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Young, Southern Women's Perceptions of Stem Careers: Examining Science, Technology, Engineering and Mathematics as a Gendered Construct

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YOUNG, SOUTHERN WOMEN'S PERCEPTIONS OF STEM CAREERS: EXAMINING SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS AS A GENDERED CONSTRUCT

by

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For Melissa

and

For Amelia and Caroline

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Philippians 2:14-16

ABSTRACT

Career interests develop over a lifetime and tend to solidify during late adolescence and early adulthood (Lent, Brown, and Hackett, 2002). The primary purpose of the present qualitative study, which is framed in Feminist Standpoint Theory (Haraway, 1988; Harding, 2007; Naples, 2007; Richardson, 2007), is to understand how eighth-grade, young women in a suburban, public, southern, middle school the South Carolina County School District (CCSD) (pseudonym) perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) courses and careers. The secondary purpose is to understand these young women's "perceptions and unconscious beliefs about gender in science and mathematics" and how their "perceptions and unconscious beliefs about gender" in the STEM fields may impact the careers that these young women may choose in the future (American Association of University Women, 2010, 9).

Within the present study, the perceptions of young women who were identified as "Interested in Science," "Somewhat Interested in Science" and "Uninterested in Science" were studied. STEM courses and careers are a major emphasis in education today. Increasing the numbers of Americans who pursue STEM careers is a government priority, as these careers will strengthen the economy (AAUW 2010). The present study reveals how young women who are highly motivated, talented

students perceive STEM courses and careers and how they are influenced by their experiences, gendered messages, and knowledge of STEM careers.

To analyze the data, four of Saldana's (2010) dramaturgical codes were utilized including: 1. OBJectives, or motives; 2. CONflicts the participants faced; 3. TACtics to dealing with obstacles; and 4. ATTitudes toward the setting, others, and the conflict. The InVivo Codes allowed the participants stories to emerge through the set of dramaturgical codes that allowed for viewing the girls' experiences in different ways that added depth to their stories.

The young women in the present study were affected by gendered messages and stereotypes about a woman's place in STEM. The participants felt better suited for some STEM careers based on interest, experience, and skill level. However, the participants perceived other STEM careers to be out of reach due to a lack of knowledge of the careers and the influence of gendered messages.

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Do Today's STEM Curriculum & Pedagogy Continue to Shortchange Girls?

"Gender stereotyping . . . appears to influence whether girls persist in mathematics. . . . girls who reject traditional gender roles have higher math achievement than girls who hold more stereotyped expectations."

*(*AAUW, 1992, 49).

INTRODUCTION

The quote by the Association of American University Women (1992) represents that organization's long research agenda and focus on the quality and quantity of science and mathematics education that girls and young women receive in secondary schooling and college. In, *How Schools Shortchange Girls* (1992), the AAUW revealed that most girls in United States secondary public schooling were not taking higher-level science and mathematics classes such as physics and chemistry. In the twenty years since that study was published, the numbers of girls taking and succeeding in higher-level mathematics and science classes has increased (AAUW, 2010). However, in *Why So Few?* (2010) the AAUW reports that girls who take higher-level mathematics and science classes in high school and college do not necessarily pursue mathematics and science careers.

The AAUW reports that while girls and young women are taking higher-level mathematics and science courses with increased frequency in secondary and post-secondary schooling, upon graduation they are not breaking into STEM careers with the same frequency. Some of the reasons for this include:

1. STEM careers are stereotypically viewed as male careers;
2. There is still a strong socially constructed belief that males are better suited for STEM careers;
3. The progress of females in mathematics and science classes (as judged by standardized test scores) has not disrupted the stereotype that STEM is for males (AAUW, 2010).

These reasons lead to the overarching question: After two decades of educators and policy makers encouraging girls and young women to pursue STEM careers, why has there not been a greater influx of female into these careers that tend to pay higher than average salaries?

