp et al., 2009; Eccles, 1994; Rayman & Brett, 1995). These studies found that women have a higher probability of persisting in STEM fields if both parents have a college degree or higher. In this study, five participants’ parent(s) had only a high school degree. Three of these women were stayers and two were leavers. The summary of parental education level and whether a parent worked in STEM can be found in Table 5.2 for each participant. These results provide evidence that previously reported predictive factors, such as parent educational level, only provide a piece of the much larger picture.

All of the women in this study identified a number of positive precollege experiences. These experiences affected their perceptions of STEM fields, which was evident in their motivations to pursue STEM majors in college. In turn, these motivations affected the strength of their commitment to and their interest in STEM fields as they encountered STEM experiences in college. The motivations to pursue STEM in college will be discussed next.

**Motivation for STEM Major**

Previous studies have found that the motivation for choosing STEM majors can also be important in predicting persistence (Farmer, 1997; Rayman & Brett, 1995). These studies found that female high school and college students tended to be motivated toward STEM careers because of their goal of helping others, whereas the male students tended to choose STEM careers to make money or gain fame by making a new discovery. In this study, participants often mentioned more than one motivation for choosing a STEM major. (See Table 5.3 for the motivations for each of the participants.) The motivations fell into five categories with ten participants identifying personal interest as their only motivation. Eight described a desire to help others as their only motivation. Two women mentioned a combination of personal interest and helping others. Two wanted to make a lot of money and believed that STEM fields could help them to do this. And two were motivated by their previous success in STEM before college. In
addition to these motivations, four women were also motivated by misconceptions regarding STEM fields. Each of these motivations will be discussed next.

**Personal Interest**

Personal interest was described as curiosity in the concepts of STEM. For example, WS2 chose her STEM major because she “just like[s] learning and is really curious about science.” Similarly, WS4 described her personal interest as a “love” for science. “I just am so fascinated with science. It’s how the world works. Everything in this world is science.” There was a difference between stayers and leavers in this category of motivation, as ten stayers said they were motivated because of their personal interest in STEM fields compared to only two leavers.

**Helping Others**

Although research suggested (Eccles, 2007; Seymour & Hewitt, 1997) that women tend to choose STEM careers because of a gendered desire to help others, the results of this study indicated that only ten of the participants mentioned this as a factor. Of these, four of the stayers and six of the leavers mentioned helping others as a source of motivation for their chosen STEM major. The leavers also reported this motivation as a reason for their decision to leave. Once these leavers learned more about their chosen STEM career in college, they began to question their motivation. For example, WL2 discussed how her chemistry major no longer felt like a field where she could help others: “I just want to help people a lot and I feel that I can make a difference in psych[ology] as opposed to chem[istry] by working with people, not chemicals.”

**Making Money and Previous Success in STEM**

Only leavers reported making money and previous success in math and science classes as motivations for entering STEM majors in college. Two of the leavers explained that their main motivation for choosing a STEM major was because they knew these careers made a high salary. Two other leavers reported being motivated to choose a STEM major because they had experienced previous success in these classes. Neither of these motivations (making money and previous success in math and science) appeared to be strong enough to maintain the women’s interest or persistence in STEM fields after they encountered negative college STEM experiences.
Misconceptions of STEM

Science education researchers have found that students often hold misconceptions regarding science concepts and language (Bransford, 2000; Duschl et al., 2007; Olitsky, 2006; Settlage & Southward, 2007; Wandersee, Mintzes, & Novak, 1994). Misconceptions, such as, science provides exact, unquestionable answers can be detrimental to students’ persistence in STEM fields. Students who have expectations of a STEM career based on falsehoods have to reevaluate their STEM understanding and goals after they encounter the actuality (Wandersee et al., 1994). If students’ motivation to pursue STEM fields were based on misconceptions, then they could either reevaluate whether their identity fits with the actuality or they could choose to leave the field altogether because of a lack of identity fit (Duschl et al., 2007). In this study, four of the participants listed misconceptions regarding scientists and engineers as part of their original motivation. Three of these women chose to leave STEM based partly on a decision that their misconception was being challenged.

Two of the leavers, GL3 and GL4, believed that science always found the right answer, which was a misconception that frustrated them when they reached college and found out that there is a large amount of uncertainty in STEM. For example, GL3 discussed how she “really enjoyed those parts of science that gave you a definite answer.” She reported that this misconception was “part of the reason why [she] decided to go into engineering.” Once she realized that engineering did not provide the “right answers,” she began to reconsider her career choice because it no longer matched her previous misconceived ideas. Once these two women encountered the actuality of science and engineering in college, their misconceptions were challenged, which caused them to reevaluate their interest in STEM.

Another misconception mentioned by one of the leavers was the concept of science being “magic.” GL6 said that her interest in science stemmed from her perception that science was like magic, which was exciting for her in secondary school:

I guess I was pretty much in science in the first place for the explosions and all the visuals and fun aspects. It kind of looked like magic to me when I was little. But that just kind of went away for me once I got to college.

Once GL6 realized that there was more to STEM than just explosions and magic, she realized that it no longer aligned with her interests, which contributed to her decision to leave.
Only one stayer described a misconception as part of her motivation for choosing a STEM career. WS1 believed that scientists work mainly alone and thought that this would be a good fit for her personally. At the time of this study, she still maintained this belief that she would be able to work alone and not interact with people. The three leavers who reported misconceptions as their motivation for choosing STEM careers had their misconceptions invalidated during their college years, which led to their sense of frustration and disappointment with STEM fields. Their changed perspective affected their interest in STEM careers, leading to their eventual decision to leave.

**Motivation Summary**

Based on these data, personal interest in STEM appeared to be the strongest motivator for persistence in these majors. This personal interest helped participants to perceive STEM classes and experiences in college as positive. These college experiences combined with their interest to build on their overall expectations of success and the value of that success. Helping others, did not have as positive a role on women’s persistence since it was mentioned by more leavers. Only two stayers reported helping others as their sole motivation compared to six leavers. Three of the women whose interest in STEM was based on a misconception had difficulty maintaining interest after their misconception was challenged. This finding indicates that misconceptions can negatively affect persistence. Finally, extrinsic values such as making money or personal success were not sufficient to maintain persistence after the women entered college. The college influences that affected women’s decisions are discussed next.

**College Influences**

By the time each of the participants entered college in 2006, they believed that their past success in STEM classes combined with the support they experienced from parents and teachers would help them to be successful in a STEM career. These women also believed that their perceived identity would fit in with their desired career and the career would fit in with their goals (Eccles, 2007). However, after these women entered college, 12 of them eventually chose a non-STEM major (leavers) and 14 persisted in their STEM major (stayers). The most striking difference between the two groups during college was that only two leavers experienced positive STEM influences in college compared to 13 stayers who mentioned positive experiences.
Fourteen participants mentioned positive research opportunities. Twelve discussed the effects of supportive mentors and six mentioned the influential role of supportive peers. Both leavers and stayers mentioned negative STEM experiences in college as well; however, the leavers mentioned them at a higher frequency than their staying peers. Fourteen participants mentioned the negative influences of the perceived chilly climate within their STEM major. Twelve women discussed the negative effects of poor grades on their confidence within their STEM major. Eight women reported that they lost interest in their original STEM major and found a non-STEM major more interesting, leading to their switch. Three participants described an overall sense of doubt or frustration with their major that led them to leave. Two women reported having negative research experiences that led to their decision to change majors. And two participants identified the superior attitudes of peers within the major that made them feel inferior and contributed to their decision to leave.

The most obvious trend that appeared in the college experiences data was the leavers identified more negative experiences and fewer positive experiences in their college STEM major. All of the leavers mentioned negative experiences in college which led to their decision to leave their STEM major. Only three of the stayers discussed experiencing doubt or frustration with their major. Six of the stayers mentioned the perceived chilly climate within their major. And three stayers reported the negative effects of poor grades that they received in one or more of their major courses. In comparison, the leavers mentioned the latter two factors in much larger numbers, as nine leavers mentioned poor grades and 11 mentioned evidence of the chilly climate as factors that affected their decisions to leave STEM. None of the leavers believed that the culture of their STEM major was supportive, and two leavers said the negative attitudes of their peers were one of the factors that affected their decision to leave.

The college experiences that contributed to each participant’s decision to stay or leave their STEM major are summarized in Table 5.3. The individual paths for each of the participants in this study appear as rows in Table 5.3. The table shows the precollege experiences, motivations, and college experiences that led to each individual’s final decision to remain or leave their STEM field. The leavers had more negative experiences than the stayers.

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27 These numbers represent the total number of stayers and leavers who described these experiences in their interviews.
Table 5.3: Individual paths to STEM career decisions.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Precollege Positive Experiences</th>
<th>Precollege Negative Experiences</th>
<th>Motivation to pursue STEM degree</th>
<th>College Positive Experiences</th>
<th>College Negative Experiences</th>
<th>Final Major</th>
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<td>M, R</td>
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<td>HO</td>
<td>M, R</td>
<td>PG, R, CCg</td>
<td>STEM</td>
<td></td>
</tr>
<tr>
<td>GS4*</td>
<td>C, HST</td>
<td>PI</td>
<td>M, R, S, CCg</td>
<td>STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS5</td>
<td>C, HST, PPS, BC, T</td>
<td>PI</td>
<td>M, R, S, CCg</td>
<td>STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS6</td>
<td>C, HST</td>
<td>PI</td>
<td>M, R, S, CCg</td>
<td>STEM</td>
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<td></td>
</tr>
<tr>
<td>GS7</td>
<td>C, PPS, BC</td>
<td>PI</td>
<td>M, R, S, CCg</td>
<td>STEM</td>
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<td></td>
</tr>
<tr>
<td>GS8</td>
<td>C, HST, PPS</td>
<td>PI</td>
<td>M, R, S, CCg</td>
<td>STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL1</td>
<td>C, HST, PPS</td>
<td>HO</td>
<td>R</td>
<td>CC, PG, Non-STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL2</td>
<td>C, HST, PPS</td>
<td>HO</td>
<td>M, R, S, CC, PG, LI</td>
<td>Non-STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL3</td>
<td>Ex, HST</td>
<td>HO</td>
<td>CC, L, PG, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL4</td>
<td>HST, PPS</td>
<td>PI</td>
<td>LI</td>
<td>Non-STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL5</td>
<td>C</td>
<td>PG</td>
<td>HO</td>
<td>CC, LI, PG, Non-STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL6</td>
<td>Ex, PPS, T</td>
<td>PI</td>
<td>CC, L, GI, PG, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL1</td>
<td>C, HST</td>
<td>MM</td>
<td>A, CCg, PI, PG, R</td>
<td>Non-STEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL2</td>
<td>C, HST</td>
<td>PG</td>
<td>A, CCg, LI, PG, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL3</td>
<td>C, HST</td>
<td>MM, Ms</td>
<td>CC, L, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL4*</td>
<td>HST, PPS</td>
<td>HO, Ms</td>
<td>CC, PG, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL5</td>
<td>C, HST</td>
<td>PS</td>
<td>CC, L, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL6* (PA)</td>
<td>C, HST</td>
<td>HO, Ms</td>
<td>CC, PG, R, Non-STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Positive Precollege Experiences: C = success in math and science classes; HST = positive high school teacher; PPS = positive parental support; T = tinkering; Ex = Experience in STEM career. Negative Pre-College Experiences: PG = poor grades in math/science classes; BC = boring STEM classes. Motivation for choosing STEM major: PI = personal interest; HO = help others; MM = make money; Ms = misconception related to STEM; PS = previous success. Positive College Experiences: R = participated in research related to major; M = positive mentor in STEM major, S = felt supported by peers and faculty in major. Negative College Experiences: A = attitudes of peers in their STEM major that made them feel like they were inferior or a failure in the major. These attitudes were not necessarily critical of individuals but more critical of what participants perceived as a general disrespect for non-STEM majors.; R = research experience influenced decision to leave STEM; PG = poor grades in classes in major; DF = doubt or frustration with major; LI = loss of interest in STEM major; CC = perceived chilly climate; CCg = perceived chilly climate gender related.

28 For a representation of each participant’s more detailed original and final major and their high school and college grades, refer to Appendix G.
The Role of Perception in STEM Decisions

Before I discuss the observed college paths for the participants, I highlight the role of perception that was evident during the interviews with all participants. These perceptions affected whether each woman viewed her experiences as positive or negative. As I analyzed the data, four categories emerged that were highly influenced by each person’s perceptions: poor grades, reactions to negative experiences in STEM major, culture within STEM major, and gender conception. I describe these findings here to explain to the reader the full impact of each person’s perceptions on her eventual decision to stay or leave STEM.

Poor grades. Both stayers and leavers mentioned poor grades as a negative influence on their STEM experience in college. The term poor grades had different meanings for each of the participants. These meanings became evident when their interview responses were compared to their actual grades. (Each participant’s self-reported high school and college STEM course grades can be found in Appendix G.) On the original survey, participants were asked to provide their average high school math and science grades and their average college math and science grades. As I reviewed these, it became apparent that each individual had a unique view of what represented poor or low grades. For example, only one participant (GL2) received failing grades for her STEM courses. She did mention these low grades as one of the motivations for her decision to leave. Of the five participants who perceived one or two C grades as low grades in their STEM courses, only one stayed in her STEM major. The remaining five participants considered a B to be a low grade. Of the five women with B grades, two decided to stay in their STEM majors. All these women had been high-achieving high school students; consequently, some of them were deterred by grades lower than an A. GL6 described this reaction in her statement:

I think the highest grade I ever got on one of the chemistry tests was like a B, and I am just not used to being the B or C student. I’m usually like the A and B student so I wasn’t comfortable I guess getting those grades.

Eventually her self-perception of her low grades influenced her decision to leave her STEM major.
These results suggest that individuals have varying perceptions of what constitutes poor grades. However, what was common for all the women who mentioned poor grades was the influence these grades had on their beliefs in their ability to succeed in a STEM field (Eccles, 2007). All of these women questioned whether they could succeed in their desired STEM field if they were receiving low grades in their college STEM classes. These women also saw these grades as a reward for the work that they were doing in their classes (i.e., hard work should receive a higher grade). As a result, they also began considering whether the amount of time and work spent on these classes was worth the end grade (reward). Those women who stayed in their STEM major tended to see these grades as just one measure of their overall understanding and not a prediction of their overall success in their desired STEM field, whereas the leavers tended to believe they would not be successful and the grades and subsequent low GPA were not worth the STEM career.

**Reactions to negative experiences in STEM majors.** Second, perceptions were unique for each individual’s reaction to negative experiences in their STEM major just as Eccles (2007) argued in her expectancy value model. Stayers appeared to view negative experiences, such as poor grades, as a source of frustration but not as an indication that they could not succeed in a STEM major or career. Many of the women were motivated to succeed by aspects of the chilly climate (i.e., male-dominated class sizes, poor grades, weed-out courses). For example, WS5 described her reaction to the long hours of studying she had to complete in engineering: “You have to have a certain, I guess, drive and you have to know you’re not going to be right all the time; it’s not going to be easy.” GS8 described the sense of motivation she derived from her male-dominated major: “There definitely are a lot more males. I don’t find that disheartening or discouraging at all. I almost find it more empowering.”

Yet the leavers saw these aspects and interpreted their experiences as reasons to leave. For example, WL6 described her reaction to the long hours of studying:

I just felt like I couldn’t hack it. Because I had no desire to pour over my books for 5 hours a day and everybody else did. Everybody else was willing to do that, and I kind of wanted to go out and do other things.

This difference in perception was very evident in their description of the cultures within their original STEM majors, which is discussed next.
Culture of STEM major. Third, each participant’s perceptions affected her description of the culture within her chosen STEM major. The following subthemes emerged from the participants’ descriptions of the culture of their STEM major: level of nerdiness, level of difficulty, and the chilly climate. (See Appendix H for a summary of each participant’s full description of the culture of her STEM department.) Participants described the level of nerdiness within their STEM majors as a hierarchy with varying levels of nerdiness both within STEM majors and between STEM and non-STEM majors. For example, GL5 said that STEM majors are considered to be “more geeky” than other majors. This definition of geeky for her was the idea that STEM majors spend long hours working on their subject and have very little time to be involved in social activities. This perception was also described by three stayers. The stayers’ descriptions differed in that their hierarchy of nerdiness just referred to STEM fields and was used to show that their particular major was not as nerdy as others. For example, both of the civil engineer stayers (WS5 and GS8) described civil engineering majors as more social and loud compared to the other engineering majors, who WS5 described as having more “awkward wallflowers.” GS7 poked fun at physics majors by saying that despite her biology major having a majority of “nerds in it, it was not as bad as physics.” Here GS7 defined nerdy as being “interested and captivated in their courses and the research going on on campus.”

A second subtheme related to perception arose from these comments: a hierarchy of difficulty among the STEM and the non-STEM majors. This concept was described by Seymour and Hewitt (1997) as the level of “hardness” in STEM majors (p. 150). Eighteen of the participants (ten stayers and eight leavers) perceived their original STEM major as difficult, wherein students were incredibly focused and worked long hours studying. The fact that more of the stayers described their major as difficult could relate to the hierarchy of difficulty and the perceived attitude within some STEM majors that persisting in STEM is a sign of superiority because of the difficulty. For example, GL2 discussed her perception that biology majors seem to feel that their major is harder than “soft options like English.” She felt that this made the biology majors appear “stuck up” and in turn affected her decision to leave. Interestingly, according to GS3, within the STEM fields, she felt that individuals from the “core” sciences like chemistry, math, and physics looked down on biologists as the “soft or hippy option.” She did not believe
that biology fell into this core and was somewhat inferior to the other sciences. Other participants also mentioned this perception of one major being inferior to another.

The third subtheme was the aspects of the chilly climate that were mentioned by all but two of the participants’ descriptions of their STEM experiences. The comments related to the chilly climate fell into two broad categories of gender-related discrimination (i.e., male-dominated classes, fewer female professors, sensing that they were treated differently because of gender) and aspects that were not gender related (i.e., large class size, unsupportive peers and faculty, competition for grades). WS2 commented on the gender-related chilly climate:

They [male peers] think that women are basically average or the ones who are failing the class, or who don’t know anything, or who are going to bring you down if you study with them. So they’re [women] thought of as the people that you can’t study with because they’re in different scales of how you understand things. But then when I start explaining things, and I understand things and I explain them to them, they’re like, “Okay, I’m sorry.”

WLI gave an example of a perceived chilly climate that did not necessarily relate to gender when she described the lack of help she received from her engineering professors: “The faculty . . . I call them the untouchables. Nine times out of ten they are never in their offices.” The leavers tended to identify aspects of the chilly climate as reasons for their decisions to change majors, whereas the stayers mentioned these as sources of frustration that did not affect their interest or ability to fit in with the major.

**Gender conception.** Gender and gender roles in STEM fields were discussed by participants in three ways. Participants believed the only difference between genders is biology (no difference), participants exhibited hidden gender stereotypes in their discussion of gender, and participants exhibited obvious gender stereotypes when describing the role that gender plays in choices and lifestyle. An example of a no-difference comment on gender was GL3’s comment that

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29 I use the term hidden because each of these participants claimed that gender did not create differences between men and women but then reverted to gender stereotypes when they were asked to explain their conception of gender.
Gender doesn’t play much of a role unless you let it. If you let it get to you, if you think ‘oh I’m a girl so I can’t do this’, of course you can’t do it because you don’t think you can.

The hidden gender stereotypes typically came up in terms of differences between men and women. For example, WL1 believed that women were “more emotional” than men. GL1 summarized the obvious gender difference category in her description of the “average female”:

My concept of the average woman is a derogatory one and what does that say, like if I as a female think that the average woman, think of them in terms of them as barefoot and pregnant in the kitchen.

GL1’s comment also highlighted an aspect of gender that appeared in four participants’ comments, which was the concept that, for women, gender is often used or at least seen as a weakness.

This section has discussed these perceptions because they were mentioned by leavers and stayers. However, upon further analysis these two broad groups were broken down into five cohorts based on their shared paths to STEM (or non-STEM) career decisions. Next, I will discuss the five cohorts that were differentiated by their paths to staying or leaving STEM. The following section broadly divides the participants into stayers (those who persisted or stayed in their STEM field as evidenced by their career plans post graduation) and leavers (those who chose to leave their STEM field). Within the stayer label, three different paths are described. And within the leaver label, two different paths are subsequently described.

The Paths to Staying and Leaving

After analyzing each participant’s college STEM path, there appeared to be five different cohorts of women whose paths led to each woman’s decision to stay or leave her original STEM major. Each cohort contained a variety of original STEM majors, including biology, chemistry, physics, geology, civil/environmental engineering, chemical/biomedical engineering, and environmental science. This suggests that all these majors are equally successful and equally unsuccessful in helping women to persist. None of the departments at State University appear to be losing women in any significant numbers.

This section describes the five paths highlighted by my participants to a STEM (or non-STEM) career decision. Figure 5.1 highlights how these women went from declaring a STEM
major as freshmen in college to their final STEM decision at college graduation. These decisions resulted in five eventual paths to the STEM (or non-STEM) career decision. Table 5.4 outlines the five types of paths, the participants who fell into that category, and their final stem decisions. These paths are Cohort 1: Stayers who only experienced positive influences in college; Cohort 2: Stayers who experienced a mix of positive and negative influences in college; Cohort 3: A stayer who experienced only negative influences in college; Cohort 4: Leavers who experienced a mix of positive and negative influences in college; and Cohort 5: Leavers who experienced only negative influences in college. Each of these paths is highlighted with qualitative evidence that exemplifies how all the influences (including gender conception, expectations of success, and the value of that success) led to members of each cohort making a final decision to stay or leave STEM fields.

Figure 5.1: The pathways to career decisions.
Table 5.4: The five observed paths to staying or leaving STEM fields.

