



Keeping University Women in STEM Fields

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ABSTRACT

Policies have been implemented at all educational levels to increase access and persistence in science and engineering education for women (Rosser, 1995; Spielhagen, 2008). A popular policy approach has been single-sex programs to advance women's networking capabilities, confidence and interest in science (Spielhagen, 2008). The purpose of this study is to identify how women, who participated in a single-sex living and learning community (LLC) that focuses on women in science, technology, engineering and mathematics majors at a large research focused university in the United States, make their STEM career decisions and how the LLC affected that decision. Seven women who persisted in their chosen STEM field were interviewed via life history analysis methods. The results showed that these women shared similarities in their decisions to pursue STEM fields. The participation in a single-sex LLC had positive effects on women's persistence. The results also showed that subtle discrimination still exists in the laboratory setting.

KEYWORDS

Gender; single-sex living and learning communities; STEM; chilly climate; higher education.



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INTRODUCTION

Researchers and policy makers have long recognized an underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields (Anderson, 1995; National Science Foundation (NSF), 2007). Policies have been implemented at all educational levels to increase access and persistence in science education for women (Rosser, 1995; Spielhagen, 2008). One level where the largest underrepresentation of women in STEM fields occurs is higher education where fewer female students choose STEM majorsⁱ and even fewer persist (compared to their male peers) (NSF, 2007).

A prominent policy initiative at the university level in the United States has been single gender living and learning communities that focus on undergraduate women in STEM fields (STEM LLCs) (Inkelas, Szelenyi, Soldner, & Bower, 2007). Although these programs vary from one campus to another, they each possess common characteristics including: the participants live together on the same floor within a residence hall; participants engage in common social and educational activities; and, participants are provided with academic and social support. All of these programs (25) began within the last two decades and, as yet, few researchers have had the opportunity to study them and their effects on women's STEM career choices and retention (Inkelas et al., 2007).

National studies and survey instruments only explore the surface of the underlying cultural, social, and individual influences that affect women's STEM career decisions (Inkelas et al., 2007). These previous studies demonstrate that to gain a more informed understanding of these influences it is necessary to determine how participation in single gender STEM LLCs influences women's career decisions (Farmer, 1997; Seymour & Hewitt, 1997). The research suggests the best way to investigate the underrepresentation of women is through in-depth studies utilizing qualitative methods. Using a narrative life history methodology, I examined the factors that influence women's decisions to stay in STEM fields at a Research 1 Universityⁱⁱ.

The research questions for this study are:

- 1) What influences women who are interested in STEM majors as first year university students to stay in STEM fields?
- 2) How does participation in a single gender living and learning STEM program affect women's decisions to persist in STEM majors/fields?

BACKGROUND

Women's Underrepresentation in STEM

Currently, women appear to be experiencing less overt discrimination in STEM fields, however, many female scientists describe the subtle forms of discrimination that continue to influence their underrepresentation in these fields (Anderson, 1995; McGrayne, 2005). According to the NSF (2006) women comprise less than one-third of all science and engineering degrees and women represent less than one-third of the science and engineering workforce in many nations including the

United States. Science organizations, researchers, educators, and government officials have begun to address the underrepresentation of women in STEM fields by implementing initiatives, such as single gender support programs (Spielhagen, 2008; Tessler, 2008). These initiatives aim to address the national implications of not retaining female scientists within the workforce. This loss could, potentially, have a negative impact on the number of scientists and engineers that are working on issues affecting the United States' technological and environmental standings (Jackson, 2003; Tessler, 2008).

There are a number of reasons for the underrepresentation of women in STEM fields at the university level. Studies find that women experience a sense of marginalization based on the culture of STEM departments (Seymour & Hewitt, 1997). They are outnumbered by their male peers in their science courses (Leggon, 2006) and they encounter few female role models and professors (Leggon, 2006). These aspects lead women to feel isolated within their chosen majors. According to researchers, this isolation along with the 'institutional atmosphere, environment, or climate – both within and outside the [STEM] classroom' can impede 'women students' full personal, academic and profession development' (Hall & Sandler, 1982, p 2). Researchers refer to this 'institutional atmosphere' as the 'chilly climate', which is often credited as a reason that female students leave STEM fields at higher rates than men (Hall & Sandler, 1982; Shakeshaft, 1995, p. 74). Other studies have found that female and minority students' cultural influences make the language of science or even excelling in science appear negative or inappropriate (Lemke, 2001; Olitsky, 2006). These students are then forced to make a decision as to whether to maintain their cultural affinity or to join the science community where there has been historical marginalization for women and minorities (Leslie et al., 1998).

Each person's view of identity affects the internal choices they must negotiate in order to persist in STEM fields. For women, gender can be a major component of this view of identity. Often in research, gender is simply used as a term to differentiate between biological sex (Glasser & Smith, 2008). However, gender is a much more complicated and encompassing term since 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.