According to feminist researchers (Harding, 1986; Haraway, 1988; Fausto-Sterling, 2000; Butler, 2004), implicit messages influence girls and the gendered meanings constructed through science research reinforce gendered norms and these implicit messages deter females from pursuing careers in STEM. Following feminist theory, feminist critiques of science and socially constructed gender norms, I will theoretically frame the present study in the scholarly discourse.

THE PURPOSE OF THE STUDY

The primary purpose of the present qualitative study framed in feminist theory, is to understand how eighth grade young women in a South Carolina middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The secondary purpose of the present study is to understand girls' "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. Perceptions of girls who identify as "Interested in Science," "Somewhat Interest in Science" and "Uninterested in Science" were studied so that a better understanding of girls' experiences in STEM courses can be obtained.

METHODOLOGY

In the present study, I aim to address these larger enduring questions first asked by the AAUW (1992) from a feminist research design (Hesse-Biber and Leavy, 2007). This methodology enabled me to analyze the middle-level students' social construction of beliefs about gender and STEM and how those beliefs influence their construction of knowledge about STEM. My goal was to extrapolate from my data a new model with new strategies for creating a more gender-equitable STEM curriculum.

In order to address the underrepresentation of girls/women in STEM fields, the present study addressed:

1. the gendered messages created by "objective" science;

2. how these gendered messages influence females and their participation in STEM careers and;
3. the ways in which females can be encouraged to pursue STEM careers.

POSITION STATEMENT

As a white, female, middle-level, science educator, I am interested in girls and young women in STEM because my own life was shaped by science. Both of my parents pursued science careers. My mother is a nurse and my dad is an engineer. My parents valued formal education, post-secondary schooling, and hard work and instilled the importance of education and hard work in me. My father especially placed science and mathematics classes in high regard. As a young woman in high school, this value on science and mathematics classes encouraged me to pursue higher-level classes and because I was successful in these classes and because I was taught that it was necessary to take these classes in order to prepare for college, I believed I could be a medical doctor and majored in biology during college. As a sophomore in college I decided to take science teacher preparation courses as a "back-up plan" in case I did not get into medical school. That choice changed my career and now I am a middle level science teacher.

My sister is a professional civil engineer and she and I frequently discuss the challenges that she faces as being a woman in a male-dominated STEM career. Her experiences added to my curiosity about how women can be success in male-dominated STEM fields. These life experiences have shaped my curiosities about STEM and the ways in which I prepare my female students for STEM challenges. I

also actively work to provide opportunities for historically marginalized groups of students to look at their lives in new ways and in particular access and equity in STEM. For instance, I challenge their beliefs that certain opportunities are only for certain people and I strive to provide hands-on science activities for all students regardless of race, class or gender.