<table>
<thead>
<tr>
<th>Participants</th>
<th>N</th>
<th>College Paths</th>
<th>Final Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS5, GS6, GS7</td>
<td>3</td>
<td>All positive experiences</td>
<td>Stayers</td>
</tr>
<tr>
<td>WS1, WS2, WS3, WS4, WS5, WS6, GS1, GS2, GS3, GS8</td>
<td>10</td>
<td>Mix of positive and negative experiences</td>
<td>Stayers</td>
</tr>
<tr>
<td>GS4</td>
<td>1</td>
<td>Only negative experiences</td>
<td>Stayer</td>
</tr>
<tr>
<td>WL1, WL2</td>
<td>2</td>
<td>Mix of positive and negative experiences</td>
<td>Leavers</td>
</tr>
<tr>
<td>WL3, WL4, WL5, WL6, GL1, GL2, GL3, GL4, GL5, GL6</td>
<td>10</td>
<td>Only negative experiences</td>
<td>Leavers</td>
</tr>
</tbody>
</table>

**Stayers**

**Cohort 1: Stayers with only positive STEM college experiences.** Cohort 1 contained three participants representing stayers who described only positive experiences within their STEM major in college. (See Table 5.5). These women shared the same motivation for choosing their STEM major, which was personal interest in the subject matter associated with their desired STEM career. All three women credited the positive mentoring they received and the positive research experiences in college for their continued persistence in their STEM major. GS6 met her college mentor through her research experience and explained how she was supportive since GS6 could “always call her” and ask her “what to do or what would be the best path.” Her mentor also provided an example of what her future career could be like (Eccles, 2007). This interaction allowed GS6 to assess the attainment, intrinsic, and utility value associated with the career as exhibited by the following comment:

> She was a woman in power and it was nice for me to see that, that you know, I’m not just going to be stuck behind a desk, punching numbers after I get out, so it was nice to see.

GS7 mentioned her mentor as being influential in helping her find research opportunities, noting he “motivated me to do independent study, he kind of inspired me”. Her mentor helped her improve her confidence in her abilities by allowing her to work in his lab. Later GS7 participated in an internship, which further supported her commitment to her career choice. This research opportunity helped her realize that her future career was worth the cost of the hard work
she needed to put in for her biology major and this career fit in with her goals, interest, and identity (Eccles, 2007).

Table 5.5: Individuals in Cohort 1.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Chilly Climate</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS5</td>
<td>Marine Biology</td>
<td>Geology</td>
<td>Master’s in research</td>
<td>None</td>
<td>No difference</td>
</tr>
<tr>
<td>GS6</td>
<td>Biology</td>
<td>Environmental Studies/Bio minor</td>
<td>Wildlife biologist</td>
<td>None</td>
<td>No difference</td>
</tr>
<tr>
<td>GS7</td>
<td>Biology</td>
<td>Biology</td>
<td>Veterinarian</td>
<td>Exists but never affected her</td>
<td>No difference</td>
</tr>
</tbody>
</table>

*Self-reported.

Both GS5 and GS7 discussed the support network within their major as another factor that helped them to persist. GS5 described her faculty and peers as follows: “They’re all just really friendly, they just want you to be interested in it, because they think it’s cool too, so they try to make it exciting, even if it’s not.” It is important to note how different the geology department at State University was compared to other STEM departments. GS5 described smaller classes where she was able to get to know her professors and peers. This was often not the case for participants in other STEM departments.

Yet GS5’s experience was not unique. GS7 also described the support network she found within the biology department, which has large class sizes. “I’ve met several people who are willing to tutor and help out. And different discussions are formed to just talk about research and just different opportunities so it’s competitive but a really helpful community.” GS7 even credited this “helpful community” with increasing her interest and commitment to the major:

Discussing it outside of class just helps, you don’t just draw in what you learn from one course but draw from several different courses from over the years and apply it to actual real-life situations and not only apply to real-life situations but when you are discussing it with people, you’re getting a different viewpoint and also being able to support your findings.

GS7 overcame the typical complaint that large class sizes prevent students from meeting their professors (Seymour & Hewitt, 1997). She made it a point to talk to each of her professors. Her
own curiosity about the material motivated her to ask them questions after class, which led her to interact with all her professors in a positive way as she explained, “I never thought it was hard to meet with any professor. They are more than willing to adjust their schedule and just talk about anything.”

Based on my interviews and observations of the participants, it appeared that their conception of gender affected their perceptions of STEM. All three of the women in Cohort 1 believed that gender differences did not exist, only biological differences. However, all three also realized that social stereotypes could be imposed on individuals by society, and these imposed stereotypes could affect decisions. However, GS5 and GS6 believed that there was no evidence of a chilly climate in their majors, particularly as it related to gender. GS7, however, recognized that some women could be affected by gender stereotypes, such as the idea that women “won’t work as hard because they are more dedicated to family affairs than career,” but she had not witnessed this.

All the women in Cohort 1 believed that the value associated with their desired career matched their expectations of success. Their research experiences combined with their support networks helped them to see how well their career fit with their identity. They were able to try on the identity of researcher within their interested career and for all three women they saw it as a good fit. The research experience also served as a source of knowledge regarding their future STEM career. They explained that the costs associated with that career (i.e., long hours of work, perhaps putting family plans on hold) were worth the end result. The support systems and research experiences helped the students to realize their interest in STEM fields to a greater extent and to decide whether their goals matched their career. And finally, all these women had high expectations for success in their field. Their expectations and values were colored by their perception that gender was not a hindrance, which also allowed them to persist and see success in their STEM field as a viable option.

**Cohort 2: Stayers with mixed college STEM experiences.** Cohort 2 contained ten participants representing stayers who described having a mix of positive and negative experiences in their college STEM programs. (See Table 5.6). These women reported positive factors similar to Cohort 1. Seven discussed the role of positive mentors. Nine mentioned the influence of positive research experiences. And three said that their STEM major provided a
supportive environment that helped them to persist. However, these women also experienced some negative influences with three participants reporting doubt or frustration in their major choice, two mentioning the negative effects of the poor grades they experienced, and five discussing the perceived chilly climate within their chosen STEM field. Despite these negative experiences, all of these individuals stayed in their STEM major. Each of them believed that the positive experiences outweighed the negatives. I also noticed that each person’s conception of gender influenced their overall perception of these college experiences.

Like the members of Cohort 1, many of the women in Cohort 2 described how helpful their mentors were in making them feel like they could succeed and were welcome in the STEM community. For example, GS1 described the open door policy of her professor that made her feel comfortable: “He wasn’t bothered at all if you’d go to his office hours every time; every day he would just be there and answer your questions.” Similarly, GS2 described the confidence she gained in her own abilities because of her mentor’s support. Her mentor used his connections to help her find a summer internship, which she interpreted as follows:

He believed in me enough or put his reputation on the line to recommend me to another scientist. So besides the fact that he helped me in the lab, he also helped me like get outside of [State University] in the physics community.

The relationships with mentors gave participants’ confidence that they were worth the time and resources of the scientist/engineer and therefore could fit in and succeed in STEM.

Mentors also affected the views of the women in Cohort 2 regarding the high level of support they received in their STEM majors. Two women who had participated in WSTEM mentioned their involvement in this program as a source of support. WS4 described the sense of confidence she felt just from having other people that she knew in classes: “Every single science class that I’ve had, I’ve had at least 2 or 3 WSTEM girls in it. So I am never alone in any of my science classes.” This sense of support as a source of confidence was also mentioned by WS5:

[Engineering] is a challenge and it’s hard to know that it’s possible for you if you’re like self-doubting or whatever and I think that’s what SWE [Society of Women Engineers] and WSTEM do, is just prove to you, “look it’s possible, you can do it” . . . which is good. Similarly GS8 described the support network in her engineering major as a “little family” whose members were “always there for each other.” She credited this support as helping her to realize that she could succeed in her major. These descriptions of mentors, supportive faculty, and peers
highlight how much the support from faculty and peers affects students’ expectation that they
can not only fit in but also succeed in STEM fields (Eccles, 2007).

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Chilly Climate</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1</td>
<td>Biology</td>
<td>Environmental chemistry</td>
<td>EPA/Fish and Wildlife/SeaWorld/Zoo</td>
<td>Exists but does not affect her</td>
<td>Hidden stereotypes</td>
</tr>
<tr>
<td>WS2</td>
<td>Biology</td>
<td>Biochemistry/ Biomathematics</td>
<td>PhD in physiology or molecular medicine</td>
<td>Gender related and affected her</td>
<td>Hidden stereotypes</td>
</tr>
<tr>
<td>WS3</td>
<td>Physics</td>
<td>Physics</td>
<td>PhD/Physics</td>
<td>Exists but does not affect her</td>
<td>No difference</td>
</tr>
<tr>
<td>WS4</td>
<td>Biology</td>
<td>Biology/ Psychology</td>
<td>Pediatric Endocrinologist</td>
<td>Exists but does not affect her</td>
<td>No difference</td>
</tr>
<tr>
<td>WS5</td>
<td>Chemical Engineer</td>
<td>Environmental Engineering</td>
<td>Grad school engineering</td>
<td>Exists but does not affect her</td>
<td>Hidden stereotypes</td>
</tr>
<tr>
<td>WS6</td>
<td>Biology</td>
<td>Biology</td>
<td>Pediatric Dentist</td>
<td>Affected her career decision</td>
<td>Hidden Stereotypes</td>
</tr>
<tr>
<td>GS1</td>
<td>Biology</td>
<td>Chemical-Biomedical Engineering</td>
<td>PhD specializing in robots</td>
<td>Exists but does not affect her</td>
<td>No difference</td>
</tr>
<tr>
<td>GS2</td>
<td>Physics</td>
<td>Physics</td>
<td>PhD/Physics</td>
<td>Exists but does not affect her</td>
<td>No difference</td>
</tr>
<tr>
<td>GS3</td>
<td>Biology</td>
<td>Chemistry</td>
<td>PhD chemistry</td>
<td>Exists but does not affect her</td>
<td>No difference</td>
</tr>
<tr>
<td>GS8</td>
<td>Engineering</td>
<td>Environmental Engineering</td>
<td>Grad school engineering</td>
<td>Gender related and affected her</td>
<td>No difference</td>
</tr>
</tbody>
</table>

Similarly, research experiences were also reported as positive influences on persistence,
even if they caused individuals to change their career goals. For example, WS4’s research
experience in marine biology helped her to realize that she was not as interested in the major as
she had originally thought. “It [the marine biology research] was tedious and it just wasn’t fun.
And then I worked in a diabetes lab with the college of Medicine. And I loved it. I’ve learned so
much and I actually get to work with patients.” WS4’s experience, even her negative research
experience, helped her try on the career she was interested in and realize that the original career
did not fit with her goals or interests. Her later experience in the college of medicine helped her to find a career that she was interested in, fit with her goals of helping children with diabetes, and her identity as a person who loved working with children (Eccles, 2007).

All the women in Cohort 2 also experienced negative influences that caused them to question their STEM career goal. These negative influences were often colored by their conception of gender. Five of these women believed that the only difference between men and women was biological sex. Like the women in Cohort 1, these five women understood that gender stereotypes could be imposed on women but none of them felt personally affected by these imposed stereotypes. For example, GS8 recognized that there were fewer women in her major; however, because of her perception of gender, she saw this male domination as a source for the solidarity she described among the women in her major. Similarly, WS1 said,

I like being in a field that’s predominantly men because I just feel like I have something else to bring like a different mind-set, like I can offer a different perspective on something and so I would say that definitely the science field is dominated by men, but I am not intimidated by that aspect.

Both GS8 and WS1 felt a sense of motivation to succeed based on their minority status in their STEM fields.

The other five women in this cohort held some hidden stereotypes of women because these women believed that gender did not make a difference but then when asked to describe their gender conception, they reverted to gender stereotypes. For example, WS1 and WS5 said that there was no difference in terms of gender, however they described women as being caregivers and men as being providers based on their own experiences with their parents. WS6 believed that women “tend to be more emotional.”

These gender stereotypes affected the way that these women saw the chilly climate within their STEM majors. For example, WS5 hinted at an observation of the chilly climate within engineering in her description of the male-dominated classes. She described “all of the female professors” as looking like they were “extremely in over their heads.” She said that she never saw them “slowly walking; they’re just running from one place to the next, so busy it appears, just bogged down.” Despite these observations of female professors, she believed that
female students were “not treated any different” from their male peers, yet when pressed to explain this further she said,

You can definitely feel . . . not quite competition but the strain of, like, “Okay, well I have to make it, I have to do good because I am not going to be forgiven so much.” . . . It’s a lot easier to notice a girl is missing than a guy is missing from a class.

Despite witnessing a gender difference in the workload of female professors, WS5 said that she had not personally experienced gender discrimination but thought that she might later on in her career.

WS5 was not the only person to suggest that women might not be “wanted in the science workforce.” GS1 made similar comments when she discussed the “good old boys club in physics” that she observed. She reported that her male peers often “did not take her as seriously right off the bat”; however, she perceived this good old boys club and the treatment she received from her peers as evidence of the scientists’ lack of experience and understanding of how to interact with female peers since there had always been so few and not to gender discrimination.

Some of the negative experiences that the women in Cohort 2 mentioned related not to gender but to the difficulty of their STEM major. GS1 described the amount of time she put into the major:

During the school year, I maybe get four hours of sleep a night, so like I mean I wake up, go to the gym, go to class, go to the lab to do research, come home, then I have quantum mechanics until two o’clock in the morning or three o’clock in the morning and it’s like you’ve got to get it done, so you finish it.

She said this pace affected her health during one semester. When I asked her if this experience affected her decision to stay in physics, she replied that it did not deter her from her commitment to the major.

GS3 described her frustration with some of her grades in her major, but she said, “You have to keep going. If you stop, then everything is going to fall apart and I’m not that lazy. You just have to suffer until you get what you want.” And for GS3, working in organic chemistry was what she wanted. She explained that her love for the subject matter motivated her. She tended to be tough on herself over grades because she felt that she made “rash decisions” on tests that hurt her grades. And yet even with this frustration, GS3 plans to continue in the organic chemistry field in graduate school. She considers the cost of the career worth the end result.
Similarly, GS8 experienced frustration in her major of engineering which she considered leaving. “Physics was so tough to me, because it is a huge class and the professors were all so smart. I just cracked. I didn’t think I could do it because I thought “if all these classes are this hard then how the heck am I going to do when I actually get into my major?” She discussed her concerns with a male peer who convinced her over a series of conversations that she could be successful in engineering. “Then, I changed my classes back and I am so happy that I did.” Both GS3 and GS8 said poor grades were a negative influence that affected their confidence in their ability to succeed in their STEM major and eventual career. However, both women were able to overcome this doubt. Their positive experiences with mentors, research, and peers helped them to see that their eventual career was worth the cost associated with it. These women also reported their continued interest in the subject matter as well as their ability to identify with their peers as positive influences on their persistence.

As a group, the members of Cohort 2 were able to overcome their negative experiences and persist in their STEM major. Each woman’s experience associated with STEM helped her to perceive that she fit in with the culture of her major and that her desired career fit with her current and future goals, as well as with her interests. All the women in Cohort 2 felt that they could succeed in their STEM fields and find personal satisfaction in these fields, which made the cost of the major worth the end result (Eccles, 2007). However, the gender stereotypes that some of these women held, such as women as caregivers, could affect their continued persistence in their future STEM careers (Butler, 1999; Harding, 1997).

Cohort 3: The stayer with only negative college STEM experiences. Cohort 3 was composed of one stayer who reported having only negative college STEM experiences. (See Table 5.7). At first, I was confused by this individual’s stayer status because she was the only member of this cohort. However, further analysis indicated a number of aspects about GS4 and her path that explain her membership in this cohort. First, one of the negative influences she mentioned was the poor grades that she had received in some of her STEM classes. She self-reported that her average college science and math grades were B’s. By some measurements, this average would not be considered poor. However, GS4 described her experience within her major as “an everyday battle. Science classes are so frustrating.” She credited her frustration to the low grades she received on quizzes even after spending long hours studying for them.
Second, GS4 had never found a mentor in her college STEM classes, which is an issue that she said, led to her indecision in her major (she briefly switched to religion during her freshmen year but then returned to chemistry in the same semester). She believed that her inexperience as the first member of her family to go to college affected her ability to find mentors, noting, “I’m charting new territory so it’s kind of hard for me to find a mentor and I think that has affected my stability within my major.” This lack of mentoring often affected her ability to see herself as a member of the STEM culture.

Table 5.7: Individuals in Cohort 3.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Chilly Climate</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS4</td>
<td>Chemistry</td>
<td>Chemistry</td>
<td>Physician’s assistant/later in life chemistry teacher</td>
<td>Affected her career decision</td>
<td>Hidden stereotypes</td>
</tr>
</tbody>
</table>

Third, GS4 encountered aspects of the chilly climate, especially as it pertained to gender, which added to her frustration. She said that she had yet “to have a female teacher,” saying that “it can be hard to only have male professors because I think that because they’re male, they inherently don’t understand a female’s perspective.” And yet she was able to see this positively because she believed that women have a unique female perspective to provide that makes her an asset to her classes.

Depending on one’s categorization of stayers and leavers, GS4 could be considered a leaver in that she originally wanted to be a medical doctor but then changed her career goal to a physician’s assistant\(^{30}\). She said that this decision was related to her future family plans:

I think that [being a physician’s assistant] makes a great option for being a mom one day, only having one part-time job as opposed to having to go to work from 9 to 5 every day or the crazy hours that doctors also work. So I think that PAs [being a physician’s assistant] would allow more flexibility for having a family.

\(^{30}\) I made the decision to keep GS4 in the stayer category because her major was biology and a physician’s assistant career requires more science specialization after college, similar to master’s programs in other STEM fields.
She also mentioned becoming a chemistry teacher after working as a physician’s assistant for a few years. In terms of the hierarchy of difficulty, physician’s assistant and chemistry teacher would fall into lower levels of difficulty and into the periphery of the STEM label (Kuenzi et al., 2006).

Her decision to change her career goals appeared to be a result of her view that a medical career was chilly toward women who wanted to have a family. This change also was affected by the values she placed on her career. Being a medical doctor was not worth the years of school she would have to attend and perhaps jeopardize her childbearing years. And this goal of having children outweighed the goal of being a medical doctor. She saw the career of a physician’s assistant as allowing her to still work in the medical community in a career that fit with her interest and identity, but would also allow her to achieve her goals of having a family (Eccles, 2007).

Despite GS4’s experience with low grades in some of her classes, her overall GPA was still high. Her success helped her to feel confident that she could succeed in her desired career. She credited her motivation and “passion” for her eventual career that drove her to persist. “I really have to soak up those moments where I really love what I’m learning so that I can fight through the times where it’s frustrating.” She said that the difficulty of her chemistry classes motivated her to continue as she described when she discussed her brief time as a religion major. “I loved my religion classes but they weren’t challenging enough.” Despite her STEM classes being “so challenging and frustrating at times,” she saw her STEM career options as “more practical.” In the end, she saw chemistry as a “practical” major that would help her to find a career that would allow her to accomplish her goals of having children and challenging herself.

Consequently, GS4 was able to overcome her doubts and frustrations by changing her career goals to better fit with her life goals. One piece missing from her life history was the idea that she fit in with her peers. She never described a sense of fitting in, which as the next section will show tends to negatively influence STEM persistence. And perhaps this could affect her later career decisions. In this case, the career was enough of a motivation to get GS4 through the frustrations of her STEM major.

**Summary of stayers.** All three of the cohorts discussed so far have represented the fourteen women who stayed in a STEM major and continued onto a STEM career path. Their
college STEM experiences caused eleven of these women to question their desired STEM career. Each of these women was able to reach a STEM career decision that allowed her to see the value that the career holds. Each of these women believed that she would be successful in her STEM career. This chosen career matched the women’s identity, interests, and goals and was worth the cost required to achieve it (Eccles, 2007).

All 14 of the women in Cohorts 1, 2, and 3 believed that their gender had not been a barrier to them in STEM, although some of them felt that gender could be a barrier for some women. Three of the stayers perceived gender discrimination in future careers based on family planning issues; however, this perception did not deter them from persisting. For two of these women, this perception mainly affected their choices for more female friendly STEM careers (i.e., GS4 chose to change from medical doctor to physician’s assistant, WS6 chose dentistry because dentists’ hours were not as long as medical doctors’ hours). And for some of these women (GS8, WS3, and WS4), the possible discrimination that existed motivated them to try to get more women into STEM fields. Consequently, these women did not see gender as an issue that affected them in college. Their perception of gender as not having a role in STEM at the college level combined with their expectations and values associated with their future careers led to their decisions to stay in STEM. This was not the case for the next two cohorts.

Leavers

**Cohort 4: Leavers with mixed college STEM experiences.** The fourth cohort contained two participants who had a mix of positive and negative college experiences that eventually led to their decision to leave their STEM field. (See Table 5.8). Both of these women identified positive experiences within their STEM fields. WL1 participated in a paid research opportunity that she enjoyed. She felt that her experience in research had strengthened her desire to persist in her engineering major. However, other factors convinced her to leave STEM. WL2 also participated in research at a chemistry lab at State University and noted the following regarding the support and mentoring she received in her chemistry major, including her work with the head of the chemistry department: “I could talk to her about the class at work and vice versa. And so she was supportive.” WL2 also mentioned the positive STEM support she received as a member of WSTEM.
It was just very supportive because we all lived on the same floor, we were taking the same classes so we had people to go to if we needed help or just vent about chemistry . . . and [the WSTEM director] was always there if we needed her to talk to. She was definitely supportive in whatever we did, she wanted us to excel.

WL2 mentioned both the positive support she received from her peers as well as from the director of WSTEM and physics faculty mentor.