This concept is particularly relevant in activities related to the male dominated fields of science, technology, engineering, and mathematics. Women have not only been historically marginalized in these fields based on their sex, but they continue to feel like only peripheral participants within these fields because of the gendered role of the sciences (Harding, 1997; Kahveci, Southerland, & Gilmer, 2007). Feminist scholars argue that the representation of science as unbiased and objective 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 in order to be accepted and to succeed (Harding, 1997; McGrayne, 2005; Ong, 2005).

This concept of gender has important implications for policy initiatives that aim 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 may force women to fit into the masculine behaviors that dominate specific STEM fields (i.e. physics and engineering). Therefore, an important component of my study will be to determine how each of the participants conceptualizes the notion of gender and to determine how this concept affected their perceptions of and decisions related to science and science careers.

Conceptual Framework

To aid me in a contextual understanding of the cultural and social factors, I chose to incorporate two theories into my conceptual framework. Since each person creates their own singular path to their career decision, I chose to incorporate Butler's (1999) concept of gender especially as it relates to individuals' career choices. 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 saw terms like gender as categories which are 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).

Based on this conception of gender, it becomes necessary to study individuals' life histories as they relate to STEM career choices to gain a better understanding of their individual goals/experiences related to their differing conceptions of gender. Butler's (1999) definition of gender stresses how each individual will not only have their own understanding of gender, but that understanding will evolve over the course of their life. My choice of narrative life histories allowed me to understand how each participant's conception of gender affected their STEM career decisions.

Although Butler's theory provided a conceptualization of gender that supported the unique and changing aspects of this social construct within each person, it did not account for career choice. To understand the individual and cultural factors (besides gender) that influence women's STEM career decisions, I chose to draw on Eccles' Expectancy-Value model (2007). The cultural concepts include the influence of: gender roles; cultural stereotypes; socializers, including parents, peers, and teachers; and, achievement and abilities in science and math. According to Eccles' (1994; 2007) 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. According to Eccles, one's expectation of success is influenced by their confidence in their abilities. This confidence level is also affected by the estimated difficulty of the tasks required for a STEM career. An individual's beliefs regarding her abilities are

influenced by her performance in science and math courses, and by the support she receives from socializers (Carlone, 2002; Rayman & Brett, 1995). Even if a person expects to be successful in a career, she may not choose it because of the low value she places on this success. Both the expectation of success and the value one places on a particular career are unique to that individual and depend on the experiences they have had and their own interpretation of those experiences. Therefore, this model complements Butler's (1999) view which highlights the role that gender plays in each individual's decisions.

METHODS

To address my research questions and the complexity of STEM career decisions (Eccles, 2007) combined with the added intricacies that gender creates (Butler, 1999; Carlone, 2002; Lemke, 2001), I chose to use qualitative methods for this exploratory study. To uncover how women make their decision to persist in STEM fields and what effect single gender STEM LLC's have on this decision, I chose narrative life history. According to Denzin (1989) the goal of narrative life history is to determine how people ascribe meaning to their lives. The goal of this exploratory study was to have participants explain in their own words how they came to the decision to remain in science. Participants took part in in-depth interviews related to their life histories, during which individuals described their life experiences with science and how they came to their decisions to stay in STEM fields.

The STEM career choice decision making process also draws on feminist theory, which highlights the differing experiences of women within STEM that affect their career choices. Consequently, interviewing women who had persisted in their STEM majors offered an in-depth view of individuals within a particular group who have historically been marginalized within these fields. The small sample allowed me to focus on the entire life history of seven women who had persisted in their chosen STEM fields. In my study, I interviewed seniors in a large university in the United States and graduate students at that same university who demonstrated an interest in STEM fields and participated in a single gender STEM LLC as first year university students. This helped me to understand the process by which they reached the decision to pursue a career in a STEM field. I chose students close to graduation and graduate students because they are at the age where they are forced to make decisions regarding careers due to their impending graduation, a time during which they should be able to articulate both their career plans and their decision process that cultivated those plans.

Data Collection and Analysis

This study was an exploratory project to determine the validity and reliability of my conceptual framework and to determine if there were other factors in common to the participants in my study that have not previously been addressed in the literature. To identify participants, I sent emails to all members who had participated in a specific single gender STEM LLC (Women in Science, Technology, Engineering, and Mathematics (WSTEM)) program from 2002-2006, who were still at the university either as undergraduates or graduate students. Those students who agreed to participate were sent a survey that provided demographic information (i.e. major, grades received in STEM classes, race/ethnicity). The

response rate for this group of women was low, resulting in seven final participants who were interviewed regarding their life history and how it affected their STEM career choice.