CONCEPTUAL FRAMEWORK

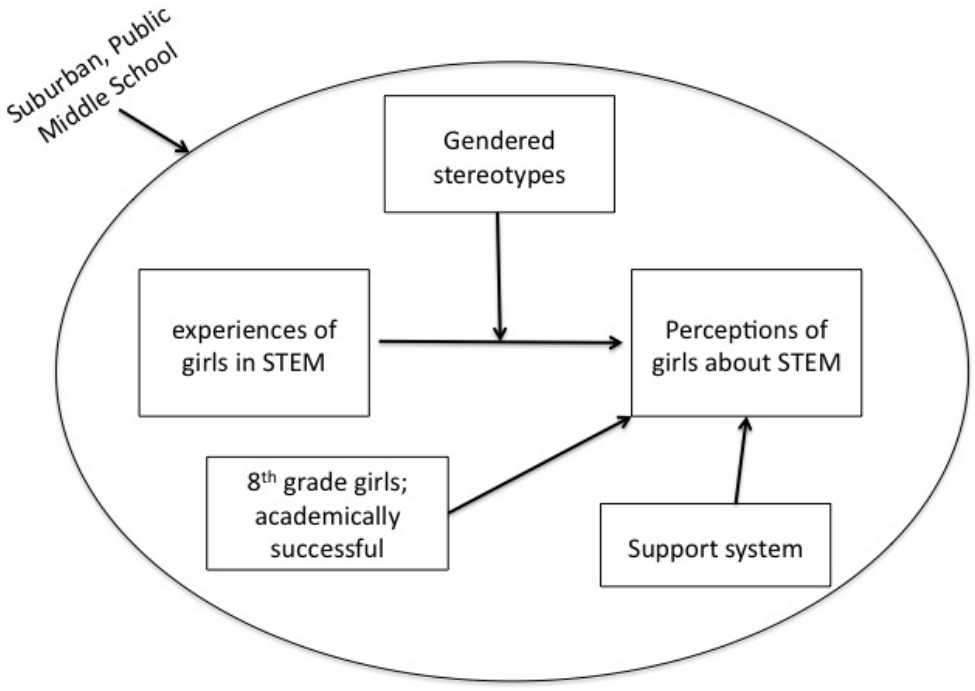

Figure 1.1 Conceptual Framework

THEORETICAL FRAMEWORK

Following Haraway (1988), I understand the importance of creating equal economic, political and social status for women. STEM careers can provide

opportunities for women to be paid better and gain opportunities for advancement than other careers may provide in the U.S. capitalist economy (AAUW, 2010). When working with girls in middle school, the gendered stereotypes that are present often cause girls to feel pressured to fit in with their peers (Butler, 2004). By viewing science from multiple perspectives these girls can view their situations from different perspectives (Haraway, 1988; Hesse-Biber and Leavy, 2007).

My study is framed by Feminist Standpoint Theory (Haraway, 1988; Harding, 2007; Naples, 2007; Richardson, 2007) to understand one way that girls experience STEM and the perceptions these girls have about their accessibility to STEM. As outlined in Hesse-Biber and Leavy in, *Feminist Research in Practice* (2007), feminism is described as being concerned with women's viewpoints of how women experience life. For them, feminism is a rejection of an essentialized or biological experience and feminism recognizes that the researcher brings certain viewpoint that color the ways in which data are interpreted. Standpoint Theory provides feminists with a way to explore knowledge claims, knowledge production, and power relations by beginning with a researcher's particular experiences and working outward toward society's experiences (Harding, 2007). Naples (2007) discusses three different approaches to Standpoint Theory. She identifies these areas as "embodied in women's social location and social experience, as constructed in community, and as a site through which to begin inquiry" (Naples, 2007, 581). My study will approach Standpoint Theory as a site through which to begin inquiry.

Richardson (2007) shows how Standpoint Theory can be used as a site through which to begin inquiry in her research method "Writing for Another." She

discusses how second wave feminism and post-structural theory intersect when researchers use experiences from their lives and connect them with other people's experiences. She uses the novel, *Too Late for Phalarope*, by Alan Paton, to read for her mother. She connects the characters and story to her mother and her mother's life. By doing this, she views her mother in a new perspective. Richardson theorizes that this type of research allows for feminist ways of knowing, the ability to construct knowledge and as new experiences are had, reconstruct knowledge. She can present her experiences and allow others to connect with her experiences.

Richardson (2007) also writes about how experiences can create connections. By using a qualitative method like "Reading for Another," a researcher can use reading and writing to create connections. When researchers write about their personal experiences, others can create understanding about their own experiences.

> Most important to me in terms of feminist social research and dealing with its dilemmas, though, is that this method of writing/research sparks identification. It offers an expanded feminist consciousness and a method for other feminists to make sense of their worlds in ways that connect us to one another in common cause. (Richardson, 2007, 466)

Small pieces are not presented as the whole in this type of research but as ways to connect to the whole. My study will provide opportunities to eighth-grade, young, southern, women, at a suburban middle school to explain their experiences with STEM that will provide connection points for other young women as they pursue STEM courses and careers.

One critique of Standpoint Theory is that it is essentializing (Naples, 2007). A small group's experiences is deemed the norm and applied to anyone who may fit into that group. Collins (2000) writes that not all Black women suffer oppression in the same way but that all Black women are oppressed. By using Black Feminist thought, Black women can create definitions of themselves instead of being defined with respect to the dominant group.