Table 5.8: Individuals in Cohort 4.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Chilly Climate</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>WL1</td>
<td>Chemical Engineering</td>
<td>Chemistry Education</td>
<td>High School Chemistry Teacher</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>WL2</td>
<td>Chemistry</td>
<td>Psychology</td>
<td>Child Psychologist</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
</tbody>
</table>

Unfortunately for both WL1 and WL2, their grades, in combination with their conception of gender and the chilly climate (both gender related and nongender related) within their majors, eventually caused them to leave. Both of these women originally were doing well in their STEM classes. However, as they moved forward in their majors to their higher level classes (i.e., for WL1 classes specifically geared to chemical engineering and for WL2 organic chemistry), they began to question their ability to succeed because of the grades they were receiving. To compound this lack of self-confidence, WL1 also felt that she was not receiving adequate support in her major and referred to the faculty in her department as “the untouchables” because they were never available. Even when she was going to office hours, she still felt that she was not succeeding.

I was involved in the classes. I put in more work. I was going to office hours and spending all my time doing homework and trying . . . and doing reading and I still felt like I wasn’t getting anywhere. It was like my grades didn’t reflect the effort I put in. This frustration with her performance in class compared to the work she was putting in eventually led WL1 to leave her chemical engineering major.
These two women also had very distinct conceptions of gender that were different from any of the previous cohorts in that they believed that obvious differences exist between genders. For example, WL1 said that women were better leaders and tended to “think more deeply about things” than men. WL2 believed that men could be “less compassionate” than women. This idea that women were more compassionate also led her to believe that they were better teachers because they “make sure you’ve learned it and explain things differently.”

Each of these women began considering other career options when they encountered both the chilly climate and other frustrations, including low grades and lack of help from faculty. WL1 described her decision as follows:

So I got to a very stressful moment where I am just like, I don’t like the feeling of not knowing what’s going to happen to me, because if I fail any of these classes, I have to wait a whole year to retake them. I got to a point where I was like, I need to make a decision that fits.

This “stressful moment,” as she called it, led her to look at other majors that would accept the courses that she had already taken. She found that chemistry education would accept most of her STEM courses, which would prevent her from having to pay for an additional year of school.

WL1’s decision to leave her chemical engineering major was also based on her inability to see herself as a member of the program. In her first interview, when she was still a chemical engineering major, she said, “Science has nothing to do with me. I’m just wide open and science is just the complete opposite of me.” Here she suggested that her identity as someone who was “wide open” did not fit in with science, which she described as the complete opposite. This description of her peers as the “complete opposite” highlighted that they were “the nerds of the nerds” who “look like the sleep deprived students.” She added that she tried “not to make it [the engineering building] her second home,” noting, “I try to go home and take showers as often as possible.” Here she again makes a point to separate herself from the other students. These comments highlight how WL1 never identified with the other engineering students, which suggests that her identity did not fit with this career. She also saw the poor grades she was receiving in her major as an indication that she would not be successful in the eventual career. This lack of perceived success in combination with her lack of interest and inability to identify with her major, were seen as costs for her (Eccles, 2007). Consequently, the costs of the major
were not worth the career. As a result, she changed her major to chemistry education, where she felt she could still maintain her interest in chemistry and find people that she could identify with.

WL2’s decision also highlighted the aspects of Eccles’s expectancy-value model when she decided to switch from chemistry to psychology. She expressed how she enjoyed her major when she was doing well and could still see herself as being successful in her career, but she began to question her STEM career choice when she began to do poorly in classes. “It got harder and I just found that working in the lab all day every day probably wasn’t for me. I realized that to be happy I would have to work with people and children especially.” WL2 expressed how she began to realize that chemistry and “working in the lab all day” were not going to meet her goals and interests of working with people. She also found that the teaching styles of the faculty in her department were not conducive to her learning.

They just come in, teach the class and get out. I didn’t feel the connection with them to the subject, which I think helps. If you feel that they like it, then you’ll be able to ask them more questions.

As WL2 spent more time in the chemistry department, she began to realize that her personality did not fit with the other individuals in the chemistry major. She described chemistry majors as “more into doing the research and spending long hours in the library,” whereas she saw psychology majors as more “friendly.” Eventually, WL2 chose to change her major to psychology with a focus on child psychology. Her decision was based on her interest in children and her sense that she was the type of person people come to with their problems. Her experience in the chemistry department gave her a sense that she did not fit in with her peers in the department (despite fitting in with her peers in WSTEM). Her experience with low grades and the workload of chemistry made her desired career no longer worth the cost. She also felt that she would have a higher likelihood of success in her desired career of child psychology. All these expectations and values combined with her gender view of women as caregivers led to her decision to leave her STEM major.

Both of the women in Cohort 4 reported that they spent time reflecting on their decision to leave their STEM major. In the end, the positive experiences they had were not enough to sustain their interest in STEM. Neither of these women fully identified with the STEM culture of their major, which also led to their decision to leave and affected their perception of the STEM major. As each woman progressed further in her STEM major, she began to doubt her ability to
succeed. Both chose careers that fit better with their interest, identity, goals, and gender perceptions. The gender perceptions in particular influenced these women to change their career choices to ones that they considered to be more female friendly, such as teaching and child psychology, which is a concept that both said made them feel more comfortable.

**Cohort 5: Leavers with only negative college STEM experiences.** Cohort 5 contained 10 participants representing six leavers from the general population and four leavers who participated in WSTEM. (See Table 5.9). Before describing the influences that led to each of these women’s decisions to leave STEM fields, I will briefly mention the rationale for how the WSTEM members were assigned to this group.

Three of the four WSTEM members mentioned the positive social support they received from their peers in WSTEM. However, their comments all related to friendships and not to STEM. The positive and negative experiences in this study focus on those related to STEM. For example, all the general population leavers enjoyed their college experiences and made friends despite their decision to leave STEM fields, but those experiences were not related to STEM and therefore not part of their narrative life history as it pertained to their STEM career decision. Consequently, because the WSTEM leavers’ positive comments about WSTEM were limited to the social network they formed and unrelated to STEM, I chose to put them in this group of participants who had only negative STEM experiences that led to their decision to leave.

The women in this cohort all changed their major from STEM to non-STEM within the first year and a half that they were at SU. (The members of the previous cohort stayed in their STEM major for at least 2 years before making their decision.) These women also shared a common gender conception (except for GL5) as they believed that there were obvious differences based on gender and used gender stereotypes to make these differentiations. For example, WL3 described women as “more emotional,” and WL4 believed that women were “friendlier.” GL6 stated that she believed the stereotype that women were not as good at math and science as men was “valid to a certain degree.” These beliefs affected how these women viewed their ability to succeed in male-dominated STEM fields. The gender views of these participants could also be seen in two of their perceptions of “average woman being more interested in finding a boyfriend than having a successful career” (GL1). However, both of these
women (GL1 and GL2) believed that they were different from this “average woman” description, which was a quality that allowed them to compete on the same level as men.

Table 5.9: Individuals in Cohort 5.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Chilly Climate</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>WL3</td>
<td>Biology</td>
<td>Sociology</td>
<td>Social Worker/Counselor</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>WL4</td>
<td>Biology</td>
<td>Marketing Psychology</td>
<td>Marketing representative for fashion industry</td>
<td>Exists but does not affect her</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>WL5</td>
<td>Exercise Science</td>
<td>Social Science Education</td>
<td>Teacher</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>WL6</td>
<td>Biology</td>
<td>Environmental Studies</td>
<td>Lawyer/Lobbyist</td>
<td>Gender related and affected her</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>GL1</td>
<td>Biology</td>
<td>Creative Writing/ Communications</td>
<td>Editor/Writer</td>
<td>Gender related and affected her</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>GL2</td>
<td>Biology</td>
<td>Humanities</td>
<td>Run an exotic animal shelter</td>
<td>Gender related and affected her</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>GL3</td>
<td>Civil engineering</td>
<td>Classical civilizations</td>
<td>Master’s/PhD in history</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>GL4</td>
<td>Chemistry</td>
<td>Nursing</td>
<td>Nurse</td>
<td>Affected decision (not gender related)</td>
<td>Obvious stereotypes</td>
</tr>
<tr>
<td>GL5</td>
<td>Biochemistry</td>
<td>Sociology</td>
<td>PhD sociology</td>
<td>Affected decision (not gender related)</td>
<td>No difference</td>
</tr>
<tr>
<td>GL6</td>
<td>Biology</td>
<td>English literature</td>
<td>Book editor/advertising</td>
<td>Affected her career decision</td>
<td>Obvious stereotypes</td>
</tr>
</tbody>
</table>

GL5 was the only individual who believed that there was no difference between genders, saying that gendered traits are socially imposed but “each individual has a choice in how they create their gender and respond to those that are imposed.” She described gender as a scale with
individuals falling somewhere between a “level of femininity or masculinity.” GL5 graduated with a sociology degree and is now in graduate school working on her PhD. Her senior thesis focused on gendered perspectives of rape. Therefore, her conception of gender was shaped by the sociological definitions of gender that she learned in her major.

The remainder of the women in this cohort described gender differences in terms of stereotypes. These stereotypes were often supported by the lack of women that served as role models within these fields. For example, GL1 discussed the “old boys system” that she observed as a science major. “All the science directors are male. I can’t even imagine if I was a female scientist at [State University] and 95% of my colleagues are male, who is my role model at [State University]?” Similarly, WL6 said that “I still feel like women are looked at like we can’t do as much as men can.” GL2 discussed her feeling of not fitting in as a woman in a male-dominated field: “Most of my teachers in science and math were male, which could have subconsciously played into some of the insecurities I had in the subject already, like maybe they were intensified by the fact.” GL2 understood that her feelings were based on her perceptions but admitted that the lack of female professors affected her confidence within the field.

Even GL5, who believed that gender was based on a continuum and not in gendered stereotypes, recognized the gender division in all fields, including STEM. She believed women’s decisions to start a family played a role in their ability to achieve tenure. Despite believing that men and women were equal, here she described the inequitable treatment that she believed women received in higher education because of their gender.

Other members of Cohort 5 identified aspects of the chilly climate that did not pertain to gender. GL1 described her perception of the negative influence of the weed-out system within the science culture:

I always felt to some extent that science is designed to pick people off like flies . . . like that’s even how the program is described to you. And I thought, “What if I am one of those people who fails this? I should jump ship now.” And I think that mentality is what was probably detrimental to my experience.

Here GL1 expressed how she was already beginning to doubt her success merely at the mention that half of biology majors tend to switch to non-STEM majors.
Another aspect of the weed-out system that affected the heightened perception of a chilly climate was poor teaching by college faculty. GL4 described the poor teaching she received in her major and how it influenced her decision to leave:

I was a chemistry major because I wanted to go into research and find a cure for some disease, like breast cancer. And then I changed my mind because of my organic teacher. He was a really bad teacher. He didn’t really relate to students that well. He didn’t really seem to care if people knew what we were learning, he just kind of went over the material and was done with it. Nothing that he did made you want to listen in class. That was a really big deal.

For these leavers, the negative teaching styles they experienced in college were often compared to the positive teaching styles they had in high school. This often affected their decision to leave, as was the case for GL3 and GL4. This difference between high school and college affected their ability to feel like they fit in with the major.

This concept of not fitting in was another aspect of the chilly climate that is often ascribed to the weed-out system. For instance, GL6 discussed how the large classes within her STEM major (a typical weed-out system tactic) affected her ability to meet people in her major: “I wasn’t making friends in a lot of my classes because the class size is huge and everyday you would sit next to someone different.” She discussed how she really yearned for “someone that [she] could just settle down and study with . . . like a friend in the class.” GL3 highlighted this sense of not fitting in when she described what the culture of her STEM major was like: “Science is just so much more uptight. It was a much more tense culture; as a general rule they weren’t the most joyous crowd.” For both GL6 and GL3, the fact that they were not doing well combined with their sense that they did not fit in with the culture of their major led to their lack of interest in their STEM career and resulting choice to switch majors (Eccles, 2007).

Many of the participants in this cohort reported poor grades. These women would compare their performance in college to their performance in high school where they had received A’s and B’s. GL6 described how she was getting B’s and C’s on tests in chemistry, which she “was not used to.” Similarly, WL6 described her reaction to low grades as follows:

I took Organic II for about a week. I took the first test and I got a 12 . . . and I was just like, wow this is horrible. And I decided obviously that I needed to drop the class. I kind
of came to grips that I was never going to get into vet school with the grades that I had. I just couldn’t.

WL5 said “I quickly learned, after being forced by an advisor to take 17 hours my first semester and getting basically all C’s, that science was not going to be my thing.”

GL2 had a similar reaction to her poor grades: “I figured if I couldn’t do it, trying wasn’t going to help me. Basically I felt like, oh I’ll never be good at this.” These women began to doubt their ability to succeed in STEM fields, which influenced their decision to leave.

All the women who mentioned poor grades believed that they could not improve their test scores. They believed that their subsequent low GPAs would prevent them from obtaining their career goal. However, all these participants took honors and Advanced Placement STEM classes in high school and received merit-based tuition scholarships for college, indicating that their high school GPA was above 3.0 and their SAT scores were above 970. Again the issue raised here is the difference in each individual’s experience during high school. Classes are not exactly the same at each high school; therefore, preparation might differ. And GPAs and SAT scores might not adequately gauge the level of preparation necessary for college STEM classes. Therefore the question raised here for future research is as follows: Were the students in Cohort 5 less prepared than the stayers or was it the way in which they perceived the meaning of low grades?

Some of these women did take advantage of research internships, like the women from other cohorts, but their experiences helped them to decide not to persist in STEM. GL6 described her research experience as follows:

I enjoyed the research, but once I really got a taste of the laboratory setting, you’re not making ground breaking discoveries every day and you know it’s just a lot of tedious observation and a lot of its not even that cool to watch.

Her statement shows that based on her experience during research, science was not fun. This perception affected her motivation to remain in her STEM major. Similarly, GL1 described her experience in a male-dominated research lab: “I would say that it was a good experience but it convinced me that it was not the right place for me. It was a silent, sterile environment where I was not trusted to do anything.” Here she described the dichotomy she felt in that she enjoyed some of the things she did in the lab, however, she felt that she was treated as inferior and did not fit in with the others present.
Both GL1 and GL2 discussed this perception of being treated as inferior within a STEM major. These two women reported that the attitude within their original STEM major affected their decision to leave. For example, GL2 described the sense of superiority her fellow science majors had that made her feel inferior. “To be around people who would think ‘my major is superior,’ that made me uncomfortable.” GL1 described a similar attitude of superiority among science majors:

It’s competitive in a more “this is how much I know and this is how you know” kind of way. Even when I would do study groups, I never got things as quickly as the others did and they would look at me and say, “how do you not get that?” And there is nothing that will make you feel more stupid than that. Like “how are you not getting this, we’ve all got this, do you see that we all understand this and you don’t?” Yea . . . they didn’t need to tell me; I was aware.

Both GL1 and GL2 felt that this attitude within the major made them feel inferior, affecting their ability to identify with their peers and influencing their decisions to leave (Eccles, 2007).

For each of the women in this cohort, a combination of experiences eventually led to the decision to switch to a non-STEM major. For example, WL3 described how she began to doubt her ability to succeed in a STEM career because of her poor grades combined with her lack of interest in STEM and her desire to participate in other activities that she could not do because of the time commitment (cost) to her studies. These eventually led to her decision to switch to sociology. Similarly, GL1 mentioned how her lack of success in her classes compounded with her sense of not fitting in with her peers led to her lack of interest and decision to leave.

Things never clicked for me. I never felt camaraderie with my fellow students. And being an outsider affected my inability to find someone who was willing to sit down and really spell it out for me in a way that made sense for me.

Two of these women believed that they could succeed in their STEM field, but the cost of this success was not worth it to them. GL3 described her experience in the engineering major as follows:

I just remember sitting in there and thinking, “Do I really want to be doing this for the rest of my life?” And it was one of those things where I could work towards it, I could finish it, but at the end of the day, I wasn’t enjoying it.
Also, after her introduction to engineering course she had a clearer picture of what engineering would be like.

It [engineering] didn’t fit my idealized perception of what I would be doing and that’s when I decided you know since I love history and it’s something that I could always have fun at . . . so I decided to switch to that.

Here, GL3 realized that the career and subject matter she had originally envisioned were very different from what she was experiencing. Her disinterest in the subject and heightened interest in another affected her decision to leave STEM. All the leavers highlighted how they began to realize that their original STEM career choice did not really fit with their overall goals and interest, which made the cost of attaining those careers not worth the end result.

**Summary of leavers.** All the women in the leaver group entered college with confidence in their ability to succeed in a STEM field. Perhaps they had not been adequately prepared for the workload or expectations of their chosen STEM career; however, their grades and high school courses were comparable to the women who stayed in their STEM career. Rather, the leavers tended to believe in gender stereotypes of women being caregivers, emotional, and, for some, not genetically predisposed to be successful in math and science. This perception of the female gender had some impact on these women’s perceptions of the chilly climate and their overall ability to fit in and be successful in male-dominated STEM fields. These women also weighed their options and decided that the STEM career no longer fit with their identity, did not provide the same level of interest or enjoyment, did not fit in with their current and future goals, and was no longer worth the cost to achieve it (Eccles, 2007). The negative experiences within the STEM major also made many of these women lower their expectations of success in STEM careers. Consequently, gender conception combined with components of Eccles’s expectancy-value model to influence these women’s decisions to leave STEM fields.

Even for those leavers in Cohort 4 who had positive experiences in their major, their conception of gender, expectations of success, and values ascribed to that success affected their decisions to leave STEM fields. All these women found careers that they believed fit with their identity, interests, and goals much better than their previous STEM career plan. And for many of them, the costs associated with these careers were either much lower than their previous STEM major (i.e., less workload, better grades) or worth the end result (i.e., lower pay).
Discussion

This chapter presented the findings related to my first research question regarding the influences that affect college women’s decisions to stay or leave STEM fields. The use of narrative life histories revealed that each individual had a unique path to her eventual STEM career decision. However, some of these paths overlapped to create five cohorts (three stayer cohorts and two leaver cohorts). The conceptual framework for this study helped to tease out the trends within each cohort that led to STEM career decisions. Butler’s (1999) concept of gender did not make the assumption that there is a common female experience based on gender. And that was the case for the participants in this study. Each of them had a conception of gender that was colored by their own experiences. This conception of gender was just one aspect of their identity, a concept that is a crucial part of Eccles’s model.

Eccles’s (2007) expectancy-value model for career choice provided a framework to view this decision process. In the expectancy-value model, individuals weigh the value they place on a desired career with the expectation of success in that career to make their decision. In this study, all the participants planned on working in a STEM career when they entered college based on the positive precollege experiences they had, including successful science and math experiences), having a supportive high school teacher who fostered their interest in STEM, and supportive parents. These results supported findings in the literature related to the role of positive STEM experiences (Burkam et al., 1997; Jones et al., 2000) and positive socializers (Carlone, 2004; Dick & Rallis, 1991; Rayman & Brett, 1995).

All these women entered college believing that they could not only succeed in their desired STEM field but that they also would fit in with this career. This concept of identifying with a STEM career has been shown to be important for persistence (Olitsky, 2006; Ong, 2005). None of these women believed that gender discrimination existed in STEM fields before college. They all had been positively supported by their parents or their teachers and they all had success in science and math classes. These results differed from previous research that concluded women tend to receive less support from their teachers and parents in precollege STEM experiences (Carlone, 2004; Dick & Rallis, 1991). And the participants’ beliefs before entering college that gender was not an influence or concern in STEM contradict previous research on the masculinity of STEM (Brickhouse & Potter, 2001; Carlone, 2004). Consequently, all these women focused
on the positive experiences that they had had before college and saw these as evidence that they could succeed in STEM and that this success was valuable.

**Motivation**

These positive experiences also affected their motivations to choose a STEM major (and the subsequent STEM career) when they entered college. These motivations introduce the first value in Eccles’s theory: intrinsic value. Those students who were motivated by personal intrinsic interest had a higher likelihood of persisting because personal interest motivated 12 of the stayers and only two of the leavers. This intrinsic value associated with career choice (i.e., how much interest or enjoyment one derives from the career) appeared to be more motivating than extrinsic values (i.e., making money or simply because one was successful in the subject). The positive influence that personal interest had on persistence in comparison to the other motivations (i.e., helping others, misconceptions regarding science, making money, and previous success) also supported the positive role of intrinsic value.

Ten women mentioned helping others as their only motivation for choosing a STEM career. This result indicates two implications. First, helping others is not a strong enough motivation to maintain persistence in STEM fields. Or, students who want to help others tend not to persist in STEM fields because of a perception that STEM careers are not helping careers. However, despite six leavers mentioning helping others compared to only four stayers, this is not a significant difference. Based on these results, I cannot adequately conclude that either of these implications is correct. However, the overall low frequency of this category (only 10 women mentioning helping others as a source of motivation) could indicate that previous research on gendered motivations such as helping others is beginning to change (Eccles, 2007; Seymour & Hewitt, 1997). And finally, the misconceptions about STEM fields that were motivating factors for four of these women (three of whom left after their misconceptions were challenged) were consistent with research on the negative role that misconceptions can play in students’ understanding of STEM (Bransford, 2000; Duschl et al., 2007; Olitsky, 2006; Settlage & Southerland, 2007; Wandersee et al., 1994).
Perception of Leaving

The concept of leaving STEM is important to address here. Six of the women, who were part of the leaver cohort did not see their decision as leaving. These women believed that their new majors were still science related. For example, both WL3 and GL5 believed that sociology was a form of science because it studied people and used statistics. WL2 believed that her psychology major was also a science because it too used statistics and “focused on the brain”. These examples highlight a possible third category of quasi-STEM careers that was not addressed by the two categories in this study. Those leavers who joined social science majors or science teaching majors considered themselves members of a science community in that they utilized statistics or discussed science concepts in their daily lives. (I provided my rationale for why I chose to put them in the leaver category in Chapter 4.) These women believed that their choices of quasi-STEM careers fit with their identity better than STEM careers. And members of both the quasi-STEM majors and STEM majors would differentiate the STEM majors through the term *hard sciences* as opposed to quasi-STEM majors, which were often referred to as *soft sciences* by participants.