All interviews were transcribed and then analyzed to determine codes and thematic matrices via a within- and across-case basis (Ong, 2005). I created a narrative summary for each individual's narrative life history as well as a storyline chart representation (see Figure 1). This storyline drew on Eccles (2007) and Butler (1999) by highlighting the consecutive phases of each woman's life and the transitions between them: Childhood, secondary school, and university. Through interviews, I identified specific incidents or stages that served as catalysts that contributed to each individual's interest in STEM and decisions as they related to STEM fields. A storyline like the one found in Figure 1 was created for each participant based on their interview responses. Each participant was sent their storyline and transcribed interview as a form of member checking. The influences listed in the second and third column of Figure 1 are taken from Eccles' 2007 Expectancy Value Model and I added the additional focus on gender to this conceptual framework. All of elements listed in these columns combine to affect individuals' expectations of success and subjective task values, which in turn result in their career decisions.

Figure 1: Conceptual Framework for Participants' Storylines

Phase	Environmental Influences (Eccles, 2007)	Influences within individual (Eccles, 2007)	Definition of Gender
Childhood (including elementary school)	Socializers, gender roles, family demographics, gender, aptitude, birth order	Interpretations of experiences, affective reactions, Identity development, goals	Conception of gender (how do you see gender?); How does gender relate to people's treatment of you in STEM classes and fields? What role does your gender have in your career decisions?
Secondary school	Previous achievement, Socializers, gender roles, family demographics, gender, aptitude, birth order	Interpretations of experiences, affective reactions, Identity development, goals	
University	Previous achievement, Socializers, gender roles, family demographics, gender, aptitude, birth order	Interpretations of experiences, affective reactions, Identity development, goals, expectations of success and subjective task value that leads to career choice	

After each interview was transcribed, I carefully read it to identify codes or themes that were indicated within each participant's transcript (Miles & Huberman, 1994). Originally, I used the codes identified in Eccles' (2007) model: gender roles, socializers and role models; science practice and preparation; identity; future family

plans; chilly climate; reactions to chilly climate; policy issues; expectations for success; value of science career; and, cost of career. As I read through the interviews, however, I noticed that some of these codes could be combined and I added some other themes that I found in the data. Based on these themes the final codes that I used to analyze the interview data were: role of parents; mentors (positive or negative); science experiences; future family plans; identity (perception of oneself as a geek/nerd); gender roles; chilly climate; and, influence of WSTEM. Each of these themes will be discussed in turn in my results section.

The choice of narrative life history helped me to finalize these themes. This method gave each of the participants time during the interview to reflect on their life experiences and to determine how these experiences affected their current STEM choices. These reflections and my own interpretations were sent to each participant for their approval. These themes may not have been apparent if a different methodology was used, such as a large scale quantitative study. In this study, I was able to spend more time interviewing each participant (one and a half hours on average). I was able to develop a rapport with each participant that improved the dialogue during subsequent follow up interviews, including the exchange of their storyline, which they then approved and returned to me. This ongoing dialogue strengthened the analysis, ensuring that each of the participants was able to voice their experience.

PROGRAM DESCRIPTION: WSTEM

This paper focuses on senior level students and graduate students who participated in WSTEM during their first year at a Research 1 University² in the southeastern United States. The administration at the university initiated the WSTEM Program in 2000. The program has had an average of 36 participants each year. The program accepts women who are first year university students with an interest in STEM majors. Acceptance into this program is based on each individual's expressed interest in STEM majors and their reasons for this interest. The program director reviews the applications and purposefully picks students who demonstrate an interest in research careers in STEM fields. There is no grade requirement, but the current director of the program stresses that individuals who are accepted must demonstrate in their application essay an interest in and curiosity for a STEM major (Personal communication, program director, October 8, 2007). These women live together on the same floor of a dormitory on campus during their first year of university.

The program director states that the shared living space promotes a supportive environment where participants can find mentors and support within their STEM majors (Personal Communication, October 8, 2007). She also encourages the young women to participate in research activities beyond the classroom so that they will have more exposure to STEM fields. The director believes that this exposure will help the students make informed decisions regarding their careers.

During the year, the WSTEM participants attend a weekly one credit course where they attend guest lectures, typically given by female scientists in different STEM fields. The students are encouraged to ask these speakers questions about their

own experiences in STEM and their research. Students also attend monthly lab visits as part of the WSTEM program. Participants in the program have access to free tutoring throughout their university experience. The young women participate in a number of social gatherings each month as well. After the first year, students are welcome to continue to be part of the WSTEM program, which includes participation in any of the semester activities and the paid research opportunities.

Description of Participants

All seven of my participants were part of the WSTEM program and have persisted in their STEM major. Two of these women were working towards a graduate degree in a particular STEM field at the time of the study. The other five were seniors at the university with a STEM undergraduate degree at the time of this study. In order to maintain my participants' anonymity I will refer to them by pseudonyms.