> Through the lived experiences gained with their extended families and communities, individual African-American women fashioned their own ideas about the meaning of Black womanhood. When these ideas found collective expression, Black women's self-definitions enabled them to refashion African-influenced conceptions of self and community. (13)

Collins does not try to generalize Black women's experiences. Her writing allows Black women to connect to similar and different experiences that they may face due to oppression. Likewise, the present study will not provide a universal young woman's experience in STEM. However, the present study will uncover how eighth grade, young women from a suburban, southern, middle school self-define themselves in STEM to contribute to the "collective expression" of how these young women identify with STEM.

Standpoint Theory includes the experiences of marginalized groups. These experiences are not meant to be essentializing but "situated knowledges" (Haraway, 1988). She writes:

> I want to argue for a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections,

and hope for transformation of systems of knowledge and ways of seeing. (585)

Through these Feminist standpoints and situated knowledges a more complex story can be told and knowledge can be created through multiple perspectives.

RESEARCH QUESTIONS

The present study is an investigation of how eighth grade, young women, in a southern, public middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. STEM courses and careers are a major emphasis in education today. Increasing the numbers of American who pursue STEM careers is a government priority, as these careers will strengthen the economy (AAUW 2010). The present study seeks to understand young women's perceptions about STEM courses and careers. Theses young women are highly motivated, talented students who have big dreams for themselves. Their perceptions of STEM courses and careers are influenced by their experiences, gendered messages, and knowledge of STEM careers. In order for me to understand these young women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future, my research questions are written so that the perceptions of the participants can inform my STEM model of curriculum development and thus influence the career trajectories of my middle-level participants and empower them to be influential leaders in the STEM fields.

The following Research questions are posed:

1. How do eighth-grade, female, southern students, who are identified as "successful" (i.e. maintained a consistent A or B+ average in science classes during their sixth and seventh-grade years) perceive the STEM courses they took or are presently taking?
2. What are these students' perceptions of STEM careers (e.g. stereotypes, accessibility, gender equity)?
3. What are these students' perceptions of STEM as a career option for themselves?

PARTICIPANT SELECTION

I used criterion sampling to determine my participant selection. Criterion sampling allows for specific phenomenon to be studied by choosing participants that "meet some predetermined criterion of importance" (Patton, 2002, 283). Patton (2002) describes criterion sampling as useful for program monitoring systems.

> The point of criterion sampling is to be sure to understand cases that are likely to be information-rich because they may reveal major system weaknesses that become targets of opportunity for program or system improvement. (283)

By using criterion-based sampling to choose my participants, I studied young women who are successful in science classes. Understanding their perceptions

about STEM courses may identify strengths and weaknesses in science curriculum that can lead to improvements in science curriculum.

The purpose of the present study is to understand young women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. Participants will be selected by identifying eighth grade, southern girls who have maintained an A or B+ average in science classes during middle school (grades 6 – 8). From this group, girls were subdivided:

Group A, "Interested in Science"

Girls who have expressed an interest in pursuing STEM courses in high school;

Group B, "Somewhat Interested in Science"

Girls who have expressed an interest in pursuing some STEM courses in high school;

Group C "Uninterested in Science"

Girls who are not planning on pursuing STEM courses in high school.

Participants were chosen by results from a careers survey taken in 7th grade, high school course selection in which they choose an area of interest to focus during high school, and science grade averages. Demographic make-up (race and SES) was

similar to the demographic make-up of the school. Nine girls, three from each group, were invited to participate in this study.

GATEKEEPERS

To gain access to the site, I applied for permission to conduct research in the school district through the proper channels. Then, I contacted the principal for permission to conduct my research study in his school. Then I identified participants by discussing the criteria with the guidance counselor and science teachers. Selected participants were asked to join the study allowing for participant and parent permission. To establish a researcher-participant working relationship, I met with the participants before the interviews begin so that the participants can ask questions and we can get to know each other.