Role of Expectations and Values on Career Choice During College

Eccles’ (2007) and Butler’s (1999) theories helped to shape the results of my study. Each of these participants was affected by their conception of gender, their expectations for success in STEM fields, and the values they placed on this success. As the participants entered college, they began to have differing STEM experiences that affected their STEM career choice. In college, all but three participants had some negative STEM experiences. These experiences forced them to reflect on their desired STEM career and decide if they still wanted to persist. During this reflection process, each of these women contemplated the values present in Eccles’s expectancy-value model and combined their views of expected success and value with their conception of gender to decide whether to stay or leave STEM.

*Attainment value.* Butler (1999) argued gender is one aspect of each individual’s identity. And each of these women considered at some point in their college experience whether their identity fit with their desired STEM career. Consequently, gender conception and identity were integral to the final STEM career decision. None of these women reported experiencing
gender discrimination before entering college, which resulted in their beliefs that gender discrimination did not exist in STEM fields. However, in college many of them began to see differences based on gender. The impact that these gendered differences had on their career decisions was shaped by their own conception of gender.

For example, all the participants mentioned either male-dominated classes or a lack of female faculty in their major. Many of the stayers recognized this trend but did not feel that it existed for them or affected them. Other stayers saw this male dominance in college STEM majors as a motivation to succeed. Leavers tended to perceive the prevalence of male students less positively. These perceptions were affected by each individual’s view of gender differences or stereotypes. All but one leaver believed in obvious (and often stereotypical) differences based on gender. These women tended to see their gendered beliefs about women as not fitting in with what would be required to be successful in a STEM career, whereas stayers varied between believing that there were no intellectual differences based on gender and believing in hidden stereotypes that they themselves did not possess (i.e. women tend to be more emotional).

Many of the stayers believed that gender differences in STEM fields did not affect them. This belief could indicate their desire to fit in with their major. For example, GS2 believed that an old boys’ club existed in her physics major but she did not believe that this was because of gender stereotypes. Instead she believed that these men were simply not used to dealing with women since historically there had always been so few women in physics departments. Because this study only focuses on perception, it is impossible to determine the accuracy of this perception. Perhaps GS2 denied the existence of gendered stereotypes because she wanted to fit in with this male-dominated career choice. She wanted people to see her as a physicist first and a woman second. This concept is akin to Ong’s (2005) and Rosser’s (2003) discussion of the androgynous roles women present to succeed in STEM fields. These researchers suggested that women in STEM fields feel that they need to hide the feminine part of their identity to fit in with their male dominated fields. Perhaps some of the women who believed that gender did not play a role in STEM were trying to adapt their identity to fit in. These women believed that the cost of denying parts of their identity were worth the career decision, and these women identified with the STEM career enough to view their decision as worthwhile.

These gendered factors in college STEM experiences are part of the chilly climate within STEM majors (Allan & Madden, 2006; Leggon, 2006; Seymour & Hewitt, 1997). Some of the
aspects of the chilly climate, such as male-dominated classes or pedagogy that benefits males over females, tend to be associated with gender (Rosser, 2003). However, other aspects of the chilly climate are non-gendered and were mentioned by participants in this study as well (i.e., large class sizes, unsupportive faculty and peers, large workload). Often these chilly climate factors affected both the cost value and the attainment value for the leavers in this study. All but one of the stayers (GS4) indicated that they felt like they fit in with their STEM major and future career based on their experiences during college (i.e., mentors, supportive peers, and research opportunities).

However, many leavers said that they were unable to identify with their peers in their major. Six of the leavers indicated that one of their reasons for leaving was they did not feel like they fit in with their major. Some of the leavers reported the attitude of the individuals within their major as having an influence. These leavers indicated that not only was their STEM major difficult, in that the concepts were difficult and the workload was high, but their peers seemed to create a superior attitude regarding this level of work. This hierarchy of difficulty was evident in some of the stayers’ comments regarding their pride in their ability to succeed in STEM fields. The leavers discussed this hierarchy but saw it as negative factor. These leavers reported that many STEM majors feel that their major is better than non-STEM majors because it is more difficult. This perceived superior attitude made many of the leavers feel inferior and made them believe that they did not belong in this particular major (i.e., the major no longer fit with their identity).

Similarly, participants also discussed the hierarchy of nerdiness, which affected their sense of belonging in STEM majors. Four of the leavers described their original STEM major as nerdy. Four of the stayers used the same wording; however, these stayers also described themselves as nerdy, indicating that their perceived identity (a nerd) fit in with their perceived description of the typical person in a STEM major. The leavers who described STEM majors as nerdy did not feel that their identity fit in with this perception. Consequently, these leavers chose fields where they felt they fit in better.

**Utility value.** A person’s identity is closely tied to his or her goals, which is the basis for the utility value of career choice: how well the career fit with a person’s current and future goals. Participants mentioned part of this value when they were discussing their future family plans.
The majority of the stayers did not perceive the STEM career as a threat to their future family plans indicating that this issue was too far off to worry about or that they would focus on their career first. Four of the participants (two stayers and two leavers) reported that they changed their career plan to have a career that would allow them to have a family. However, this relatively low number of women mentioning future family plans as a negative influence on their persistence in STEM careers contradicts past research (Farmer, 1997), and could be an indication that the fear for women of balancing work and family, is changing. Leavers also indicated the utility value was a reason for their decision to leave STEM. Many of these leavers indicated that while they were in college they realized that there was a better career option that would fit with their current goals (i.e., for some having more free time, being less stressed) and their future goals (i.e., helping others, being happy). For most of these leavers, their desire for happiness and enjoyment fit in with their non-STEM career and this career allowed them to feel less stressed.

**Intrinsic value.** All the participants in this study had to weigh their level of interest and enjoyment derived from their desired STEM career. During college, many of the leavers began to lose interest in their original STEM major. This loss of interest and enjoyment made them reconsider their career choice, leading them to decide on a non-STEM career that would help them to pursue their intrinsic values of happiness. The stayers, however, were able to maintain their interest in STEM despite the negative experiences that some encountered. These women believed that their interest was valuable enough to continue to pursue their STEM career.

**Cost.** The previous sentence hints at the fourth value of cost, wherein individuals weigh the perceived costs and benefits of a career to guide their choice. For the leavers, the cost of a STEM career was the stress and workload of the STEM major in college. For the majority of the leavers, this cost did not seem worth the eventual career. The leavers did not feel that this workload and the perceived cost fit with their current and future goals. Nor did these women derive the same level of enjoyment and interest in their STEM major as they had before college. The decision regarding the negative cost of the STEM career for leavers could be seen in their college experiences. For example, both leavers and stayers (23 of 26 participants) mentioned negative experiences in their STEM major; however, the stayers tended to view these as a source of frustration that caused them to have doubts in their major, although they eventually overcame
the doubts. The leavers mentioned more negative experiences, including large class sizes, which prevented them from feeling welcome and a lack of help from or poor teaching by professors in STEM courses. These costs were not worth the eventual career for the leavers.

**Expectation of success.** The second major component to Eccles’s (2007) model is the expectation of success. Despite experiencing doubt or frustration with their major, all the stayers planned to persist in their STEM career. Both stayers and leavers experienced poor grades in their STEM classes during either precollege or college, yet only the leavers believed that these poor grades were an indication that they might not be successful in a STEM career if they could not succeed in STEM courses. Consequently, each of these participants’ STEM career decisions was affected by their conception of gender along with their STEM-related experiences and the interpretations of those.

**Conclusion**

Each of these 26 participants was influenced not only by experiences both before and during college but also by their perceptions of these experiences. The intrinsic value each woman derived from her career goal affected her decision to stay in STEM or not. This value combined with how well the career fit with their goals (utility) and their identity (attainment). For most of the twelve leavers, their goal of happiness and their desire to fit in with their major affected their decision to leave STEM, which they saw as thwarting these goals. The 14 stayers, however, felt that the STEM career fit with their goals and their identity. Each of these individuals weighed the perceived costs of achieving the STEM career with the perceived benefit (the STEM career). For the leavers, the career was not worth the cost, whereas the stayers believed the career was worth the cost. The stayers also believed that they would be successful in their STEM career despite some negative experiences along the way, whereas the leavers did not feel that they would be successful based on their experiences in college. Consequently, each individual had a unique set of experiences and interpretations of these experiences that influenced their decision to leave or stay in STEM fields. The next chapter addresses the second research question regarding the role that WSTEM played in participants’ career choice.
CHAPTER 6

WSTEM’S EFFECT ON PARTICIPANTS’ STEM DECISIONS

The second goal for this study was to understand how participation in a women-only living and learning STEM program affected women’s decisions to persist in STEM majors and fields. As stated in the Introduction of this study, there has been an increase in the number of programs and policies aimed at increasing the number of women and minorities in STEM fields, particularly in the United States. One of the prominent programs has been single-gender STEM LLCs at the college level. Federal and state dollars are being given to many of these programs across the United States, including the program in this study (WSTEM). Organizations such as AAUW and NOW that focus on women’s issues believe that single-gender programs promote gender stereotypes. The research on these programs has provided mixed results regarding whether they positively impact women’s persistence in STEM fields. This chapter discusses the results with regard to the role that WSTEM, as a single-gender support system, had on its participants’ decisions to stay or leave STEM majors at State University.

WSTEM Persistence Rate

In this chapter, persistence rate refers to the number of women who stayed in their STEM major and planned to continue in a STEM career after college. The cohort of women in this study included those women who entered State University (SU) in the Fall of 2006. The general population of female STEM majors included 613 women in the Fall of 2006. In the spring of 2010, the number of female STEM majors from this original cohort was 309 for a persistence rate of 50%. The 613 women included those who eventually left the university. This rate was then compared to the cohort of women who entered SU in the Fall of 2006 and participated in WSTEM. Thirty-eight women were part of WSTEM during the Fall of 2006 with a declared STEM major. Twenty-one of the original 38 remained in their STEM major, for a retention rate
of 55%, which is slightly higher than the general population but not significantly so as evidenced by a proportion test\textsuperscript{31}.

As noted in the literature review for this study, these percentages often do not provide the full picture. Despite the WSTEM program not making a significant difference in persistence rates, participants provided evidence for the importance of the program. WSTEM was positively identified by all but one of the participants in this study for the support that they received as well as other opportunities. These qualitative descriptions provided a broader understanding of how this program influenced its participants’ STEM decisions than the persistence rates alone. The description of the findings in this chapter is guided by program evaluation (what effect did the program have on its participants) along with the conceptual framework discussed in Chapters 3 and 5.

Eccles’s expectancy value model (2007) along with Butler’s conception of gender (1999) helped guide my research and analysis for this chapter. The genesis and structure of the WSTEM program was dependent on three women. These women’s own experiences in STEM related to their gender had an effect on their choices regarding the structure of the WSTEM program. Consequently, it is important to include a brief description so that the reader understands the history and context behind the WSTEM program. This chapter will first briefly describe the directors, their views of women in STEM fields, and their goals for WSTEM. The next section will identify the student participants’ discussion of the advantages and disadvantages of the program. This section will explain what role participation in WSTEM had on these women’s decisions and how this role was affected by the goals of the directors.

**The Women behind WSTEM**

The choice of State University as the location for this study was made because of the existence of the WSTEM program housed within the university. In Chapter 4, I provided a brief description of how WSTEM began at State University. The official program began in the 2000-2001 school year. Even before this school year, one professor at SU, Dr. Gallagher, was already advocating the need for a women-only dormitory hall where women with STEM career interests could live. Therefore, Dr. Gallagher’s role will be discussed first.

\textsuperscript{31} Of the 38, 32 were still students at State University And six had left the university. Even after calculating the retention rate with this reduced number (21/32), the resulting 66% is still not significant. A proportion test showed no significance.
Dr. Gallagher

Dr. Gallagher\(^{32}\) was a female chemistry professor at State University. She wrote a proposal in 1993 regarding the need for a residence hall where women who were interested in math and science could live together as a way to improve women’s interest and persistence in these majors (Dr. Gallagher, personal communication, October 9, 2008). Dr. Gallagher said that her original motivation for starting the floor was her own experience as a woman in science for over 30 years. She felt isolated within her field based on her gender and the overt discrimination she experienced because of it. Her experiences as a graduate student and professor in various chemistry departments made her realize the importance of having a support group of other women who could help each other through the courses and in many cases through the chilly climate that existed within the sciences.

Her efforts to improve women’s experiences in the sciences, including her department, began once she made tenure at State University. She explained that she did not want to do anything before earning tenure because “I knew not to do anything until I was promoted. Because they would say, ‘Oh she’s diverting her interests’” (Dr. Gallagher, personal communication, October 9, 2008). When pressed to clarify this statement, she said that she could be denied tenure if it looked like she was more concerned with women’s access to STEM than fitting in with her colleagues. Once tenured, she began to work with multiple organizations on campus at SU that promoted women’s persistence in STEM fields.

Dr. Moriarty

The first program that began in 1994 under Dr. Gallagher had a very small budget. The women simply lived on the same floor with no mentoring, research opportunities, or colloquium sessions. One of the members of the committee that reviewed the LLCs each year was Dr. Moriarty, a female scientist at State University. She proposed the idea of a formal LLC aimed at women in STEM fields in 1999. After submitting a formal proposal to the vice president of the university, she was given the position of director.

Like Dr. Gallagher, Dr. Moriarty had a history of supporting women in science throughout her 20 year career. Dr. Moriarty’s reasons for supporting women in STEM were also

\(^{32}\) Names have been changed to maintain anonymity.
based on her own experiences as a woman in a male-dominated field. “I’ve always been interested in promoting the participation of women and minorities in science. I saw that there was a lack and I thought it was important. I think things have greatly improved today but they’re not completely gone” (Dr. Moriarty, personal communication, July 15, 2008). She discussed the overt gender discrimination she experienced as a professor and graduate student. She also discussed the perception of always having to prove that she as a woman was good enough to compete at the same level as her male colleagues.

She, like Dr. Gallagher, also discussed the issues early on in her career where colleagues told her not to participate in programs that promoted women’s acceptance within STEM fields because it could be seen as “rabble rousing” by superiors, which would negatively affect her tenure. Dr. Moriarty recognized the value of talking to and networking with other female scientists who had experience with the male-dominated culture of STEM. This networking and support group were two of her goals for WSTEM as well.

**Dr. Smith**

In the Fall of 2005, Dr. Moriarty took over an administrative position at State University, and she knew the position would not allow her to give the necessary attention to WSTEM. As a result, the provost of the university appointed Dr. Smith, a physics professor at State University, to the position of director of WSTEM. Dr. Smith took over this position in October 2005. Her first full year in charge of the program was the 2006-2007 school year, which is also the cohort of women

Dr. Smith mentioned in an interview that she originally struggled with developing a rapport with her first cohort in 2005. It was on her recommendation that I followed the 2006 cohort because that was the first year she had entire control as the director.
Like her predecessors, Dr. Smith used her own experience to decide how she wanted to shape WSTEM. Besides the paid research, Dr. Smith felt that networking was an important goal of WSTEM. She continued the weekly colloquium sessions that involved a weekly one-hour class with the entire freshmen WSTEM cohort to improve the networking capabilities of the women within each cohort. Dr. Smith maintained some aspects of these colloquium sessions that Dr. Moriarty had originally included such as guest speakers, laboratory visits, and social outings. She has also added some other concepts. For instance, she has students read a book about scientific inquiry or women in science that they would then discuss over a period of weeks and write a short reflection on. She and her graduate assistant planned social outings for the students twice a month during the school year. Dr. Smith also schedules meetings once a semester with each of the participants to discuss their courses and any issues they are having with their major.

Like Dr. Gallagher and Dr. Moriarty, Dr. Smith described discriminatory experiences during graduate school and her career, despite being in a younger generation of scientists. She described spending the first five to ten years of her career “trying to fit in with the guys in terms of the way I dressed” (Dr. Smith, personal communication, October 8, 2007). She explained that now she does not care about “fitting in,” but it took her a while to realize that it was possible “to be accepted as a physicist and to wear skirts and make up” (Dr. Smith, personal communication, October 8, 2007). She maintained that the culture of physics still prevents women from behaving in certain ways.

How Gender Experiences Shaped WSTEM

The unique experiences of each of these women affected their goals for WSTEM and its precursor dormitory hall floor. Dr. Gallagher’s experience as the only female faculty member in her department influenced her goal of creating a residence hall where women with the same interest (STEM) could live together and not feel isolated. Dr. Moriarty’s experience as a woman in science and her knowledge of factors that improve women’s retention in STEM fields affected her decision to create WSTEM as a living and learning program that could provide peer support and networking for students. Dr. Smith’s experience in a later generation showed that women’s underrepresentation still existed in STEM fields. She mentioned being one of only three women during her graduate school career in physics.
All three of these women discussed the sense of self doubt they felt because of their gender. When they received a grant they could not be certain it was because of their exemplary work or simply because of their gender. They discussed the fear early in their careers of standing out in their departments for being too feminine or too concerned with feminine issues. For example, Dr. Smith discussed her sense early on that she needed to hide her femininity by not wearing skirts or make up. She tried to be more androgynous to fit in with her male peers and be respected by them. These experiences shaped their choices regarding the structure of WSTEM. This structure had an effect on its participants’ persistence in STEM, which is described in the next section.

How Does Participation in WSTEM Affect Persistence

Based on the life histories in this study, the WSTEM program (as designed by Drs. Gallagher, Moriarty, and Smith and directed by Drs. Moriarty and Smith) had a number of positive effects on both stayers and leavers. The positive aspects were mentioned by both stayers and leavers. Eleven WSTEM participants said that they found a support network through their membership. Five participants discussed the motivation and knowledge that meeting members of the professional community provided. Four women reported on the positive effects of the paid research opportunities provided to members. And three women mentioned the positive effect of the women-only aspect of the program. Despite these positive influences, six of these women did not persist in their STEM majors. These six women identified a variety of reason for leaving that were affected more by their STEM college experiences than their WSTEM experiences as highlighted in Chapter 5. This section will discuss the positive and negative aspects mentioned by the participants, how these affected persistence, and the role the WSTEM had in this persistence. Because both stayers and leavers mentioned the positive effects of WSTEM, they will be combined in the positive aspect section.

The Positive Aspects of WSTEM

Support network. The most reported benefit by all WSTEM members was the support group that members found within the program. This support was described in a variety of ways, including a source of study help, a source of confidence in classes, a source of motivation in
knowing that others were going through the same thing, free tutoring in STEM, and a source of
general friendships. The first four pertain to STEM and are discussed first.

Nine women discussed the positive influence that WSTEM had on their performance in
their STEM classes based on the help and support they received within the program, particularly
from their peers. For example, WS3 described how all the women on her floor were at “different
levels” in their STEM classes. She mentioned a friend who had already taken calculus in high
school who could help her with her current calculus class. WS3 also noted that a number of
women on the floor were taking the same classes, which allowed them to easily form study
groups by just “walking out of their door and yelling, ‘hey how are you doing this problem? Can
I see what you’re doing and compare it to what I’m doing?’” This sentiment was also expressed
by leavers, including WL2 who said, “My roommate and my suitemate, we were all taking bio
together and we would study together.”

This support group in the dorm also translated into confidence in classes because
WSTEM members knew others from the program in their classes and did not have the feeling of
isolation, which was a goal mentioned by Dr. Gallagher. WS2 described this feeling as follows:
“It’s nice to have someone next to you that you know. It gives you more confidence for the
class.” In a similar way, other WSTEM participants discussed this sense of comfort and
overcoming a sense of isolation by describing the concept of knowing others on their floor were
“going through the same thing” (WS2). WS1 described it as follows:

So it’s just refreshing to know that you’re not the only one struggling your freshmen year,
you’re not the only one overwhelmed, you can go down the hall and ask for help so it
was just really nice to have this huge support group of people.

WS1 hinted at the sense of isolation that falls under the concept of the chilly climate (Shakeshaft,
1995). According to WS1, knowing that other women were succeeding helped her feel more
comfortable in the sciences and consequently reduced her feelings of isolation.

Other women described the sense of comfort they felt as a member of WSTEM and how
this also served as a source of motivation. For example, WS6 said, “It kept me going, knowing
that there were others like me that wanted to reach their goals, just knowing this group of girls
was going through the same thing I was career wise, and class wise.” Both WS1 and WS6
believed that participating in WSTEM made them fell less isolated. This suggests that WSTEM
was serving the purpose of reducing students’ sense of isolation. These women also described
the positive effects of the networking they began to participate in as a result of their participation in WSTEM.

In terms of tutoring as a form of support, only three women used the tutoring but all these participants reported that it helped them feel a sense of support. WS4 mentioned the money saved through the tutoring as an added benefit to the help she received: “We get free tutoring, so that’s $20 an hour that we don’t have to pay.” Even some leavers mentioned the tutoring and its benefits. WL6 said, “I definitely used all the free tutors. I thought the tutoring was the only reason I passed those classes.”

The final effect of WSTEM participants mentioned was non-STEM related. I chose to include it because eight of the WSTEM participants cited it as a benefit of the program. These women mentioned how successful the program was in helping them to develop friendships with other women that provided support through their early college experience. WS4 described the formation of friendship as follows:

> It was amazing living on the floor and most of your friends were right there with you and we knew each other and we could walk to class together or walk back home together and that was fun. Because freshmen year, you’re like, “I’m never gonna make any friends, no one is gonna know me.”

WS5 described the environment within WSTEM as a “bunch of women” that were “all excited about the same stuff and had the same ambition.” She believed that “knowing people on her floor” helped her feel more connected to her major and the university. By being with other like minded people in terms of interest in STEM and STEM careers, WS5 explained that this made her more aware of other STEM fields and helped her feel more comfortable with individuals from those fields. The interactions among the women in WSTEM helped them to see that other women shared similar interests and consequently their chosen major fit with their perceived identity (Eccles, 2007).

Even leavers noted the benefit of meeting others. WL3 said, “The biggest benefit of WSTEM was the relationships I had with those girls.” WL4 also mentioned the social activities (such as the clean-up day, the ropes course, and the weekly class) that brought all the women together as being socially beneficial for her. And WL6 stated that she enjoyed the friendships she formed in WSTEM, noting that it “played a big role [her] freshmen year, [by keeping her] connected to the people that [she] lived with.” She mentioned that she “made some really good
friends. It also helped me get connected with tutors and find things like that on campus.” These comments suggest that WSTEM served as a source of social support but this did not always translate into persistence in the STEM major.