Table 1: Description of Participants

	College major (or focus)	Level of Education (Undergraduate or Graduate School)	Career Goal	Race or Ethnicity (self-reported)	Reason for joining WSTEM
Wendy	Biochemistry	Graduate	Medical Doctor	Caucasian	Social network ⁱⁱⁱ
Penny	Biology	Graduate	Medical Doctor	Caucasian	Social network
Anna	Biochemistry/ Mathematics	Undergraduate	Medical PhD	Hispanic	Paid research, professional connections, and social network
Cara	Physics	Undergraduate	Physics Professor	Caucasian	Social network
Christa	Biology/Pre-medicine	Undergraduate	Medical Doctor	Middle Eastern	Tutoring and social network
Sara	Environmental engineering	Undergraduate	Engineer	Caucasian	Social network
Danielle	Chemical Engineering	Undergraduate	Engineer	African American	Social network

Based on the interview data I collected, I found that each of my participants had differing paths to their chosen career. For example, although four of these women had a career goal associated with medicine (Wendy, Penny, Anna, and Christa), each had a different reason for their choice, which was affected by their life experiences as suggested by my conceptual framework. For instance, both Christa and Wendy declared that they wanted to become a medical doctor to help others. However, Christa's choice was based on her own experience with diabetes whilst Wendy's choice was based on her experience witnessing the effects of poverty on individuals' ability to find quality health care. Penny's choice of medicine was based on her desire to be successful in a difficult field. Anna's choice of a medical doctorate was based on her belief that it would allow her to continue to satisfy her curiosity related to research on the human body.

RESULTS

The narrative life histories identified the path each woman had to her STEM career. There were a number of themes that emerged during these interviews. First, I will

identify the factors that influenced the participants' persistence in STEM. These factors highlighted the role that gender, expectations of success and the value of that success play in women's STEM career decisions (Butler, 1999; Eccles, 2007). I will then move on to discuss the role that WSTEM played in this persistence and what these results mean for similar programs.

Factors that Affect Persistence

Gender Roles

In terms of gender roles, all of the participants knew about past gender discrimination but claimed that men and women were intellectually equal. For example, Penny believed that gender roles played no role in STEM fields. "I think that a long time ago, gender roles developed but I think now they just mean squat really". Similarly, Christa stated that "women are just as smart as men". However, Christa thought that men still had the "upper hand" in many STEM fields. Her comment was based on her observations that most STEM fields are dominated by men.

This attitude regarding men's dominance in STEM fields was reiterated by other participants as well. Sara and Christa both commented on the lack of female students and professors in their classes. Sara even discussed her belief that the female professors appeared to have to "prove" themselves more. When pressed to explain, Sara said that the women appeared to have to "work harder to be treated like their male peers".

Although all of the participants felt that there were few differences intellectually between men and women, some did think that women and men exhibited different behaviors based on their gender. For example Wendy felt "the males [in my classes] are more dominating and the women are more quiet and reserved". Some of the participants actually used the same gender stereotypes that promote gender discrimination in their discussion of gender roles. For instance, Anna indicated that men and women were "intellectually equal" however she felt that women tend to make "good, responsible decisions because you have more of a conscience, you have to be very morally pure". Anna felt that women tended to have a higher moral consciousness than men. Similarly, Wendy thought that women tended to discuss concepts more than men did. Both of these women saw women as offering a different viewpoint to STEM fields based on their views of gender roles.

The participants' concept of gender roles appeared to be consistent in that all of these women perceived that men and women are intellectually equal. However, these women had all experienced a STEM career path with few female role models. In fact, two women believed that women were held to a higher standard than their male peers (Sara and Christa). Yet, each of these women claimed that stereotypical gender roles played no role in STEM fields. The quotes above, however, hint that these participants still see gender as a factor that can cause differences in career choices.

In regards to career choice, some of these women (Wendy, Penny, Cara, and Danielle) felt that gender did not affect persistence. These women were able to

identify with their chosen careers, which according to Eccles will help them to persist in STEM. Others, like Sara and Anna, cited gender issues that could negatively affect their ability to identify with their chosen STEM field. At the point that this study was conducted, these women all planned to persist in their STEM major. Consequently, they were all able to negotiate their perceptions of gender with their perceptions of STEM. These women felt that they fit in with these chosen STEM fields and therefore wanted to persist and could see themselves succeeding in these fields (Eccles, 2007).

Chilly Climate

The comments regarding gender roles also highlighted these women's perceptions of the chilly climate within their majors. All seven of the participants mentioned being one of only three to five women in their STEM classes. All of the participants, however, saw this as a motivating factor to their success. These women wanted to outscore the men in their classes in terms of grades. They also wanted to better their male peers in terms of respect from their professors.

Yet, five of these women also discussed discrimination (either overt or subtle) that they experienced, which they perceived as being related to their gender and, in one case, to her ethnicity. Both Cara and Christa mentioned historical forms of discrimination in their STEM disciplines. Sara mentioned her perception that the female engineers "always looked bogged down, running from place to place". All of these women claimed that they had not perceived any gender discrimination in their education.

However, Anna and Penny both experienced overt discrimination in their university career, specifically during their research internships. Penny explained that in a summer research internship a male friend had been chosen over her for a surgery position with rats. She told her supervising professor that if there was an opportunity she would like to do some surgeries as well. The professor said that he had not chosen her because he thought that she would be afraid of working with rats because she was a woman. Penny told the professor that she was not afraid of rats and would appreciate the opportunity to work on the research. This situation shows the discrimination that Penny experienced, but it also highlights her own strong personality. Had she not approached her professor and told him about her interest in participating in the research, he might have continued to assume that she did not want to participate because rats were involved. If she had not participated in the research, she may have missed out on learning important techniques and concepts that would be necessary to her future success in medicine. This situation highlights how discrimination can affect women if they do not recognize it and stop it.

Anna mentioned the overt discrimination that she experienced in her research laboratory. She credited this discrimination to her ethnicity. She described her interactions with a white male graduate student in her research laboratory. He would refer to her and another young woman as "you Mexicans". Neither of these women was of Mexican descent and would often tell him so. Anna saw this continued reference to them as Mexicans as evidence of his lack of respect for their

cultural heritage. She also thought that he demonstrated a lack of respect for her contributions to the lab since he would often tell her, "Oh, you were useful today". She said this made her question whether there were times when she was not "useful". Anna interpreted these comments regarding her usefulness as his belief that ethnicity affected how "useful" a person could be. Although Anna at first thought that this discrimination was based on her ethnicity, during our interview she began to perceive the discrimination as also related to her gender. This particular graduate student treated all of the minority women in the laboratory in a similar fashion, but not the white men and women in the lab. Her story highlights the double discrimination that minority women potentially face in STEM fields.

Both Anna and Penny's stories highlight the overt gender and ethnic discrimination that is still occurring in STEM departments in American universities. These stories also highlight two different reactions that women can have. Penny responded by asserting herself and demanding that she be treated like her male peers. Anna, however, did not assert herself in the lab setting. She made an effort to avoid the male graduate student who exhibited the discriminatory behavior, but she did not report him to her co-workers or professors. This avoidance could result in missed opportunities for Anna to work on important research techniques and broaden her knowledge. Additionally, this could affect her perception of her value in the laboratory or in STEM fields in general.

The life histories of these seven women identified that the chilly climate still exists in STEM fields. However, each of these women believed that the discrimination could be overcome or was at least worth the cost in terms of achieving their desired career (Eccles, 2007). These women still enjoyed their chosen STEM focus and therefore saw the career as a result that they wanted.

Identity – "I am a Nerd"

An interesting finding in this section was that all of the participants referred to themselves as "nerds" or "geeks" when they were describing themselves. Two of the participants referred to their interest or love for science and mathematics as the characteristic that made them a nerd (Anna and Penny). The others referred to their love for school and academics in general as the characteristic that made them a nerd. It was interesting to find that for these participants the term "nerd" was something that they were willing to take on as part of their identity (Eccles, 2007). However, this concept could be what prevents others from succeeding in STEM fields, especially if being a "nerd" is considered integral to success in STEM fields.

Supporters

- *Parents.*

All of the participants described their parents as supportive. Cara spent the most time describing her parents' positive role in developing her interest in physics and engineering. She explained how her father, an electrical engineer, would always invite her to help him take apart tools and machinery to see how they worked and how her mom, an elementary school teacher, would create hands-on experiments with her as a child. Penny described the role her mother had as a strong woman figure that set an example throughout her life. Penny's mother was a role model for

her, in that she motivated Penny to “see that my goals were a possibility as long as I worked hard like my mom”.

For this theme, I found that participants had different understandings of parent support. Anna and Christa, two of the minority participants, described their parents as very demanding and highly influential in their decisions regarding a STEM career. Anna claimed that her parents were much more demanding and protective of her than they were of her brother. However, she credited this as part of her families’ culture where men have more freedom than women. This example demonstrated how cultural norms can affect one’s views, even their definition of parental support.

Christa described the role that her father had in her career decision. When Christa first arrived at the university she wanted to focus on marine biology, however her father said that she “would not be successful at that”. He defined success as making money and believed that medicine was a field that she would make more money in. Eventually she took her father’s advice and changed her focus from marine biology to pre-medicine. In both examples, these women perceived these demands by their parents as forms of encouragement.

The other five participants described support as “helping me with science and math” (Cara), “being there if I need someone to talk to” (Sara, Wendy), “supporting me in my decisions” (Danielle, Penny), and “setting a strong example for me to follow” (Sara, Danielle, Penny). These four statements identified aspects like helping and letting the student make her own decisions, whereas the experiences of Anna and Christa show their parents having a more prominent role in making their decisions. The common theme for all of these participants was that their parents’ support helped them to maintain their interest in STEM.