Despite most (five of six) of the WSTEM leavers mentioning the positive effect that the program had on them socially, only two of these women felt that they had received support within their major. Five leavers discussed how WSTEM helped them to make friends and develop relationships with women that they still keep in touch with, but noted it did not provide support that they felt carried over into their STEM major. This result indicates that social support found within WSTEM was not enough to maintain persistence, especially if the participants did not sense that they were supported in their STEM major. Consequently, support networks among students in STEM majors are also important to retention.

**Meeting members of the professional community.** Another benefit mentioned by five of the participants (four WSTEM stayers and one leaver) was meeting female guest speakers and researchers, which served as a source of inspiration and motivation. Some of these participants commented on the inspiration they felt seeing successful women in STEM fields. For example, WS1 mentioned how “nice it was to see successful women in all different types of fields.” Similarly, WS4 credited these women and the other opportunities provided by Dr. Smith as motivating her to work harder to be successful as a woman (and subsequently a minority) in STEM: “Dr. Smith gives all of us resources to make us better, to strive for what we really want and try to be equal to men.” Here Dr. Smith served as an example of the professional community and motivated WS4 to work toward that same level of membership.

Another series of comments focused on the motivation that the guest speakers provided just by sharing information about STEM careers. WS3 said the following in reference to the guest speakers: “I loved it, because we had people come in and talk to us about all sorts of different pieces of science, all sorts of different things, you get a real perspective.” She credited this “real perceptive” as a source of motivation to persist in her degree and eventual career goal. WS5 referenced a slightly different effect of these guest speakers, which was simply a source of information about other areas of STEM that she had never thought about. This opportunity made her feel more knowledgeable about STEM fields.
The guest speakers, added by Dr. Moriarty and continued by Dr. Smith, helped to provide motivation in a different way than living on the floor together. The guest speakers allowed the women in WSTEM to ask questions about STEM careers, including how these women balanced family and career. The one-on-one interaction and the speeches motivated many of the WSTEM participants to persist. These women were able to determine whether they could identify with the women they met and whether the professions they discussed fit with their current and future goals and interests (Eccles, 2007).

**Research opportunities.** Four of the WSTEM participants (three stayers and one leaver) mentioned the benefit of the paid research opportunities provided by the program. WS6 felt that the research opportunity she participated in would “help her along the way” to her eventual career. WS4 and WS2 felt that being paid by WSTEM opened the door for more research opportunities because the professors and departments did not have to worry about paying them. WS2 described the confidence that she developed from her research opportunities as follows:

> Every opportunity offered to me has been through WSTEM. If I hadn’t had these research opportunities, I don’t know where I would be. I probably wouldn’t have a job that I can count on and I wouldn’t really have those privileges to meet professors in that way, get closer to them, probably get a good recommendation letter from them because you’ve known them for over 3 years. When you’re in WSTEM research, they pay you, they expect you to do a really good job, you know you have a higher expectation when you get paid, you must get something really good, because you’re getting paid for it. So you carry on your own project. You’re not a clerk, you’re not someone who cleans up after the graduate students; you’re someone who carries on her own project.

WS4 also mentioned the sentiment of carrying out your own project.

These women not only gained experience in research but also felt empowered because they were able to pursue their own interests. By participating in research opportunities, the women were able to see what their future career would be like, which allowed them to decide whether their career interests matched their goals and identity (Eccles, 2007).

**Women only.** Three of the WSTEM participants (two stayers and one leaver) mentioned the positive aspect of living with and attending some classes and social outings with all women.
These women mentioned that they felt less pressure to fit in because it was all women. WS3 expressed this sentiment best:

It’s not bad to have classes with guys but sometimes it’s easier just to have a class where, cause a lot of times, yeah girls cut up too, but sometimes guys tend to get off topic and that sort of thing. And it was nice to have just the girls in a class. It just seems like there was more, you were able to relate to people more, you weren’t paying attention to “oh there’s a cute guy sitting in the corner” or you know “oh what are they wearing,” that sort of thing; it was more camaraderie I suppose.

Four of the women in this study credited WSTEM with making them aware of gender discrimination in STEM fields. For example, WS4 said her participation in WSTEM made her “a feminist” because it enforced her belief that “women are just as good as men in science and math.” Their participation and the awareness they developed made all four of the women committed to helping to increase the number of women in STEM fields. WS1 often returned to her middle and high school to talk about her physics major and to recruit students, especially female students, into physics. All four women believed that they would not have had this experience without the women-only structure of WSTEM.

Summary of positives. The common thread among all the benefits described by the WSTEM participants was the concept of confidence and empowerment that WSTEM developed in these women. This concept was best summarized by WL2 when she said,

I think it’s [WSTEM] great, It’s empowering, you see all these other women studying the same things. I think there should be more organizations like this. It just geared me up to work hard, do well, and compete really. I think WSTEM really helped me to make the close connections with different girls and have the chance to meet with different kinds of people and just get an outside look at everything going on. I feel that they just had a really good setup for me, creating my backbone, creating my place at [State University], they did that really well.

This description and positive view is even more powerful since it was made by a leaver. Despite leaving her STEM major, she still saw her participation in the WSTEM program as beneficial to her college experience. The structure of WSTEM helped to alleviate the isolation that many of these women could have experienced based on their minority status in their STEM majors or
simply based on the large class sizes at State University. Being surrounded by other women interested in similar fields helped them to feel that they fit in with their peers. Finally, the interactions with professionals in the field helped them to determine whether their career choice fit with their goals. The leavers’ decisions were affected more by the experiences they had in their majors than by their experiences in WSTEM.

Table 6.1: Summary of benefits of WSTEM as cited by WSTEM stayers and leavers.

<table>
<thead>
<tr>
<th>WSTEM Benefits</th>
<th>WSTEM Stayers (N=6)</th>
<th>WSTEM Leavers (N=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WSTEM Benefits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Support Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Help with studying</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Provide confidence in class</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Helped student to make friends</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Less pressure because all girls</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Knowing others are going through same difficulties is a source of comfort</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Student mentor helped them persist</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tutoring was beneficial</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Female guest speakers and researchers motivated them</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Research opportunities helped them see that they wanted and could succeed</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>WSTEM Negatives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disappointment with rules that required them to leave the program when they switched to a non-STEM major</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Waste of time, pushed her away from science</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Perception was also evident in each participant’s discussion of WSTEM. Leavers, however, tended to mention fewer positive influences than stayers. Table 6.1 summarizes the responses for each of the categories and divides them according to stayers and leavers. There were only two categories where either the same number of leavers mentioned the benefit or more leavers mentioned the benefit than stayers (WSTEM helped to make friends and the benefit of the student mentor). In all the other benefit categories, more stayers mentioned benefits than the leavers, which could be an indication that leavers took less advantage of the opportunities.
offered. For example, in the research category, only two WSTEM leavers utilized this
opportunity and then only one mentioned it as a benefit. In these categories the leavers seemed to
appreciate the social aspects of WSTEM the most because friendships and studying support were
the two categories where two thirds of the leavers expressed benefits. Despite the many positives
reported by the WSTEM participants, three women mentioned negatives to the program. These
negative experiences are discussed next.

The Negative Aspects of WSTEM

Only one woman (WL5) said that WSTEM was a “waste of time.” She was uncertain
about her major before coming to college but because the university requires a declaration of a
major, she chose exercise science without knowing all the requirements. Her attitude toward the
program (she was the only individual to report that WSTEM pushed her away from science) was
very negative and she admitted that this was because she was not interested in science and
changed her major to a non-STEM degree soon after entering the university, which forced her to
move out of the WSTEM floor. She also said that her main motivation for joining WSTEM was
to find a “nice” dormitory room. Her lack of interest in STEM fields and her bitterness regarding
the mid-year switch led me to consider her an outlier in this study.

In addition to WL5, two other WSTEM leavers expressed their disappointment with the
rules of the program that forced them to leave once they changed their major to a non-STEM
major. Both of these women indicated that this rule made them feel that their new major was
inferior to the STEM majors. They felt that this forced departure from the program made them
feel like failures. This sense of disappointment suggests that these women had positive attitudes
toward the social network they formed within WSTEM because they were upset about having to
leave it. The next section will provide more information on why some of these WSTEM
participants chose to leave their STEM field despite their original interest in both STEM and the
WSTEM program.

Areas of Divergence for WSTEM Participants

There were two themes that affected persistence among the WSTEM stayers and the lack of persistence among the WSTEM leavers. One theme that affected WSTEM participants’
STEM decisions was their original motivation to join the program. These motivations are summarized in Table 6.2. The two cohorts of women, WSTEM stayers and WSTEM leavers, differed in their motivations for joining the program and their views of gender. These two themes, along with other STEM experiences in college (see Chapter 5) affected members of both cohorts’ STEM major and career decisions.

Table 6.2: Reasons for choosing WSTEM.

<table>
<thead>
<tr>
<th>Reason</th>
<th>WSTEM Stayers (n=6)</th>
<th>WSTEM Leavers (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To meet other STEM majors</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Nicer dorms</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Paid research</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

**WSTEM stayers.** The six stayers were motivated by more STEM-related reasons. All six stayers mentioned either a desire to live with like-minded women or STEM research opportunities as one of their reasons for joining WSTEM. These reasons indicate that the stayers were more serious about their STEM career than the leavers, which is a difference that also could have affected persistence. For example, two of the stayers were already thinking about the benefits of paid research, which provided further examples of their commitment to and understanding of what was required in a STEM career. WS2 shared her reasons as being a combination of research and living with like-minded women that would complement her own commitment to STEM.

All these women also shared a belief that gender should not affect women’s role in STEM fields. Four of these women credited WSTEM with improving their knowledge of gender discrimination, leading them to work toward increasing the number of women in STEM fields. All these WSTEM stayers believed that women were equal to men in terms of their ability to succeed in STEM fields. The WSTEM leavers had slightly different motivations and beliefs.

**WSTEM leavers.** Based on the data collected in this study, the six WSTEM participants who chose to leave STEM fields had three categories of characteristics that affected their persistence: four of the WSTEM leavers did not participate in the opportunities provided by WSTEM, which influenced their decisions; the leavers’ motivations for joining WSTEM were
not associated with STEM goals; and all six of these women held obvious gender stereotypes regarding women’s roles that affected their ability to see women in STEM fields (see Chapter 5).

First, four of the six women in this group did not participate in any of the opportunities provided by WSTEM. This result could indicate a lack of interest in STEM fields or a lack of motivation to participate in STEM fields. This lack of full participation could be an indication that these women were not as fully committed to a STEM career as their staying peers. Consequently, when they encountered negative STEM college experiences, they chose to leave STEM.

Second, the WSTEM leavers’ motivations for joining the program supported the concept that some of them were not as interested in STEM as their staying peers. Four of the WSTEM leavers in this study mentioned meeting like-minded women as a motivation for joining WSTEM. However, most of these comments were less focused on STEM and more focused on the general social aspect of WSTEM. For example, WL4 described her motivation as follows: “When I was looking at the dorms, I saw that WSTEM was one of the programs so I was like this could be fun. So I just checked it out and then I applied.” Here WL4’s comments were not specifically related to STEM but to the general idea of living with women who had common interests. She did not say that they needed to be STEM common interests. This lack of specific reference to STEM by three of the four leavers in this category could represent a lower level of commitment to a STEM career, which would affect their persistence as well.

Finally, all six WSTEM leavers believed there were definite differences between men and women that affected their choices. Three of these leavers said women are more emotional and caring than men, which affected their career choices. And all of these leavers believed that women were treated poorly in STEM careers, despite never experiencing gender discrimination personally. This perception of the gender discrimination that existed in STEM careers influenced their decision to choose a more female-friendly career (WL4, WL2, WL3).

Consequently, the leavers tended to be motivated by non-STEM-related reasons for joining WSTEM, which could indicate that they were not as interested in STEM careers as the stayers or that these motivations alone are not enough to maintain persistence and interest in STEM fields. And yet, the leavers were able to gain some benefit from WSTEM in terms of friendships and for three leavers, a positive research opportunity, tutoring, and the female guest
speakers. These benefits were not enough to overcome the negative experiences each of these women encountered in their STEM major.

The directors’ goal was to create a place where women could support each other in their STEM majors; however the program could not change participants’ perceptions of and experiences within their STEM majors. WSTEM could not change some women’s perception that faculty and peers were unhelpful and unsupportive, nor could it change the frustration that many of the leavers felt regarding their poor grades. WSTEM could also not force members to participate in all activities, which was evident in the fact that four of the leavers did not fully participate in all the opportunities such as the research opportunities. Therefore, based on these data, one can conclude that WSTEM did meet its goals for the women who fully participated in it. Of those women who participated in research opportunities, all but one of them persisted. And all but one of the women said the social aspect of WSTEM was a positive influence on their college experience if not their STEM college experience.

Characteristics of Women who Choose Not to Join WSTEM

In this study, the WSTEM participants chose to join this program. These women were specifically looking for a formalized support network. Previous research has indicated that the benefits of programs like WSTEM are often confounded by the self-selection of the type of person who chooses to join it (Brainard & Carlin, 1998). To address this issue, I asked members of the general population what they thought about programs like WSTEM, women-only programs that provide support and opportunities to improve women’s persistence in STEM fields. These results indicated that GP stayers had a different view of these programs than GP leavers, which has implications for programs like WSTEM and their goals of increasing the number of women in STEM.

GP stayers believed that programs aimed at improving persistence in STEM fields should be based on merit not gender. All of the GP stayers in this study were aware of WSTEM but reported choosing not to join it because they wanted to persist on their own. Ironically, all of the GP stayers indicated that they found a support group among their peers and a supportive mentor who aided in their persistence. Therefore, these women became part of informal support networks that were crucial to their persistence. These stayers explained that they did not want a formalized, artificial support group; they would rather form a group of like-minded individuals
within their major. Perhaps the attitude of “I want to do it on my own” motivated these GP stayers to succeed.

In comparison, three of the GP leavers believed in hindsight that participation in a program like WSTEM could have positively affected their persistence. All six GP leavers said that when they first came to State University, they too wanted to persist in STEM without the help of a formalized support group. And yet all six chose to leave. This result could be due to their inability to find a support group or to their views of gender. All of the GP leavers believed that there were definite differences between men and women in their reactions to phenomena and their personalities (similar to the WSTEM leavers). This view that women possess traits that might not be prized in STEM fields could have affected their motivation to continue.

Consequently, this attitude of not needing help from a formalized support group separated the general population participants from the WSTEM participants. These GP women chose not to join WSTEM because they wanted to succeed based on their own merit. However, those who persisted in WSTEM found informal support groups whereas their leaving peers did not. The GP leavers listed other reasons along with the lack of support in their major for their choice to leave STEM. However, this data does highlight the important role that support networks (whether formal or informal) have on women’s persistence in STEM majors.

Limitations

I mentioned personality issues that could have affected both students’ persistence as well as their choice to join WSTEM. One of the limitations to this part of the research was the lack of psychological research used. I chose to focus on gender (Butler, 1999) and use the expectancy value model (Eccles, 2007) to identity motivations. Consequently, I did not study the effects of personality on students’ STEM major and career decisions. I could also not account the effects of personality on students’ decisions to join a women-only STEM program. However, based on my framework, the findings showed that WSTEM had positive effects on my participants despite half of these women’s choice not to pursue a STEM major. In particular, my use of Butler’s conception of gender to better understand each of my participant’s conceptions of gender highlighted how these conceptions can affect STEM persistence: those individuals who believed in gender stereotypes had greater difficulty persisting compared to those who saw gender as a
biological distinction. This influence of gender was evident in both the WSTEM and GP participants.

**Discussion**

WSTEM was successful in providing participants with a support group. This support helped raise the confidence of both stayers and leavers in their ability to succeed in college although not necessarily in STEM as it is defined by my study. In Chapter 5, I discussed the concept of quasi-STEM fields, such as psychology, sociology, science education. In my study I defined STEM fields as those that fell under the categories of physical science, life science, technology, and engineering. However, some individuals and organizations define social sciences as part of these STEM fields. In this study, all but one of the WSTEM leavers planned to work in psychology, sociology, or science education. So if one’s definition of STEM included these fields then there was only one leaver in my study. All of these WSTEM participants reported that the program reduced their sense of isolation and helped them to feel like they fit in with other STEM majors, including the quasi-STEM majors. The participants felt that both the social support and the other opportunities provided by the program (i.e., paid research and guest speakers) were a source of confidence and empowerment.

Eccles’ expectancy value model again provided a way for me to frame these results (2007). Intrinsic value was influential in these participants persistence in STEM. Those participants who joined WSTEM for extrinsic reasons, like living in a nicer dormitory, eventually left their STEM major, indicating that the type of motivation affected persistence. Those women who were motivated to join WSTEM based on personal interest in STEM fields and a desire to live with like-minded individuals persisted.

The participants also discussed the benefits of the support network they formed within WSTEM, which supports previous research (Hartman & Hartman, 2009; Leggon, 2006; Seymour & Hewitt, 1997). Eleven of the twelve WSTEM participants mentioned the support network within the program as a positive factor that led to their improved sense of fitting in at SU. All six of the WSTEM stayers were able to find a support network among either WSTEM participants or peers and faculty in their STEM major. This support network helped them feel like they could attain their STEM career (Eccles, 2007). This network helped them to better identify with the STEM major. The network allowed them to talk with like-minded individuals
who helped them through periods of frustration when confronted with low grades or heavy workloads. The network also helped them to realize that the cost of their major was worth the end result (Eccles). These stayers mentioned positive research experiences that allowed them to see whether their career fit with their goals and could maintain their interest. Consequently, these results indicated that WSTEM was successful for those individuals who self-selected into the program.

With regard to the women-only environment created by WSTEM, only three participants specifically mentioned this aspect of the program as influential in their STEM persistence. This aspect of the program was hard to differentiate from the other positive impacts that the participants discussed such as research opportunities, being around like-minded individuals, and the motivation provided by guest speakers. All these opportunities took place in a women-only living environment but were not necessarily directly influenced by this single-gender aspect. Rather, participants could utilize all aspects of the program and still have a support group within their STEM major outside WSTEM. Based on the results discussed in Chapter 5, these co-gendered support networks were just as beneficial as WSTEM to STEM persistence for those participants who found them. Therefore, it is difficult to make a conclusion regarding the benefit of the single-gender environment because it was tied to so many other positive aspects of WSTEM.

The results of this chapter suggest that conceptions of gender still play a role in STEM decisions. Gender discrimination was a driving force behind WSTEM’s formation as discussed by the three women who founded and/or directed WSTEM as faculty. These three women created WSTEM as a way to alleviate gender discrimination by providing women with access to other like-minded individuals and to opportunities within STEM fields. And yet, access was not enough for the women who participated in WSTEM as 45% of the 2006 cohort still chose to leave their STEM major. This percentage is not indicative of a failure of WSTEM, but is the result of a number of factors, including some participants finding careers that fit with their goals and identity more than STEM (Eccles, 2007).

In response to how WSTEM affects women’s decisions to persist in STEM fields, this study suggests that providing access to a female-friendly support group provides some benefits to persistence. However, the female-friendly environment within WSTEM did not always translate into female-friendly policies within STEM departments. Second wave feminists believe
that increasing women’s access to STEM fields will increase the number of women who persist in these fields (T. H. Anderson, 1995; Collins, 2009). However, recent studies suggest that the number of women persisting in STEM careers has remained stagnant over the past decade despite an increase in programs like WSTEM (AAUW, 2010). Many researchers believe that this stagnation is due to the inadequacies of access (Haier, 2007; Harding, 1997; Seymour & Hewitt, 1997). These researchers suggested that programs such as WSTEM need to address the gender discrimination occurring in STEM departments and not simply create an artificial space where women interact in a single-gender environment (Harding, 1997; Lemke, 2001). Researchers such as Ong (2005) and Rosser (2003) found that women who succeed tend to mimic the behaviors of their male peers and hide their more feminine behaviors as Dr. Smith described in her early career.

The results of this study similarly suggest that only certain women succeed in STEM fields when given access without a concept of how to change the status quo. The WSTEM stayers who persisted in STEM did not believe that they should challenge the masculine cultures of their STEM fields (Ong, 2005). The WSTEM stayers in this study believed that gender did not play a role in STEM fields or did not affect their treatment in these fields. These women did not appear to be aware of the masculine nature of STEM to which Harding (1997) described. All of the WSTEM stayers believed that gender stereotypes were socially imposed but did not affect them. The stayers accepted the culture of their STEM departments, including the larger number of male students and professors, often saying that it was not gendered.

The leavers chose to change majors rather than challenge the status quo. Perhaps if these leavers had thought to challenge or question the culture of their fields, they might have persisted, but this is not a question that this study can answer. However, the STEM departments at State University and the administration at State University are working toward increasing the number of women and minorities in STEM fields. And their work appears to be providing some benefit because the STEM persistence rates of women both in WSTEM and in the general population mirror the national higher education statistics (AAUW, 2010).

This study, like others (e.g. Inkelas et al., 2007; Mael et al., 2007), found mixed evidence regarding the impact of women-only STEM LLC’s on women’s persistence in STEM fields. The results of the study did not support the fears of women’s organizations that women-only programs will increase gender discrimination. However, the findings also did not unequivocally
support the positive impacts of women-only programs. These programs are one part of a multitude of other factors that affect persistence.

**Conclusion**

This chapter examined how participation in WSTEM affected women’s decisions to persist in STEM majors and fields. The results support the positive effect that WSTEM had on its participants, even the leavers. All but one of the WSTEM participants mentioned the positive influence of the support group they found within the program. However, the decision to stay or leave STEM was ultimately influenced by college factors other than WSTEM, as indicated in Chapter 5. The summary of the positive and negative influences of programs like WSTEM indicated that one’s perception of experiences is highly influential in career decisions.