- *Mentors.*

The participants in this study also cited supportive mentors as aiding their persistence. I identified mentors as individuals who positively influenced the students’ interest and persistence in STEM fields. All of the participants claimed that their mentors were influential to their success in and decisions to pursue STEM majors. Five of the participants (Wendy, Cara, Christa, Sara, and Danielle) claimed that their secondary school science teachers served as mentors. There were two common explanations as to how these teachers served as mentors - the teachers’ passion for the subject and their approaches to teaching.. Three of the participants mentioned that their teachers expressed a passion for the subject. This was best articulated by Wendy, “My chemistry teacher in high school...she loved what she did and her passion for science would definitely infiltrate her students”. The second theme was the use of hands-on teaching methods that made science more interesting, which was articulated by all five of the participants and best articulated by Cara, “[My physics teacher] was amazing. She pretty much let us have a hands-on approach to physics in a way that a lot of teachers really don’t at a secondary school level”.

Four of the participants (Anna, Cara, Danielle and Penny) mentioned university professors and teaching assistants as mentors that influenced their decisions to

pursue STEM majors. At the university level, the description of the influence of mentors focused more on personal skills and career advice rather than teaching styles. For example, Anna explained that her calculus professor influenced her decision to add mathematics as a major. She also participated in research with this same professor. She had another connection to a teaching assistant in a biology course because they were both from the same Latin American country. After listening to Anna discussing her interest in medicine and research, the teaching assistant suggested that Anna study for a medical PhD so that she could combine her two interests. At the time of this article Anna was applying to these types of programs for graduate school, demonstrating his effect on her career decisions.

Penny discussed a highly influential mentor who wrote recommendations for her and helped her find research opportunities that influenced her later decision to pursue a career in medicine. She explained that he stood out because of his "open door policy" and his relationship with his wife who also worked in the lab. She was impressed that he treated his wife as an equal in his laboratory even though she did not have a PhD. Penny claimed that "if he would have been very condescending to females it probably would have turned me off from him but the fact that he wasn't, made me be able to walk thru his door, just sit down and start chit chatting about science or medical school". Consequently, Penny's mentor's treatment of women made him appear even more supportive to her.

Although I have only discussed examples from two participants, the four who mentioned university level mentors all expressed similar comments regarding the help that these individuals offered them. All of these comments showed that the participants were influenced by these mentors because of the relationships they developed with them. This aspect of developing a relationship with a member of the STEM community (i.e. professor or teaching assistant) was important for these individuals because the participants were not only able to feel that they could succeed, but they also began to identify with the type of person who works in STEM (Eccles, 2007).

Science Experiences

All of the participants explained that their interest in science was based, in part, on their success in science and math classes throughout their education. This finding requires more study regarding whether their interest in science was dependent on their success or their success in science was dependent on their interest. What was evident from the interviews was that all of the participants had high expectations of success in their chosen field because of this academic success.

All but Christa described how the notion of being 'successful' in a competitive environment had influenced their interest in STEM fields. Anna and Penny described successful competition against others in their classes, especially male peers. Cara, Danielle, and Wendy mentioned the influence of success in science and math competitions as strengthening their interest in STEM fields. Sara referred to competition within herself, her desire to "get it", and since she saw engineering as one of the hardest majors she felt compelled to understand it for herself.

Christa claimed that her interest in science stemmed from her experiences outside of school, including her interest in marine biology, which was stimulated by family vacations to the beach, and her interest in endocrinology, which stemmed from her own experiences with diabetes. Although Christa did not refer to competition as an influential factor in her interest in STEM fields, she did do well in her science classes throughout her education. Even though Christa did not see success in classes as competition, she was outscoring others in her classes. Consequently, it may not be the competition as such that promotes students' interest and persistence in STEM fields, but the feeling of self efficacy associated with succeeding in science classes and competitions. All of these women believed that success was possible and therefore expected it for themselves in their STEM career (Eccles, 2007).

Future Family Plans

Many studies that have focused on women in science have found that women often choose to leave STEM fields because of perceived conflicts between working in STEM careers and having time to raise a family (Dick & Rallis, 1991; Eccles, 2007; Farmer, 1997; Seymour & Hewitt, 1997). Only two of the participants in this study mentioned future family plans and the fear that these plans may not coincide with their career choice. The other participants said that they were not worried about combining a career and a family.

Penny's fears regarding balancing the demands of her career and her future family were the most aligned with previous research. As a graduate student participant, Penny's concern was how she was going to balance her medical career and the future family that she planned. She referred to doing both of these successfully as "doing it all, being a super mom, super wife, and super doctor". She expressed her fear that this was too much for her to do on her own. Similarly Christa's concern was associated with the time it took for her to become a medical doctor. She feared the cost of putting her family on hold to complete her education or putting her education on hold to start her family. Both of these stories show the fear that these two women had about balancing both a STEM career and a family. These women saw their career as a possible cost that could prevent them from having a family or interacting with their family (Eccles, 2007).