Participation in WSTEM was an added experience that affected each woman’s perception of whether she fit in with her desired career and whether that career fit with her goals (Eccles, 2007). Butler (1999) indicated that gender is just one aspect of an individual’s identity. This aspect combined with other experiences and the interpretation of these experiences affected how each individual viewed the value and success related to her STEM career and the role that WSTEM played in this decision. The next chapter presents the conclusions for this study, its implications for policy, and suggestions for future research.
CHAPTER 7

CONCLUSION

My study had a dual focus. First, I wanted to understand the factors that influence women’s persistence in science, technology, engineering, and mathematics (STEM). These factors and the overall topic of women’s persistence in STEM fields have become an increasing concern among STEM professionals and national and state governments within the United States (National Science Board, 2008; Robelen, 2010). Women’s underrepresentation in STEM fields is affecting the ability of the United States to compete in global technological and science realms (Leggon, 2006). Consequently, my study sought to explore the issue of underrepresentation by examining how and why women choose to leave STEM fields. Second, I specifically focused on the role that WSTEM (a single-gender STEM LLC) had on women’s persistence in STEM fields. Programs, like WSTEM, have been instituted at over twenty five colleges across the United States as a way to improve women’s persistence in STEM fields (Ferrara & Ferrara, 2008; Mael et al., 2005); yet, this policy has mixed evidence to support it (Inkelas et al., 2007; Mael et al., 2005).

In terms of the factors affecting persistence, my study found three areas that are influential in women’s decisions to persist in STEM fields: precollege and college success in STEM courses, positive experiences with STEM careers and professionals, and a peer support network. WSTEM provided the latter factor for some of its participants. These key areas are discussed as they relate to my studies’ contributions to research, practice, theory, and policy.

Contributions to Research

Precollege and College Success

Previous research has suggested that successful STEM experiences before college have a positive impact on women’s choices to major in these fields in college (Burkam et al., 1997; Eccles, 2007; Jones et al., 2000). These research results were supported by my study. All 26 participants reported previous success in precollege math or science classes. These women said that their previous success was influential in their decision to major in STEM in college. These
positive experiences served as evidence that they could succeed in STEM fields and STEM careers (expectations of success; Eccles, 2007).

Once in college, some of the women began to experience low grades in their STEM courses. Individuals from both groups (stayers and leavers) mentioned poor grades as a source of frustration that caused them to doubt their ability to succeed in their chosen STEM fields. However, stayers were able to cope with this setback by separating their grades on individual tests from their overall abilities. These women believed that they could succeed in the STEM field despite a low grade on one test or in one class. These stayers also saw the desired career as worth some frustration to attain. They identified with their perceptions of STEM professionals and wanted to pursue their goals of joining these individuals (Eccles, 2007).

The leavers responded differently to their poor grades in college. Like the stayers, few of these women had received poor grades before college. The leavers believed that these grades were an indication that they could not succeed in their future STEM career. This frustration, combined with either their loss of interest in the original STEM career or their increased interest in another career that fit with their identity, affected their decisions to leave their chosen STEM major.

This difference in how stayers and leavers saw grades supports previous literature (AAUW, 2010; Farmer, 1997; Williams & Ceci, 2007). Individuals who persisted saw their grades as a baseline measurement whereas leavers tended to internalize their grades as representations of their overall abilities to succeed. Unlike previous research which identified men as representative of the former reaction (Farmer, 1997; Williams & Ceci, 2007), in this study, there were a number of women who were also able to see grades as a baseline measurement and not an overall indication of their future success in STEM.

Future research should delve into the ways in which internalization or reactions to grades affects persistence. For example, in this study, those stayers who received low grades in college STEM classes appeared to react differently than leavers. The question then is why the difference and how much of a direct impact did these differing reactions have on each person’s persistence. The conclusion based on my results indicated that all of these women had rarely received low grades before college. And yet some were able to persist despite receiving low grades in college courses. Many leavers, however, saw these grades as a direct indication that they could not succeed, or they deemed the poor grades as one piece of a variety of factors that affected their
decision to leave STEM. This impact of grades and the differing reactions by students with previous academic success is worth future study, because it can help educators and students address their internalization of poor grades and possibly increase persistence rates in STEM.

Positive STEM Experiences in College

The experiences that each of these women had within their STEM field in college influenced their perceptions of and acculturation to these fields. Experiences, such as research opportunities and interactions with professors and STEM professionals, introduced and exposed these young women to their future careers. During these experiences, the participants were able to find out more about their STEM major and future career, and then decide whether the experience matched their goals, their identity, and their interests (Eccles, 2007).

All of the stayers in this study had positive research experiences and/or an influential mentor. Each of these participants said their positive experiences were crucial to their persistence in STEM. The stayers perceived the time with their mentors as evidence that they were welcome and important in the field. The research experiences helped them to see that the work they would do in their STEM career was of interest to them (Eccles, 2007). Consequently, these stayers were able to maintain their interest in their chosen field.

The leavers had a different experience in college with fewer having positive research opportunities and mentoring. The leavers perceived the lack of mentoring as evidence that they were not worth professors’ time and therefore not important to the field. This sense of unimportance made these women question their STEM decision and whether or not it fit with their goals, interest, and identity. The resulting decision was to leave the STEM fields. This decision by the leavers supports previous research on the role that mentors and research opportunities can have on women’s STEM persistence (Seymour & Hewitt, 1997).

This result shows how important research experiences and mentor interactions are to STEM persistence. It also highlights some questions for future study. First, why were some of the participants able to find research opportunities and/or influential mentors and others were not? These questions and their results have implications for college STEM departments, which will be discussed later in this chapter.
**Chilly climate as an experience in college.** One issue that affected both stayers’ and leavers’ perception of their STEM college experiences was their sense of the chilly climate within their STEM departments (Seymour & Hewitt, 1997; Shakeshaft, 1995). The chilly climate described by participants (that is also supported by research) included a lack of female role models (Ong, 2005; Seymour & Hewitt, 1997), especially for minority women (Crisp et al., 2009; Ong, 2005); a lack of support or help; high level of competition among students for grades and internships; and the impersonal lecture teaching styles within STEM majors (Seymour & Hewitt, 1997). As previous research has suggested, this climate can result in lower confidence levels (Brainard & Carlin, 1998) and affect women’s ability to identify with the culture of the major (Duschl et al., 2007; Kahveci et al., 2007).

This result is disappointing. As I stated in Chapters 1 and 2, researchers have shown the presence of a chilly climate for women in STEM throughout history. Since 1970, the federal and many state governments have initiated policies to try to improve this climate in college STEM departments and in STEM careers. Sadly, after forty years of research and policy making, this study shows that the chilly climate is still present affects those women who believe in gender stereotypes.

**Gender.** Each participant’s conception of gender affected the role that the chilly climate played in her decision to stay or leave STEM fields. My study found that if women believe in obvious gender differences based on gender stereotypes, as most of the leavers in this study did, then their likelihood of persisting was much lower. These gender beliefs affected women’s perceptions of the negative influences they experienced in college, leading the leavers to decide that their original desired STEM major did not fit with their gender identity, interest, and goals (Eccles, 2007). These leavers began to doubt their success in the STEM major or believed that the cost of the STEM major was no longer worth the end result. The stayers were able to see the positives in their desired STEM career. They believed that it fit their identity (including gender), interest, and goals (i.e., gender).

This result has implications for research. More research should focus on individuals’ gender conception and how this matches or conflicts with their view of scientists. In my study, those women who saw gender as simply a biological difference were able to see themselves succeeding in their chosen STEM fields. These women were better able to identify with
scientists (both male and female) in their chosen STEM fields. Those women who believed in gender stereotypes appeared to have a direct conflict between their conception of being a woman and being a successful scientist. Perhaps this is an area that more research can focus on to better understand the link between gender conception and STEM persistence.

**Support Groups**

In this study, all of the stayers mentioned some form of a peer support group within their major that positively affected their persistence in STEM. These women discussed how their peer support groups made them feel like they belonged in their major (Eccles, 2007). Stayers mentioned how their participation in study groups not only helped them improve their understanding, but also helped them to see that others might be struggling with the same concepts. These discussions with peers in their support group also helped them to relate their course work to their everyday lives, which increased their interest in the field.

None of the leavers in this study discussed a STEM-related support group within their major. The leavers discussed their frustration with not being able to find people to talk to in their major that shared similar interests. The leavers also discussed how the large class sizes of STEM courses negatively affected their ability to meet people and become part of support networks. This lack of support and the perception that there were no others who shared their interests, led many of the leavers to feel that they did not fit in with their chosen STEM majors (Eccles, 2007). The leavers also mentioned a sense that some of the students in their STEM majors portrayed an attitude that these majors were superior to non-STEM majors.

This superior attitude added to the leavers’ inability to feel a sense of belonging. My findings support previous research that has looked at leavers’ perception of the lack of support in their STEM majors (Seymour & Hewitt, 1997). And yet few other studies have focused on this attitude within STEM departments, and its negative influence on retention rates for women. The results of this study suggested that some women may be negatively affected by the attitudes of superiority within various STEM majors. Consequently, the impact of the attitudes (or the culture) within STEM departments requires further study to determine how much influence it has on women’s (and possibly men’s) persistence.

**WSTEM as a support group.** The previous section identified the benefits of support networks, specifically networks formed by members of one academic discipline. However, the
program that was a focus of this study, WSTEM, was a formalized support network where participants interested in different STEM fields, were required to interact by living on a floor together and attending weekly classes and biweekly social outings together. Both WSTEM leavers and stayers believed that the program was beneficial for them because of the social aspect. These women said that living on the same floor with other women and attending classes with these women helped them to immediately make friends and find a support group, which reduced their sense of isolation and helped them to feel like they fit in at the university. This result was similar to previous research (Allen, 1999; Brainard & Carlin, 1998; Kahveci et al., 2007).

**Future Research**

My study identifies two additional research foci. This study only focused on the role that gender, expectation of success, and the value one places on that success play in STEM career decisions for college students. However, some of the participants highlighted the unique role that ethnicity/race and gender had on their willingness to persist in STEM fields. I did not focus on race/ethnicity in this study, but future research should address this. Some of the women in my study indicated that their race/ethnicity was just as negatively influential to their STEM persistence as their gender. Consequently, this was an important component to persistence especially for minority women who were significantly more underrepresented than white women (NSF, 2007). Future research should focus on the role that programs like WSTEM have on female minorities’ persistence in STEM.

Second, this study focused on female college students. Future studies could also include male students to determine if there are any differences in perceptions and STEM career decisions based on gender conception in men. Research could identify whether men and women cite similar factors that affect their STEM persistence, and investigate how gender differences affect STEM persistence.

**Contributions to Practice**

**Precollege**

The successful precollege experiences mentioned by participants suggested that science and math experiences at the precollege level are important in developing STEM interest in
students. In particular, my results highlighted the important role of science and math teachers in developing this interest. Participants reported hands-on activities that their teachers provided for them. The participants also discussed the variety of experiences with different types of STEM fields as being influential in their success in science and math. This success led to their decision to pursue STEM in college.

The results of this study suggested that K-12 teachers need to address misconceptions students have regarding STEM careers. Four women in this study held misconceptions regarding STEM careers that affected their persistence including science as magic or science as always resulting in exact answers. This finding suggested that schools could provide more information on a variety of STEM occupations to give students enough information and experience to make informed decisions about STEM careers.

College

Success in STEM. Many of the leavers in this study viewed their poor grades in STEM classes as an indication that they would not be successful in a STEM career. A number of research studies addressed this perception of failure that affected women’s decisions to leave STEM fields (AAUW, 2010; Dweck, 2007; Nosek et al., 2002). These studies suggested that teachers and parents can positively influence students’ (particularly female students’) perception of grades in math and science classes. If students are taught that science and math understanding can be improved with work and problem solving, then they will see success as a possibility (Dweck, 2007). These tactics of improving perception of abilities in STEM have been utilized at both the K-12 and college level with some success (AAUW, 2010; Dweck, 2007). Consequently, by informing teachers, parents, and professors about these approaches, socializers could, in turn, prevent students from leaving STEM fields because of their low grades.

Experiences in college. The women in my study continued to experience a chilly climate in STEM fields. However, college STEM departments can address this climate in many ways. First, my study indicated the positive influences of research opportunities on participants’ persistence. These opportunities at the college level improved students’ confidence in their abilities to succeed in STEM fields. Colleges and universities, therefore, should provide opportunities for undergraduates to work in STEM fields. These opportunities could be with professors or with private and public STEM industries in the area. Students could not only
volunteer their services in these research settings, thereby providing inexpensive labor, but also receive the benefit of experience in STEM research. A current policy goal within the federal government is to provide universities with funding to pay for research opportunities (Robelen, 2010). Consequently, universities and STEM departments could receive funding for these research opportunities. Local partnerships could also keep some of these educated college students in the local area, thereby improving the local economy and reducing brain drain.

Second, research has suggested that faculty can be more proactive in forming and being part of study groups or social events with their students (AAUW, 2010). This active participation has been found to improve students’ chances of interacting with faculty and experiencing a supportive culture (AAUW, 2010). This social interaction can also help undergraduates and faculty to form mentoring relationships.

STEM departments can also play an active role in addressing the chilly climate that still exists. First faculty members can discuss female STEM professionals who have made important contributions to STEM fields to show students the career possibilities that exist for women in STEM fields and the past success women have had (Rosser, 2003). STEM departments need to address the current culture that was mentioned by participants in my study. Both stayers and leavers discussed the attitudes of superiority present in STEM majors. Both stayers and leavers discussed the feeling of failure and loneliness they associated with the poor grades received in large impersonal classes where there was little interaction with peers and faculty. STEM departments need to evaluate their cultural attitudes and determine whether these are preventing historical minorities in STEM (like women, African Americans, and Latinos) from persisting. In particular, STEM departments should look at the role that gender, particularly the dominant gender in STEM, plays in individual’s persistence. If white men are still the dominant group in STEM departments (as was the case in this study for all departments except biology), then status quo practices like large class size and weed out courses should be examined. According to my study, those individuals who left STEM were affected by both the culture of their chosen STEM department and by their own gender stereotypes.

The gender stereotypes that many of the leavers in this study identified require cultural shifts away from current gender conceptions (AAUW, 2010; Harding, 1997; Williams & Ceci, 2007). Educators and parents can begin to address these by informing young girls of the possibilities of success in STEM fields; exposing them to STEM careers and the requirements
necessary for them; and providing examples of men and women in roles that are not gender stereotypes (AAUW, 2010; Rosser, 2003). These gender stereotypes should be addressed before college, but if they still exist, colleges and universities can provide examples through guest speakers or faculty members that confront students’ gender stereotypes and show them that success in STEM fields is possible for both genders. In addition, STEM departments should be addressing these overall practices rather than simply inviting more underrepresented individuals in, so that they can be confronted with the chilly climate, thereby influencing their decision to leave.

**Support Networks.** As discussed in the previous section, students’ ability to identify with the culture of their STEM department is important to persistence (Duschl et al., 2007; Eccles, 2007). This study identified some implications regarding support networks for program administrators, college administrators, professors, and teachers. STEM departments should try to provide students with study help and a venue wherein they can form support networks. In this study, these support networks helped the participants to derive more enjoyment from their major by discussing topics from class with others and to identify with their peers in their major by realizing they had similar interests. This study suggests that both formal (i.e. WSTEM) and informal (i.e. study groups) support networks can be beneficial.

STEM departments can improve the prevalence and accessibility of informal networks. Most departments offer study hours with a teaching assistant for students to find help. However, these practices do not necessarily promote social networking. Rather, the creation of social networking pages or blogs dedicated to constant student interaction and postings regarding STEM issues and opportunities could improve students’ abilities to find peer networks that help them to succeed. These blogs or Facebook pages could be maintained by an undergraduate for free. The position holder could be given a title that would demonstrate the responsibilities required and would look valuable on a resume for future careers.

**WSTEM.** The portion of this study that focused on WSTEM has implications for practice as well. First, the WSTEM program appears to be serving its purpose of creating a support network for its female participants. Those women who participated in the research opportunities persisted, because they were able to experience their future career and see if it fit with their values and expectations of success (Eccles, 2007). The leavers from WSTEM did not
take advantage of these opportunities at the same rate and in many cases did not persist in their original STEM major.

This concept of STEM majors was defined in Chapter 4. For the WSTEM leavers in this study, all but one of the leavers pursued a social science major. Consequently, if social sciences were included in my definition of STEM as it applied to this study, then WSTEM’s persistence rate would be much higher. This question as to where social sciences belong in the categorization of STEM majors is also something that is currently debated and could not be resolved in this study (NSF, 2007).

Finally, the WSTEM administration provided the participants with speakers and literature about the underrepresentation of women in STEM. However, the administrators did not explain to the participants how the causes of the historical underrepresentation could be addressed. Perhaps in the future, the program administrators could address strategies that women could use to overcome the chilly climate within their chosen STEM departments. In addition, WSTEM faculty could work with STEM departments to help them address the policies and procedures that continue the chilly climate, and help them eliminate the chilly climate.

For those students who chose not to belong to programs like WSTEM, colleges, particularly STEM departments, should create venues or opportunities for support groups. All of the stayers indicated that the support group they found, whether in WSTEM or in their STEM major, was crucial to their persistence. Therefore, to increase persistence within STEM majors, colleges and universities could use funds to create study sessions wherein students meet each other and one or more teaching assistants or professors, so that they form a community and realize there is support available within their STEM major. These support networks could also help to challenge the conception that STEM fields are unsupportive or masculine-friendly.

Contributions to Theory

Expectancy Value and Gender as a Lens for Career Choice

The combination of Eccles’ (2007) expectancy value model with Butler’s (1999) conception of gender was helpful to the analysis of my study. Eccles’ expectancy value model helped to frame the stories that each of the women told regarding their career decisions. This framework provided the scaffolding that allowed me to better categorize each participant’s
comments and see how their experiences and the internalizations of these experiences shaped their expectations of success in a chosen career and the value of that success. Eccles mentioned gender roles as influential in career decisions; however, she did not stress the importance of gender concept for women making decisions about predominantly masculine fields, like STEM.

To provide a stronger gender portion to my framework, I included Butler’s conception of gender (1999). Butler’s view that gender is a changing identity that influences and is influenced by experience helped frame my own view of gender throughout the study. This gender framework allowed me to highlight the role of gender in women’s STEM career decisions. Due to my focus on gender, I was able to identify important differences between stayers and leavers. As discussed earlier, stayers tended to see gender as purely biological, not a trait that should dictate what individuals become in terms of careers. The leavers, in contrast, tended to believe in gender stereotypes, which often prevented them from identifying with their masculine perception of STEM fields. Consequently, if a woman sees her gender as detrimental to success in STEM, then she will be less likely to pursue that career. Without using Butler’s conception of gender, I may have missed this crucial component regarding identity’s role in STEM career decisions.

My study showed how these two theories (Butler, 1999; Eccles, 2007) worked together to expand research on women’s career decisions. My conceptual framework helped me identify the variety of factors that affect women’s decisions to persist in STEM fields. This combined framework allowed me to see that individuals’ identities, particularly their view of gender, affected their experiences and their perception of these experiences. Each life history framed how an individual saw success, and the value that she placed on that success in a chosen field.

One limitation of these combined theories was the lack of focus on personality and its effect on women’s STEM career decisions. For example, perhaps certain personality characteristics were more evident in those who persisted in their original STEM major than those who left. This could be an additional aspect to future studies that utilize this framework.

**Feminist Theory**

My study contributed to a current debate among feminist theorists regarding the limitations of access for improving women’s underrepresentation in STEM fields. Second wave feminists have advocated for women to have access to STEM courses and careers (G. Collins,
These feminists argue that women were underrepresented in STEM because they had historically been denied access.

This was the philosophy of the women who created and directed WSTEM. These women’s experiences in STEM, particularly the discrimination they had encountered, affected their choices to provide women with access to role models and peers, a decision they believed would improve persistence. This second-wave feminist focus on access was criticized by later generations of feminists who believed women’s underrepresentation in STEM fields cannot fully be rectified until the masculine nature of these fields is addressed (Butler, 1999; Harding, 1997; Lemke, 2002). These feminist researchers believed that the masculine nature of STEM fields must be confronted and changed to a culture that is more accepting of feminine traits.

In this study, the women who persisted in STEM fields tended to see gender as purely biological. They did not see STEM fields as particularly masculine despite saying that they were often a minority in terms of gender in their classes. These persisters, as well as the three women who created and directed WSTEM, did not see a need to challenge the masculine hierarchy within their fields. This research suggested that stayers were able to persist with access policies, because they identified first with their chosen STEM career and saw their gender as a biological difference and not a cultural one. The leavers in this study often struggled with their own gender conceptions, and its place in the male-dominated fields of STEM. This result indicated that the culture of STEM fields was influential in women’s persistence. If the women who believed in gender stereotypes were not persisting in STEM, did this mean that STEM departments (and their policies) were promoting an idea that women who themselves as nurturing caregivers could not succeed in or identify with STEM careers? Many current feminist theories would argue that this is the case. Harding (1997) and Lemke (2002) argue that access to STEM fields is only successful for those women who take on behaviors ascribed to the masculine gender.

Consequently, many women who represent varying points on the gender spectrum are being turned off by the masculine nature of STEM that currently exists. Therefore, if policies continue to provide access to women without addressing the underlying gender issues within STEM, then these programs might continue to lose qualified participants.

Butler’s theory of gender as an influential part of one’s identity extended my understanding of how access policies were beneficial for those individuals did not define women using gender stereotypes. This study expanded on current feminist theory by showing that policy
initiatives that focus only on access for women in STEM may be missing many women who could succeed in these fields. Policy initiatives need to also focus on the masculine culture within STEM fields to improve women’s abilities to identify with them. These access policies will be discussed next.