Influence of WSTEM

One of my research questions for this study asked how participation in WSTEM affected women's decisions to stay in STEM fields. According to these participants, the program was highly influential in their decision to remain in STEM majors. All of the participants cited both their research opportunities and the mentors they found as a result of these opportunities as being a positive influence on their STEM career choice.

All of the participants also mentioned the positive effect of the social network they had within the program. Anna expressed the influence of the social networking as: "It was a great thing because we actually helped each other with the test and studying and we'd sit with each other. Especially your [first year of university] when you don't know anyone else, it's nice to have someone next to you that you can at

least know". Her comment provided evidence for the usefulness of the social network that she found within WSTEM.

Other participants (Wendy and Penny) described the sense of solidarity they felt not because of gender but because they were surrounded by others "going through the same thing". This concept was described best by Penny: "You know that they're going through the same crap you're going through. I wasn't the only one suffering. I'm not the only one having to stay up and study and not go out...They were doing it too. So it was very important because you don't feel so alone. That was very important for me". Other participants (Cara, Christa, Wendy, Penny, Sara) mentioned the positive effect of the study help they received from their peers as a result of living on the same floor. All of these descriptions highlight the positive influence of the social network formed within WSTEM. These women were able to find study help from their peers. They were able to feel a sense of solidarity in that others were experiencing the same tribulations and turmoil. These experiences helped them better identify with their STEM majors since they were able to see other women enduring the same experiences. These women could also see others who were succeeding in their majors, which provided them with evidence that it was possible to succeed and persist in STEM.

CONCLUSIONS

First, the findings support previous research regarding the factors that positively influence women's persistence in STEM fields. The support of socializers was very important to the persistence of these women (Dick & Rallis, 1991; Farmer, 1997; Seymour & Hewitt, 1997). All seven of my participants listed the positive impact of their parents, secondary school teachers and/or university professors in developing their interest and persistence in STEM fields. All of my participants explained how their parents' supported them and, in many cases, exposed them to science throughout their early lives. All of my participants mentioned teachers and/or professors as mentors that stood out in their life history. These mentors served multiple roles including exposing them to hands-on science activities, instilling a passion for science into them, giving them career advice, and helping them better understand science concepts.

Second, the Eccles' expectancy value model served as an excellent guide for this study, in that it helped me to highlight each participant's expectations for success and the value that they placed on their imminent careers. All seven participants had high expectations of success due to their previous success in science and math classes, which were balanced by the value that they placed on their STEM career. Each STEM career goal fit with their perceived identity, interests, and future goals. The only cost mentioned by the participants were the financial cost of going to graduate school (n = 4), or in some cases the cost of postponing future family plans (n= 2) in order to get their career started. However, all of these participants felt that these costs were worth it.

Third, in regards to gender, none of my participants' felt that they needed to change their personalities or take on a more androgynous gender to fit in with their STEM peers as mentioned by other researchers (Harding, 1997; McGrayne, 2005; &

Ong, 2005). This could be evidence of a changing acceptance of women and feminine behaviors in STEM fields, but would require a much larger sample to fully understand. As Butler (1999) theorizes, each of my participants saw gender differently, they each had different experiences that shaped their views, including the role that ethnicity played. I did find that each individual had a different rationale for choosing their particular STEM career, and their expectation of success and the value they placed on a particular career were influenced by their differing experiences.

Despite these signs of improvement regarding gender, all seven participants believed that gender discrimination still existed in STEM fields. My findings show that three of my participants (Anna, Christa, Penny) still saw evidence of the effects of gender stereotypes in their STEM majors that affected people's perceptions of women's ability to succeed in these fields. All but one of these participants believed that there were barriers to women in STEM fields. A future study could address how this perception of barriers affects how women participate in the STEM community, i.e. as legitimate full participants or as peripheral participants (Kahveci et al., 2007). A future study could also focus on women in the STEM workforce to see how their perceptions of STEM fields and the role of gender in these fields have changed due to their participation.

Fourth, in terms of female role models, this study suggests that the past two decades of efforts to increase the number of women in STEM majors at the university level have not been completely successful. All seven of my participants encountered few women in their classes and practically no female professors or role models. This is interesting in that all of these women met female STEM professionals through their participation in WSTEM, and yet, the participants compartmentalized these experiences. When asked whether there were barriers to women in science or if they ever saw their gender as having a role in science, all of my participants mentioned that there were fewer women in STEM fields. They never provided examples of female speakers and professors from WSTEM. It was not until I asked them specifically about their experience in WSTEM that they referenced these women. This raises the question, why are these participants compartmentalizing the women who they meet through WSTEM from their general perceptions of STEM fields? Is it that they see WSTEM and the women they meet there as a separate entity from the rest of the STEM community? If this is the case, then does the WSTEM program really address the issue of isolation that women face in STEM fields? This perception of isolation and the longitudinal role of WSTEM on women's persistence in STEM are concepts that could be addressed in a future study.