**Contributions to Policy**

The first policy initiative under examination in my study was a women-only STEM LLC program (WSTEM). My study focused on the role that this particular policy initiative had on women’s persistence in STEM. Proponents of these programs argued that they can alleviate the negative impact of the perceived chilly climate within STEM fields (Brickhouse & Potter, 2001; Ferrara & Ferrara, 2008; Rayman & Brett, 1995; Speilhagen, 2008). Other researchers and policymakers argued that these programs could increase the acceptance of gender stereotypes (Feminist Majority Foundation, 2009; Gandy, 2006).

The results of my study suggested that some women benefited from these types of programs, because they provide a formal support network that helped participants feel like they belonged not only in the program but also in STEM. These programs typically required only a dormitory hall where women lived and the added expense of a graduate assistant. Some of the programs relied on faculty within the university to not only spearhead the formal program but to speak and/or teach classes within it. These monetary and time costs were relatively minimal for the benefits that the programs provided to students who participated. (In my study, in comparison to all of the LLCs, WSTEM received the least amount of funds.) The social benefits of the WSTEM program in my study were mentioned by all but one of the participants. Consequently, even though half of these participants did not persist in STEM, they still described the positive benefits that WSTEM offered as a welcoming and supportive environment that alleviated some of the participants’ trepidations in terms of attending a large university.

As I discussed in the previous chapter, the success rate of the WSTEM program could also depend on one’s definition of STEM. All but one of the women that I labeled as WSTEM leavers planned to pursue a career in psychology, sociology, or science education. These fields fell under the category that I defined as quasi-STEM fields. These women credited WSTEM as helping them feel that they could be successful in their quasi-STEM majors. Consequently, this
program, and others like it, could be considered even more effective if social sciences are put under the category of STEM.

With regard to the criticisms of these programs from organizations like NOW and AAUW, the results of this study did not indicate that WSTEM enforced gender stereotypes in its participants. In fact, some of the participants were motivated to mentor other women to persist in STEM fields based on their participation in WSTEM. The gender stereotypes appeared to be part of most of the leavers’ gender conceptions before they entered college. This gender conception and their lower commitment to their chosen STEM major negatively affected their persistence. But even the women who left their original STEM major mentioned the positive impact of the WSTEM program on their overall sense of fitting in at the university. My study found that programs such as WSTEM should continue, because they provide a support network that allows participants to feel a sense of belonging within universities and for some STEM fields.

These policies provided an efficient use of funds in comparison to the benefits (i.e. social support) they provided. WSTEM was the least costly LLC on State University’s campus. All of these LLCs shared a line item budget amount granted by the state legislature. The university used a small portion of this amount (in comparison to the funds spent on the other LLCs) and yet received multiple benefits. First, the university received the benefit of positive public relations since, at the time of this study, SU was the only public university within the state to have a women-only STEM LLC. The presence of WSTEM demonstrated SU’s overarching policy to increase the number of women in STEM to the public. This positive public perception benefited SU since it theoretically attracted female STEM students who provided the added benefit of helping faculty with research projects.

Another policy initiative that was mentioned in the literature review but not specifically studied within this research was the use of federal policies and initiatives to increase the number of women in STEM fields. Both stayers and leavers in this study perceived a chilly climate within their chosen STEM majors. Despite decades of programs and policy initiatives aimed at addressing this issue, the problem still exists. Perhaps programs and policies such as Obama’s White House Council on Women and Girls and White House initiated partnerships between private industries and STEM education institutions will help address the chilly climate (White House, 2009a). Perhaps the use of Title IX within STEM majors and fields will help to alleviate inequities that have led to the perceived chilly climate (Rollison, 2003).
The results of these policies require further study to determine if they are addressing the chilly climate within STEM fields. This study contributed to the policy discussion as it related to programs and policies aimed at increasing women’s persistence in STEM fields. These programs and policies, particularly programs like WSTEM, hold promise in providing women with access to STEM careers, role models, and like-minded peers. Future studies should focus on whether these programs improve women’s persistence by creating an environment wherein women feel safe, empowered, and able to succeed in STEM and in college. These studies could provide more evidence that investments in programs like WSTEM can extend the STEM career force, which could, in turn, improve America’s technological productivity and economy.

Conclusion

In conclusion, this study investigated the STEM career decision process for women at the college level and the role that programs such as WSTEM can play in these decisions. Although this study focused on individuals at one university, it shed light on many of the factors influencing women’s persistence in STEM fields. In my study, WSTEM had a positive impact on students’ college experience and, for some, persistence in STEM. Individuals who stayed in STEM indicated that support groups, mentors, and research opportunities were the most important influences on their persistence. Leavers mentioned the presence of a chilly climate and for many a sense of not fitting in with the culture of STEM. The concept of the underrepresentation of women in STEM fields is one that policy makers and government officials are discussing and attempting to address; therefore, any studies that can add to the literature in this area are useful in informing policies. Consequently, the results of this study can help policy makers make more informed decisions regarding women-only STEM LLCs at the college level. The findings of my study suggest avenues for universities and the policies they enact that can have an important role in improving women’s persistence in STEM fields. These policies can have a broader impact on American society by increasing the STEM workforce and thereby improving its economic productivity.
APPENDIX A

WOMEN-ONLY PROGRAMS NATIONWIDE

Below is a list of Colleges/Universities with programs for women in science, technology, engineering, and/or mathematics. Those universities highlighted in yellow are part of the National Survey of Living Learning Programs 2007 Study. Those studies that are living and learning communities will have an LLC under their name.

1. Arizona State University
   WISE

2. Brown University
   WiSE – LLC
   http://www.brown.edu/Student_Services/WiSE/

3. Clemson University
   WISE - LLC
   http://www.ces.clemson.edu/wise/

4. Duke University
   WISE – not LLC
   http://www.duke.edu/web/wise/

5. Florida State University
   WIMSE - LLC
   http://wimse.fsu.edu/

6. Miami University – Ohio
7. New Mexico University
    WISE - LLC
    http://www.unm.edu/~unmwise/

8. North Carolina State University
    WISE – LLC
    http://www.ncsu.edu/wise/

9. Northeastern University
    WIE - LLC
    http://www.coe.neu.edu/wie/

10. Northern Illinois University
    LLC
    http://www.womeninscience.org/outloud.htm

11. Ohio State University
    LLC
    http://wie.eng.ohio-state.edu

12. Pennsylvania State University
    LLC
    http://www.engr.psu.edu/wep

13. Purdue University
    LLC
    http://www.science.purdue.edu/wisp/
14. Stony Brook College  
WISE - LLC  
http://www.wise.sunysb.edu/

15. Syracuse University  
LLC has two programs  
http://whitman.syr.edu/eee/wisecenter/

16. University of Arizona  
WISE not LLC  
http://www.life.arizona.edu/undergraduate/cl/liv_learn_comm/wise.asp

17. University of California Santa Barbara  
WISE – not LLC  
http://www.wise.ucsb.edu/

18. University of Illinois, Chicago  
WISE  
http://www.uicwise.org/

19. University of Iowa  
WISE – LLC  
http://www.uiowa.edu/~wise/

20. University of Maryland  
WISE - LLC  
http://www.eng.umd.edu/wie/

21. University of Michigan  
WISE-- LLC
www.wise.umich.edu/

22. University of Southern California  
WISE – not LLC  
http://www.usc.edu/programs/wise/

23. University of Washington  
WiSE not LLC  
http://www.engr.washington.edu/wise/

24. University of Wisconsin  
WISE – LLC  
http://wiseli.engr.wisc.edu/

25. Virginia Technical University  
Hypatia - LLC  
http://www.eng.vt.edu/academics/ceed_learn_com.php
APPENDIX B

DESCRIPTION OF LIVING AND LEARNING COMMUNITIES ON UNIVERSITY WEBSITE

“Specifically designed for first-year students, the Learning Communities at _____ University are designed to help contribute to the student's overall growth and development. In addition to residing in a close-knit supportive community, learning community participants are given the opportunity to interact with faculty, some may take a course in their residence hall, and interact with other students who share common academic interests. These students aren't just living together, they're learning together! Currently, there are eight living-learning communities.”

Description of WSTEM Living and Learning Community on University website

“Bryan Hall is home to the Women in STEM Program. This program provides support for women studying science, mathematics, and engineering fields through faculty interaction, study groups, and peer education. This community living unit provides access to support networks in these academic areas by offering role models, advising assistance, and opportunities for field trips. Students will experience the benefits of living in a close-knit, supportive community and at the same time be provided with leadership opportunities and experiences for women in these fields. The program is open to all female students who plan to major in any of the physical sciences, mathematics, or engineering fields. Students interested in receiving information about the WSTEM program should indicate this on their housing agreement by selecting "yes" to the appropriate question. For more information about the WSTEM Program, please visit the WSTEM website.
APPENDIX C

PRE-INTERVIEW QUESTIONS

Email Questions sent to WSTEM Stayers, Leavers, and GP Stayers
1. What was your original major as a freshman?
2. What is your current major?
3. What were your science and math grades in high school?
4. What are your science and math grades in college?
5. What are your parents’ occupations?
6. What is the highest level of education completed by your parents?

Email Questions sent to GP Leavers?
1. What was your original major as a freshman?
2. What is your current major?
3. What were your science and math grades in high school?
4. What are your science and math grades in college?
5. Can you briefly explain why you chose to change majors?
6. What are your parents’ occupations?
7. What is the highest level of education completed by your parents?
APPENDIX D

INTERVIEW QUESTIONS

Interview with program directors, staff, and professors to gain a better understanding of the culture within the university and/or different departments.

1. What makes ___ University/your department/your program different from other universities in your opinion?
2. What would you say the mission of the university/program/department is?
3. What would you say the history of the university/program/department has been as it relates to minorities and women?
4. Is there anyone else you would recommend that I talk to?

Interview Questions for Participants with Codes

<table>
<thead>
<tr>
<th>Interview Questions for Participants</th>
<th>Codes</th>
</tr>
</thead>
</table>
| 1. Tell me a little bit about yourself. (How would you define your personality? What are your hobbies or what do you enjoy doing most? Tell me about your friends and family. Who is someone you most admire? Why?) | Gend 

er Roles | Soci 

alizers and Role Models | Science practice and/or preparati 

on | Identity | Futur 

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t | Reactions to Chilly Climate | Policy issues | Expect 

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career | Cost |
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<tbody>
<tr>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. How does science fit in with that definition?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. How do you define gender? What are the biggest differences between males and females according to your definition of gender?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>p</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Do you see gender as having any role in science? Why?</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>X</td>
<td>p</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5. How long have you been interested in science?</th>
<th></th>
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<tbody>
<tr>
<td>X</td>
<td>X</td>
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<table>
<thead>
<tr>
<th>6. Was there a particular experience that you can remember that sparked that interest as a child, middle and high school student, and now college? (If yes, can you explain.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Interview Questions for Participants</td>
<td>Genders and Role Models</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>6a. Describe yourself as a student. (What were your best subjects? Why? What were your favorite subjects? Why? What were your weakest subjects? Why? What were your least favorite subjects? Why?)</td>
<td>X</td>
</tr>
<tr>
<td>7. How did you maintain an interest throughout middle school, high school, college, and graduate school if applicable?</td>
<td>X</td>
</tr>
<tr>
<td>8. Did you have any mentors or supporters who stand out to you in your science career? Why?</td>
<td>p</td>
</tr>
<tr>
<td>9. What was your original declared major when you were a freshmen? Why did you choose this major?</td>
<td></td>
</tr>
<tr>
<td>10. What is your major now? What led you to this decision?</td>
<td>p</td>
</tr>
<tr>
<td>12. Do you plan on having a family? If so, have you weighed that into your decisions about careers?</td>
<td>p</td>
</tr>
<tr>
<td>13. What role did WSTEM play in this experience and/or decision? (For WSTEM participants only).</td>
<td>p</td>
</tr>
<tr>
<td>14. How would you define the culture of the university/department/program? Has this influenced your decisions to pursue a STEM major?</td>
<td>p</td>
</tr>
<tr>
<td>15. Did you ever see your gender as having an influence on your experience in STEM fields? How?</td>
<td>X</td>
</tr>
<tr>
<td>16. Do you think there are barriers to women in science? Why? Do you think this is changing? Why?</td>
<td></td>
</tr>
<tr>
<td>17. Do you think it is the university/department/program’s role to address that? Why?</td>
<td></td>
</tr>
<tr>
<td>18. Have you ever experienced a set back in your major or previous education in science or math? How did you deal with it?</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Code</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>19. What do you think of current programs on campus and across the country that aim to increase the number of women in STEM fields? Why?</td>
<td>X</td>
</tr>
<tr>
<td>20. Is there anyone else you would recommend that I talk to?</td>
<td>X X X</td>
</tr>
</tbody>
</table>

X = Question address that code  
P = Question could possibly address that code, depending on participant’s answer
APPENDIX E

IRB APPROVAL LETTERS

Date: 1/16/2009
To: Roxanne Hughes
Dept.: EDUCATIONAL FOUNDATIONS AND POLICY STUDIES

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
The Process of STEM Career Choice for Undergraduate Women: A Narrative History Analysis

The application that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be Expedited per 45 CFR Â§ 46.110(7) and has been approved by an expedited review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 1/15/2010 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request
renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Stacey Rutledge, Advisor
HSC No. 2008.1829

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 Â· FAX (850) 644-4392

RE-APPROVAL MEMORANDUM

Date: 11/4/2009

To: Roxanne Hughes Dept.: EDUCATIONAL FOUNDATIONS AND POLICY STUDIES

From: Thomas L. Jacobson, Chair

Re: Re-approval of Use of Human subjects in Research
Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 11/3/2010, you are must request renewed approval by the Committee. If you submitted a proposed consent form with your renewal request, the approved stamped consent form is attached to this re-approval notice. Only the stamped version of the consent form may be used in recruiting of research subjects. You are reminded that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report in writing, any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc: Advisor
HSC No. 2009.3499
APPENDIX F

INFORMED CONSENT FORMS

Dear WSTEM PARTICIPANT,
The Process of STEM Career Choice for Undergraduate Women: A Narrative History Analysis

You are invited to be in a research study of the influences that affect women’s decisions regarding science majors and choices. You were selected as a possible participant because of your participation in the Women in Science, Technology, Engineering, and Math program (WSTEM) at State University. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Roxanne Hughes, Educational Leadership and Policy Studies department, College of Education, State University.

Background Information:

This study will be my dissertation. The purpose of this study is to determine the influences that have affected your STEM choices at different stages in your life (childhood, middle school, high school, and college). Then I would like to determine how these influences affected your decisions regarding STEM majors. And finally I would like to see what role gender and departmental culture played if any in this process.

My research questions for this study are:
1. How does the participation in a program aimed at improving women’s interest and persistence in science, affect the decision of undergraduate women to remain or leave science fields?
2. What influences these women’s decisions as expressed through their narrative life histories?
3. What effect if any does the culture of science departments have on women’s decisions regarding STEM majors?

To answer these questions I would like to interview and survey students who have participated in WIMSE.

Procedures:

If you agree to be in this study, I would ask you to do the following things:
1. Take a survey which should last 30-45 minutes and can be mailed to you or emailed to you (whichever is more convenient).
2. Participate in 2 interviews which should last 30 to 45 minutes and can also be done in person or over the phone. One interview will take place during the Spring semester and the other after graduation if possible.

3. Then there will be a follow-up email where I may ask clarification questions and get your feedback on either the survey or the interview questions. (This will occur within a 6-8 weeks after the interview).

During the interviews you will be audio taped. The survey and interview will be related to your experiences with science, your interest in science, your decisions related to science, and the influence WIMSE may have had on these issues.

Any information obtained during the course of the study will remain confidential to the extent allowed by law. Any data collected will not be associated with your name unless you have given permission. You will remain anonymous at all times and all data will be stored in a locked cabinet in the Educational Leadership and Policy Studies office. All data, including surveys, consent forms, tape recordings and transcribed interviews will be destroyed after 3 years (May 30, 2012). You will be emailed a transcribed copy of your interview.

**Risks and benefits of being in the Study:**

The study may have minimal risk. The survey and interview questions will ask you about your personal experience with science. If any of these experiences are negative or you do not feel comfortable explaining them then you are free to withdraw your participation or simply that part of your participation.

This study may have multiple benefits. The research may provide you with added reflection on your own experiences in science which may help you to understand how you came to your current decisions regarding science. Your participation in this study may also greatly benefit the WSTEM program’s understanding of how women make choices related to science majors which could potentially improve the program and others like it to benefit women at SU and other colleges in their pursuit of science degrees.

**Compensation:**

There will be no compensation for this study.

**Confidentiality:**

The records of this study will be kept private and confidential to the extent permitted by law. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. All audio recordings will only be accessed by Roxanne Hughes, for the purposes of possible publication. All consent forms, surveys, recordings and transcribed copies of recordings will be erased/deleted after 3 years (May 30, 2012).

**Voluntary Nature of the Study:**
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships. You are free to withdraw your participation at any time. If there are parts of the transcribed interviews that you would like to delete, then you can let me know and I will do so, as long as you notify me within 4 weeks of received the emailed transcribed copy.

**Contacts and Questions:**

The researcher conducting this study is Roxanne Hughes who will be supervised by her advisor, Stacey Rutledge, PhD. You may ask any question you have now. If you have a question later, you are encouraged to contact them at the following:

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the IRB.

You will be given a copy of this information to keep for your records.

**Statement of Consent:**

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature                                         Printed Name    Date

Signature of Investigator                    Date

**Dear non-WSTEM Participant,**

The Process of STEM Career Choice for Undergraduate Women: A Narrative History Analysis

You are invited to be in a research study of the influences that affect women’s decisions regarding science majors and choices. You were selected as a possible participant because of your declared interest in a science, technology, engineering, and/or mathematics major as a first year student at State University. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Roxanne Hughes, Educational Leadership and Policy Studies department, College of Education, State University.

**Background Information:**

This study will be my dissertation. The purpose of this study is to determine the influences that have affected your STEM choices at different stages in your life (childhood, middle school, high
school, and college). Then I would like to determine how these influences affected your
decisions regarding STEM majors. And finally I would like to see what role gender and
departmental culture played if any in this process.

My research questions for this study are:

1. What is the decision process for women in STEM majors at a Research 1 University?

2. What influences these women’s decisions as expressed through their narrative life
   histories?

3. What effect if any does the culture of science departments have on women’s decisions
   regarding STEM majors?

To answer these questions I would like to interview and survey students who had a declared
science major during their first year at State University.

**Procedures:**

If you agree to be in this study, I would ask you to do the following things:

1. Take a survey which should last 30-45 minutes and can be mailed to you or emailed to
   you (whichever is more convenient).

2. Participate in 2 interviews which should last 30 to 45 minutes and can also be done in
   person or over the phone. One interview will take place during the Spring semester and
   the other after graduation if possible.

3. Then there will be a follow-up email where I ask clarification questions and get your
   feedback on either the survey or the interview questions. (This will occur within a 6-8
   weeks after the interview).

During the interviews you will be audio taped. The survey and interview will be related to
your experiences with science, your interest in science, and your decisions related to science.

Any information obtained during the course of the study will remain confidential to the extent
allowed by law. Any data collected will not be associated with your name unless you have given
permission. You will remain anonymous at all times and all data will be stored in a locked
 cabinet in the Educational Leadership and Policy Studies office. All data, including surveys,
consent forms, tape recordings and transcribed interviews will be destroyed after 3 years (May
30, 2012). You will be emailed a transcribed copy of your interview.

**Risks and benefits of being in the Study:**

The study may have minimal risk. The survey and interview questions will ask you about your
personal experience with science. If any of these experiences are negative or you do not feel
comfortable explaining them then you are free to withdraw your participation or simply that part
of your participation.
This study may have multiple benefits. The research may provide you with added reflection on your own experiences in science which may help you to understand how you came to your current decisions regarding science. Your participation in this study may also improve the research on women’s decisions in STEM majors by helping the researcher to understand the decision process and the role of departmental culture and gender on women’s choices related to science majors which could potentially benefit women by improving the policies and programs aimed at increasing the number of women in STEM fields.

**Compensation:**

There will be no compensation for this study.

**Confidentiality:**

The records of this study will be kept private and confidential to the extent permitted by law. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. All audio recordings will only be accessed by Roxanne Hughes, for the purposes of possible publication. All consent forms, surveys, recordings and transcribed copies of recordings will be erased/deleted after 3 years (May 30, 2012).

**Voluntary Nature of the Study:**

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships. If there are parts of the transcribed interviews that you would like to delete, then you can let me know and I will do so, as long as you notify me within 4 weeks of received the emailed transcribed copy.

**Contacts and Questions:**

The researcher conducting this study is Roxanne Hughes who will be supervised by her advisor, Stacey Rutledge, PhD. You may ask any question you have now. If you have a question later, you are encouraged to contact them at the following:

Roxanne Hughes, Department of Educational Leadership and Policy Studies,

Stacey Rutledge, Office of Educational Leadership and Policy Studies

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the IRB at.

You will be given a copy of this information to keep for your records.

**Statement of Consent:**
Dear WSTEM FACULTY/STAFF/ADMINISTRATOR,

You are invited to be in a research study of the influences that affect women’s decisions regarding science majors and choices. You were selected as a possible participant because of your role in the Women in Science, Technology, Engineering, and Math program (WSTEM) at State University. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Roxanne Hughes, Educational Leadership and Policy Studies department, College of Education, State University.

Background Information:

This study will be my dissertation. The purpose of this study is to determine the influences that have affect women’s STEM choices at different stages in their lives (childhood, middle school, high school, and college). I would like to see what role gender and departmental culture played if any in this process.

My research questions for this study are:

1. How does the participation in a program aimed at improving women’s interest and persistence in science, affect the decision of undergraduate women to remain or leave science fields?

2. What influences these women’s decisions as expressed through their narrative life histories?

3. What effect if any does the culture of science departments have on women’s decisions regarding STEM majors?

Procedures:

If you agree to be in this study, I would ask you to do the following things:

1. Participate in an interview which should last 45-60 minutes and can also be done in person or over the phone.
2. There may be a follow-up email where I ask clarification questions and get your feedback on the interview questions. (This will occur within a 6-8 weeks after the interview).

During the interviews you will be audio taped. The interview will be related to your experiences with WSTEM, the goals of the program, the effects of the program, and your own experiences with science, your interest in science, and your decisions related to science.

Any information obtained during the course of the study will remain confidential to the extent allowed by law. Any data collected will not be associated with your name unless you have given permission. You will remain anonymous at all times and all data will be stored in a locked cabinet in the Educational Leadership and Policy Studies. All data, including tape recordings and transcribed interviews will be destroyed after 3 years (May 30, 2012). You will be emailed a transcribed copy of your interview.

**Risks and benefits of being in the Study:**

The study may have minimal risk. The interview questions will ask you about your personal experience with science. If any of these experiences are negative or you do not feel comfortable explaining them then you are free to withdraw your participation or simply that part of your participation.

This study may have multiple benefits. The research may provide you with added reflection on your own experiences in science which may help you to understand how you came to your current decisions regarding science. Your participation in this study may also greatly benefit the WIMSE program’s understanding of how women make choices related to science majors which could potentially improve the program and others like it to benefit women at FSU and other colleges in their pursuit of science degrees.

**Compensation:**

There will be no compensation for this study.

**Confidentiality:**

The records of this study will be kept private and confidential to the extent permitted by law. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. All audio recordings will only be accessed by Roxanne Hughes, for the purposes of possible publication. All consent forms, recordings and transcribed copies of recordings will be erased/deleted after 3 years (May 30, 2012).

**Voluntary Nature of the Study:**

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships. If
there are parts of the transcribed interviews that you would like to delete, then you can let me
know and I will do so, as long as you notify me within 4 weeks of received the emailed
transcribed copy.

Contacts and Questions:

The researcher conducting this study is Roxanne Hughes who will be supervised by her advisor,
Stacey Rutledge, PhD. You may ask any question you have now. If you have a question later,
you are encouraged to contact them at the following:

Roxanne Hughes, Department of Educational Leadership and Policy Studies,

Stacey Rutledge
Office of Educational Leadership and Policy Studies

If you have any questions or concerns regarding this study and would like to talk to someone
other than the researcher(s), you are encouraged to contact the IRB at
You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent
to participate in the study.

________________________  ______________________  ______________________
Signature                   Printed Name                   Date

________________________  ______________________
Signature of Investigator                   Date
**APPENDIX G**

**STORYLINE RUBRIC**

Participant ID  
Race/Ethnicity  
Original Major during Freshmen year (Fall 2006)  
Current Major (Spring 2010)  
Parents’ occupation and educational level  
Description of participant  
Future Family Plans  
Conception of Gender  
Culture of Major  
Experience in Major  
Reaction to programs like WSTEM

<table>
<thead>
<tr>
<th>Phase</th>
<th>Outside Influences</th>
<th>Influences within individual</th>
<th>Career Goal or Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood (Including Elementary school)</td>
<td>Experiences with science Socializers, gender roles, family demographics, gender, aptitude, birth order,</td>
<td>Interpretations of experiences, affective reactions, Identity development, goals</td>
<td>(Expectation of success and value if applicable)</td>
</tr>
<tr>
<td>Secondary School (Middle and High School)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School (If applicable)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subjective Task value**
1. Attainment  
2. Intrinsic  
3. Utility  
4. Cost

**Expectation of Success**

**Current Career goal**
## APPENDIX H

### PARTICIPANTS’ MAJORS AND CAREER GOALS

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Final Major</th>
<th>Career Goal</th>
<th>Ave HS Math and Science Grades*</th>
<th>Ave College Math and Science Grades*</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1</td>
<td>Biology</td>
<td>Environmental chemistry</td>
<td>EPA/Fish and Wildlife/SeaWorld/Zoo</td>
<td>A/B</td>
<td>B</td>
</tr>
<tr>
<td>WS2</td>
<td>Biology</td>
<td>Biochemistry/Biomathematics</td>
<td>PhD in physiology or molecular med</td>
<td>A/B</td>
<td>A</td>
</tr>
<tr>
<td>WS3</td>
<td>Physics</td>
<td>Physics</td>
<td>PhD/Physics</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>WS4</td>
<td>Biology</td>
<td>Biology/Psychology</td>
<td>Pediatric Endocrinologist</td>
<td>A/B</td>
<td>A/B</td>
</tr>
<tr>
<td>WS5</td>
<td>Chemical Engineer</td>
<td>Environmental Engineering</td>
<td>Grad school engineering</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>WS6</td>
<td>Biology</td>
<td>Biology</td>
<td>Pediatric Dentist</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>GS1</td>
<td>Biology</td>
<td>Chemical-Biomedical Engineering</td>
<td>PhD/specializing in robotics</td>
<td>A/B</td>
<td>A/B</td>
</tr>
<tr>
<td>GS2</td>
<td>Physics</td>
<td>Physics</td>
<td>PhD/Physics</td>
<td>A/B</td>
<td>A/B</td>
</tr>
<tr>
<td>GS3</td>
<td>Biology</td>
<td>Chemistry</td>
<td>PhD chemistry</td>
<td>A/B</td>
<td>B/C</td>
</tr>
<tr>
<td>GS4</td>
<td>Chemistry</td>
<td>Chemistry</td>
<td>Physician's assistant/later in life chemistry teacher</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>GS5</td>
<td>Marine Biology</td>
<td>Geology</td>
<td>Master's in research</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>GS6</td>
<td>Biology</td>
<td>Environmental Studies</td>
<td>Wildlife biologist</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>GS7</td>
<td>Biology</td>
<td>Biology</td>
<td>Veterinarian</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>GS8</td>
<td>Engineering</td>
<td>Environmental Engineering</td>
<td>Grad school engineering</td>
<td>A</td>
<td>B/C</td>
</tr>
<tr>
<td>WL1</td>
<td>Chemical Engineering</td>
<td>Chemistry Education</td>
<td>HS Chemistry teacher</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>WL2</td>
<td>Chemistry</td>
<td>Psychology</td>
<td>Child Psychologist</td>
<td>A</td>
<td>A/B/C</td>
</tr>
<tr>
<td>WL3</td>
<td>Biology</td>
<td>Sociology</td>
<td>Social Worker/Counselor</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>WL4</td>
<td>Biology</td>
<td>Marketing Psychology</td>
<td>Marketing representative for fashion industry</td>
<td>A</td>
<td>A/B/C</td>
</tr>
<tr>
<td>WL5</td>
<td>Exercise Science</td>
<td>Social Science Education</td>
<td>Teacher</td>
<td>A</td>
<td>A/B/C</td>
</tr>
<tr>
<td>WL6</td>
<td>Biology</td>
<td>Environmental Studies</td>
<td>Lawyer/Lobbyist</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>GL1</td>
<td>Biology</td>
<td>Creative Writing/Communications</td>
<td>Editor/Writer</td>
<td>A</td>
<td>A/B/C</td>
</tr>
<tr>
<td>GL2</td>
<td>Biology</td>
<td>Humanities</td>
<td>Run an exotic animal shelter</td>
<td>A/B</td>
<td>A-F</td>
</tr>
<tr>
<td>GL3</td>
<td>Civil engineering</td>
<td>Classical civilizations</td>
<td>Master’s/PhD in history</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>GL4</td>
<td>Chemistry</td>
<td>Nursing</td>
<td>Nurse</td>
<td>A</td>
<td>A/B</td>
</tr>
<tr>
<td>GL5</td>
<td>Biochemistry</td>
<td>Sociology</td>
<td>PhD sociology</td>
<td>A</td>
<td>B/C</td>
</tr>
<tr>
<td>GL6</td>
<td>Biology</td>
<td>English literature</td>
<td>Book editor/advertising</td>
<td>A/B</td>
<td>B/C</td>
</tr>
</tbody>
</table>

*Self-Reported*
## APPENDIX I

### PARTICIPANTS’ DESCRIPTIONS OF ORIGINAL STEM MAJORS

<table>
<thead>
<tr>
<th>Participant</th>
<th>Original Major</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>WS1</td>
<td>Biology</td>
<td>“All the people that I hang out with that are science more serious and more like focused than the ones that I know that aren’t in science.”</td>
</tr>
<tr>
<td>WS2</td>
<td>Biochemistry</td>
<td>“Everyone in the biochemistry department seems to be always busy, hard to reach, perfectionists, competitive and over achievers. I guess in a sense we are all the same in how our personalities are built and maybe that's the reason why we are in the same major. Maybe it's that drive that pulled us to become involved in a biochemistry major or maybe it's just what fits for our personalities.”</td>
</tr>
<tr>
<td>WS3</td>
<td>Physics</td>
<td>Describes herself as a nerd because of her interest in academics but described the major as “Everyone’s very open, everyone’s like, ‘oh, well I have this idea, what do you think about it?’ It’s a very open community b/c everyone’s working towards the same goal.”</td>
</tr>
<tr>
<td>WS4</td>
<td>Biology</td>
<td>Did not feel that a culture existed.</td>
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<tr>
<td>WS5</td>
<td>Civil Engineering</td>
<td>Described herself as nerdy because of her interest in academics. “I feel like the way the classes are structured in the engineering school is more toward the way that the man thinks. In engineering you have to have a certain drive and you have to know you’re not going to be right all the time, its not going to be easy.” But when comparing her engineering focus to other engineering foci she said, &quot;Civils are very social. There’s not as many awkward wall flowers like there are in other engineering programs. So I think that we’re all like very open, loud not really loud but honest, we don’t really hold back much and everyone I can think of will let you know if they don’t get it. They’ll ask why, they’re not ashamed to be wrong or to not get it.”</td>
</tr>
<tr>
<td>WS6</td>
<td>Biology (pre-dentistry)</td>
<td>In Pre-med and pre-dentistry: “I see a lot of competitiveness. It’s good but at the same time I was disappointed in some people, no one in particular, just as a whole. I feel like a lot of people….b/c it is very competitive to get into med or dental school these days or vet school. But I see that some people that are in it, they’re very cut throat, they’re trying to get above everybody b/c they want it and that’s good b/c they’re gonna get what they’re aiming for but at the same time I just see different personalities and I feel like if you know once someone becomes a doctor or a dentist I want them to have that compassion. I’m not going to want to go to a dentist just because they had perfect grades, if they were doing it by cutting people down or not treating people nicely then you’ll see it when they are working on you.”</td>
</tr>
<tr>
<td>GS1</td>
<td>Chemical Engineering</td>
<td>“we’re all geeks, mainly men, not athletically inclined, and no one has much of a social life”</td>
</tr>
<tr>
<td>GS2</td>
<td>Physics</td>
<td>“Nerdy”; “poorly dressed”; “the men have a hard time talking to females b/c they are inexperienced with dealing with women.”</td>
</tr>
<tr>
<td>GS3</td>
<td>Biology/Chemistry</td>
<td>“Organic chemists are the hippies of the chemistry world, we’re kind of like ‘we’re just going to throw some stuff in a pot and see how it does and it will be beautiful and wonderful’ and it requires a vast amount of”</td>
</tr>
<tr>
<td>GS4</td>
<td>Chemistry</td>
<td>“I would recognize a chemistry, biology, or exercise science major, the really hard sciences. First of all b/c we go to school more than any other undergrad, I mean we have to be on campus everyday from basically 8 in the morning until 5 at night. And I think that makes a very different culture than say a business major that goes to school twice a week. And how little they have to do in between their exams and how a science major is generally doing something for every single one of their classes every day. So I think that makes us a different culture, that our commitment to school is every single day kind of thing.”</td>
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<tr>
<td>GS5</td>
<td>Geology</td>
<td>“I joke that at school it’s such a small department and there’s so many random people there that we call it, it’s like the misfits, b/c you’ve got people …it’s kind of like you try every other major and then you come to geology I guess, I don’t know exactly it’s just there’s some weird people in my major, I mean they’re awesome people, and they’re smart, and they’re funny but I probably wouldn’t hang out with them if I didn’t know them from classes. And it’s such a range of ages too.”</td>
</tr>
<tr>
<td>GS6</td>
<td>Biology Environmental focus</td>
<td>“They’re hippies. My field botany class is filled with them. Most of them are really nice people, they’re political views and they’re assumptions of other people is just straight from the 60’s like hippies, like no government, marijuana, drugs everywhere, …not really my cup of tea. But a lot of pre med students are you know, their dad was a doctor or a dentist so that’s what they are going to do, that’s what they were bred to do. And they just kind of have that air about them that says I’m pre med, I’m going to be a doctor. I feel like a lot of the environmental studies and animal science people are really just more down to earth, going with the flow kind of people, whereas pre med is like I have to get my A, I have to get into med school. You know, it’s very competitive in the classroom and that’s great, I’m a very competitive person, so it’s not a problem for me. But I don’t like when people are like, well is this going to be on the test, why do we have to know this, just so focused on getting their grade and getting out.”</td>
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<tr>
<td>GS7</td>
<td>Biology</td>
<td>“Medical students and vet students are definitely looking for that A, looking to get on the top, but they kind of bring everyone along with them and that’s something that was surprising with me. I always heard that premed and prevet students were kind of harsh in their blood thirst for grades but I’ve met several people who are willing to tutor and help out and different discussions being formed to just talk about research and just different opportunities so it’s competitive but a really helpful community. So I like our nerdy little sect. I would describe myself as nerdy. But …yea the majority of people that I’ve met in biology especially have definitely been a little nerdier than other…I mean maybe not as much as physics. [Defined nerdy as] interested and captivated in their courses and the research going on on campus.”</td>
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<tr>
<td>GS8</td>
<td>Civil Engineering</td>
<td>“Well, out of all the disciplines; it's kind of funny because we joke about it, we're the loud ones. We've got inter mural teams that are always out there with posters. We're very supportive of everyone. We kind of make this place our home, like people will take naps and stuff and we'll go out. I feel...”</td>
</tr>
<tr>
<td>Name</td>
<td>Major</td>
<td>Quote</td>
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<tr>
<td>WL1</td>
<td>Chemical Engineering</td>
<td>“Science has nothing to do with me. I’m just wide open and science is just the complete opposite of me but I enjoy it. The chemical engineers are the nerds of the nerds. I don’t know like, 9 times out of 10 we look like the sleep deprived students. You meet any engineer student more than likely they have spent 10 hours at the E school after hours that is our second home I try not to make it my 2nd home. I try to go home and take showers as often as possible. The faculty…I call them the untouchables b/c you can never get office hours or have time to speak to them.”</td>
</tr>
<tr>
<td>WL2</td>
<td>Chemistry</td>
<td>“So I think people who are in the hard sciences compared to the soft sciences they’re more serious but at the same time it’s just different you’re studying different things, you’re doing different things, I think they’re more into like doing the research like that and spending long hours in the library.”</td>
</tr>
<tr>
<td>WL3</td>
<td>Biology</td>
<td>“Classes were semi interesting. I was taking like bio and trig and I was spending a lot of time studying and I wanted to get involved in other things but didn’t have the time.”</td>
</tr>
<tr>
<td>WL4</td>
<td>Biology</td>
<td>Claimed that she was not in the major long enough to determine the type of culture that existed.</td>
</tr>
<tr>
<td>WL5</td>
<td>Exercise Science</td>
<td>Claimed that she was not in the major long enough to determine the type of culture that existed.</td>
</tr>
<tr>
<td>WL6</td>
<td>Biology</td>
<td>“I didn’t fit in. I just felt like I couldn’t hack it. B/c I had no desire to pour over my books for 5 hours a day and everybody else did. Everybody else was willing to do that and I kind of wanted to go out and do other things and …I wasn’t that motivated.”</td>
</tr>
<tr>
<td>GL1</td>
<td>Biology</td>
<td>“I feel like most of the science people I met were people who like science and probably not people as much. It’s competitive in a more ‘this is how much I know and this is how you know’ kind of way. Even when I would do study groups, I never got things as quickly as the others did and they would look at me and say, ‘how do you not get that?’ And there is nothing that will make you feel more stupid than that. Like ‘how are you not getting this, we’ve all got this, do you see that we all understand this and you don’t?’ Yea…they didn’t need to tell me, I was aware. I would say that there is that subculture and definitely in the lab. I think it’s just people who go into science…and they want to do science lab work…have a certain mentality that I just don’t. They like being alone, they like quiet…I mean the fact that I was in a lab where those people had been working together for at least a semester and I only saw a conversation once.”</td>
</tr>
<tr>
<td>GL2</td>
<td>Biology</td>
<td>“When it comes down to it, if I think of a scientist in my mind, I see a man in a lab coat. Most of my teachers in science and math were male…I don’t know if subconsciously if that played into some of the insecurities I had in the subject already were intensified by that fact. I think biology majors tend to hold a bigger presence…some of the higher level majors put themselves out there a little more…they are less…they’re very unabashed to discuss openly their major and everything like that. Whereas you get a lot of liberal arts majors who don’t really want to talk about it, b/c a lot of times people want to put them down for having what they perceive as a lesser major like they think that you know think a humanities major is a soft option, like oh you’re an English major, that’s easy. When really it isn’t, it’s just not math and science so definitively, I’d say, you know, math and science majors are a little bit stuck up and a little bit more boisterous about themselves and their difficult major.”</td>
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</table>
| GL3   | Civil Engineering              | “Science is just so much more uptight. I just saw the science culture as
something that as a general rule, the really good ones were very uptight, the semi good ones were still uptight and the ones that were sucking were uptight b/c they were sucking. So it was …they’re a much more tense culture and to me it’s just…you can always find the ones that are out there to have fun, but as a general rule they weren’t the most joyous crowd.”

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<tbody>
<tr>
<td>GL4</td>
<td>Chemistry</td>
<td>Didn’t see a culture.</td>
</tr>
<tr>
<td>GL5</td>
<td>Biochemistry</td>
<td>“I don’t know you know the STEM majors tend to be more geeky, you know not always but they do.”</td>
</tr>
<tr>
<td>GL6</td>
<td>Biology</td>
<td>“You’ll get a lot more people in the biology department who are very focused and their minds work in very set paths. They are very logical minded. And they’re not quite as creative usually I would say…I don’t know…its not that they are not creative…they are just creative in a different way. in my experience the people in the biology classes that I was in…weren’t very outgoing you know. They were great students but for the most part you know unless you already had a friend in the class it was kind of hard to make a new one in there for me.”</td>
</tr>
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</table>
REFERENCES


BIOGRAPHICAL SKETCH

Roxanne Marie Hughes grew up in southern New Jersey. She graduated cum laude from Bishop Eustace Preparatory School in 1995. Her success in the classroom and in cross country and track won her two scholarships to LaSalle University. At LaSalle she completed her Bachelor of Arts in Biology and then her Master of Arts in Secondary Education.

Roxanne then worked at Bishop Eustace Preparatory School as a science teacher and cross country/track coach for five years. During that time she began to experience the discrepancies between education policies as they were dictated by policy makers compared to how they were implemented in classrooms. Her curiosity motivated her to attend Florida State University and become a doctoral student within the Department of Educational Leadership and Policy Studies.

At Florida State University, Roxanne continued her teaching as an instructor for five semesters of the Introduction to Education (EDF 1005) course offered by the Department of Educational Leadership. She worked as a research assistant for Dr. Patrice Iatorola in 2005, conducting research for a grant proposal on the effects of class size reduction in New York City and Florida public schools. In 2006 and 2007, she worked as a graduate research assistant for Dr. Lora Cohen-Vogel on an article that she was researching with Dr. Kyle Ingle. During this assistantship, Roxanne conducted literature reviews related to policy diffusion, qualitative coding and other services to help with the manuscript. She was a third author on the final article, The Public Policy Process among Southeastern States: Elaborating Theories of Regional Adoption and Hold-Out Behavior, that was published in the Policy Studies Journal in 2007. Roxanne also served on multiple committees within the department including the Student Advisory Committee from 2006-2007 and the student representative for the department’s Administrative committee for the 2007-2008 school year.

Outside of Florida State University, Roxanne has worked in a variety of policy related positions. In 2005 she worked as a research assistant for the Florida Department of Education in the Exceptional Education Bureau. There she conducted literature reviews for reports and helped analyze documents used for policy decisions related to exceptional education. In 2006, she worked as a research assistant for the Children’s Forum, where she performed a needs-
assessment for pre-school services in Orange County, Florida. During this same time period, Roxanne worked as a policy analyst within the Office of Program Policy Analysis and Government Accountability housed within the Florida Legislature. In 2007 she also became the managing editor for the Politics of Education Bulletin, the official publication of the Politics of Education Association.

In 2007, Roxanne returned to Florida State University to work as a graduate research assistant within the Biology Department and as a research assistant within the Office of Graduate Studies. The former position provided her with opportunities to work with both qualitative and quantitative data on science teachers who attended a summer professional development program. Her work in the office of graduate studies gave her experience with surveying graduate students and tracking their educational trajectories. In 2008, Roxanne accepted a research assistantship at the National High Magnetic Field Laboratory, within the Center for Integrating Research and Learning. For this position she helped with educational outreach, conducted research on programs housed within the center which worked with K-12 students, science teachers throughout Florida and research experiences for undergraduates.

Roxanne’s research focuses on policies and programs that attempt to increase the number of women and minorities in science, technology, engineering, and mathematics fields. She has studied the effects programs that focus on K-12 students as well as those at the undergraduate and graduate levels. Her dissertation, *The Process of Choosing Science, Technology, Engineering, and Mathematics Careers for Undergraduate Women: A Narrative Life History Analysis*, focused on a program at the undergraduate level that was structured to help women persist in STEM fields. Her dissertation work has been recognized by various organizations, including the David L. Clark National Graduate Student Research Committee in Educational Administration and Policy. Her dissertation work has also been awarded dissertation grants from the Office of Graduate Studies at Florida State University and the Myra Sadker Foundation.

Roxanne is an active member in various professional organizations and has served as a discussant/chair at many of their annual conferences. She is a member of the American Educational Research Association, the Eastern Educational Research Association, the Florida Educational Research Association, the Women in Engineering Programs and Advocate Network, the National Association for Research in Science Teaching, the Association for Science Teacher Education, and the American Association of University Women.