Fifth, despite some of these questions, WSTEM was successful in helping all of these participants through the initial challenges of their STEM majors. All of the students found the supportive environment crucial in helping them through the difficulties of the STEM major (Seymour & Hewitt, 1997). All of the students participated in the paid research provided by WSTEM and believed that this strengthened their desire to pursue a STEM career. All of the participants also cited the researcher that they worked with as a mentor. This highlights the importance of

exposing undergraduate students to research opportunities in STEM fields to not only show them examples of possible careers, but to also introduce them to possible mentors and role models who can help them in their decision process.

Some of the goals of the WSTEM program did not seem to be beneficial to these participants. First, the director wanted to help these women establish a national network of women, hence the female STEM speakers who came from across the country. Yet, none of the women in my study mentioned any further contact with these guest speakers. Instead, they formed a social network with their peers. Perhaps this network could be beneficial and align with the goals of the director in the future when presumably these women are in the STEM workforce. The weekly course, wherein the WSTEM members met STEM professionals, discussed current STEM concepts, and attended social events, was also rarely mentioned, however it did help the students to get to know each other better which strengthened their camaraderie.

IMPLICATIONS

This exploratory study has many implications for practices, policies, and programs aimed at improving the gender gap in STEM fields. The themes that appeared to improve each of these women's desire to stay in their STEM field were: positive mentors at all educational levels; supportive parents; and, successful science experiences in and outside of school. Consequently, one implication for practice is to expose science teachers to teaching techniques and professional development programs that educate them in running hands-on activities, and develop a passion and understanding of STEM careers. Another implication for higher education is to promote undergraduate research experiences for all STEM majors so that they can be exposed to STEM research and meet STEM mentors who can help them with career advice.

In regards to policies and programs aimed at increasing the number of women in STEM careers, this study had some important findings. The STEM LLC in this study appeared to positively promote a source of camaraderie among the participants and provided them with a support network for advice and studying help. Most importantly, all of the participants mentioned that living on the same floor served as a source of comfort since they saw others putting in the same long hours as they were. Finally, the research opportunities were mentioned by all participants as the most important influence on their decision to persist in STEM fields, particularly because these research opportunities allowed them to "try on" the identity of scientist. All of these parts of the program could be initiated at other universities with similar benefits.

In my study I did find one surprising theme related to identity. All seven of my participants saw themselves as "nerds". In fact, all of these participants were actually willing to embrace the term "nerd" as part of their identity. This conception of nerd may be useful when I begin to study leavers in my next project. For instance, does the inability to see oneself as a nerd affect one's decision to persist in STEM fields? The women in this study saw their "nerd" identity as a positive

aspect, perhaps, the inability to perceive “nerdiness” as positive can prevent others from persisting.

There were two findings that highlight a continuing need for improvement in programs aimed at increasing the number of women in STEM careers. The interviews showed that the participants believe that women have different choices, interests, and behaviors based on gender. This finding requires more study to determine if these differences are based on deep-rooted gender stereotypes. If this is the case, how can programs change these ingrained views that still exist in a younger generation? Finally, despite policies and programs aimed at improving the chilly climate in STEM fields, two of these participants experienced overt gender/ethnic discrimination in their labs. This finding suggests that the chilly climate still exists and may be preventing some women from succeeding in STEM fields. The conceptual framework and methods used in this study, helped to uncover examples of the chilly climate as they relate to gender. By focusing on gender, the participants were able to articulate how they perceived their gender’s influence on the ways they were treated, which for many resulted in some chilly encounters in their STEM experiences.

In conclusion this study explored the influences that lead to STEM career decisions and the effects of participation in a single gender living and learning program on these decisions. The results contribute to the growing literature on the transitions and influences that lead to STEM career choice at the university level. The use of narrative life histories offered a detailed view of each individual’s decision making process as it relates to staying in STEM majors. This decision process was unique to each individual based on their views of gender, their expectations of success, and the value they placed on that success. My choice of narrative life histories complemented the intricate decision making path of each participant. This study also highlighted future research that needs to be conducted to continue to address the underrepresentation of women in STEM fields.

ENDNOTES

ⁱ In the United States, university students decide a focus of study (major) either when they enter school or within the first two years. This time line is dependent on each university’s requirements. The university in this study has students declare their focus of study (major) when they first arrive.

ⁱⁱ The United States uses a classifying system for its Universities known as the Carnegie Classification system (<http://classifications.carnegiefoundation.org/>) which is based on the number of enrolled students, whether the university is under public or private control, how many bachelor degree and graduate degree programs, and the amount of research that is conducted. The university where this study occurred was labeled a Research 1 university with an enrollment of 38,431 annually with faculty that conduct very high research activities. In the United States there are only 96 universities with this research rating or higher.

ⁱⁱⁱ Social network refers to the following reasons that were coded under this theme: being around like minded individuals who were interested in STEM careers; being

around others going through the same classes and difficulties; having other individuals to study with.

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