OPERATIONAL DEFINITIONS

1. STEM – acronym for Science, Technology, Engineering and Mathematics
2. Title IX - an educational amendment to the Civil Rights Act, was passed in 1972 to prevent gender bias in schools. The law 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. (http://wwww.dol.gov/oasam/regs/statutes/titleix.htm, n.d, Section 1681.Sex).

Title IX also encompasses the issues of "sexual harassment, pregnancy, parental status and marital status." (Ford, 2010, 239). Title IX is used mainly to ensure that girls have equal access and funding in athletics.

3. AAUW – American Association of University Women is a network whose mission is to advance the equity of girls and women.
4. Interested in Science – students who are successful in science classes and are interested in pursuing STEM courses in high school.
5. Somewhat Interested in Science – students who are successful in science classes and are interested in taking some STEM courses in high school.
6. Uninterested in Science – students who are successful in science classes and are not interested in pursuing STEM courses in high school.
7. STEM courses – middle and high school mathematics, science, technology and/or engineering classes.
8. STEM careers – careers that use mathematics, science, technology and/or engineering as core skills.
9. Student – girls who are enrolled in science classes at a suburban, public middle school.

ASSUMPTIONS

Based on the research about girls in STEM, the assumptions I have for this study are:

1. Girls can perform at equal success levels as boys in STEM curriculum;

2. Girls will identify ways that gender stereotypes have been applied to them while participating in STEM; and
3. These gender stereotypes will either hinder their pursuit of STEM or the girls will have developed "coping mechanism" or have outside support (i.e. family support or teacher support) to overcome the gender stereotypes to pursue STEM courses and/or careers.

DELIMITATIONS

The participants were eighth grade girls in a suburban public middle school who are successful in science classes. The girls may or may not be interested in pursuing a STEM career.

LIMITATIONS

Data was collected by interviews; it may difficult to know if participants are telling the truth. The power relation between teacher (myself) and student (the participants) may have contributed to skewed results.

SCOPE

Girls' participation in STEM is a broad research topic. My study focused on how eighth grade, southern, young women perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is therefore to understand not only their perceptions, but also the

larger stereotypes they hold about STEM and how these stereotypes impact their career selection.

SIGNIFICANCE OF STUDY

The present study is an investigation of how eighth grade, young women, in a southern, public middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The girl's perceptions provided insight into how pervasive the influence of gender stereotypes are on girls as they choose high school courses and future careers. The study also uncovered the support that girls perceive from family, educators, schools, and school districts in pursuing STEM courses and careers.

PROFESSIONAL APPLICATION

This study enabled me to understand some of the ways to disrupt gender stereotypes in my middle-level science classes. I aim to understand how I can encourage or discourage them in their pursuit of STEM courses and careers. This knowledge enabled me to improve my curriculum and pedagogy and assessments for my female students in my science classes. Other educators may find my study useful as they aim to connect to in their own understandings of girls' experiences in STEM.

SOCIAL CHANGE

Ultimately, I hope my study will add to the research that is on-going about creating an equal playing field for both boys and girls in STEM. The present study identified how gender stereotypes affect girls in their pursuit of STEM. Educators can understand the ways in which girls are encouraged and discouraged to pursue STEM courses and careers. My study uncovered potential hindrances that educators can address while creating STEM curriculum and pedagogy and assessments to create a more welcoming environment to girls who are interested in pursuing STEM courses and/or careers.

RESEARCH FINDINGS

STEM courses and careers are a major emphasis in education today. Increasing the numbers of Americans who pursue STEM careers is a government priority, as these careers will strengthen the economy (AAUW 2010). The focus of the present study was to understand young women's perceptions about STEM courses and careers. These young women are highly motivated, talented students who have big dreams for themselves. Their perceptions of STEM courses and careers are influenced by their experiences, gendered messages, and knowledge of STEM careers.

The young women's experiences have influenced their interests in their future career choice. Participants spoke of wanted to pursue a career in which they had previous experience. Whether this experience was being an athlete, helping with family, or vacation experiences, the participants were more likely to want to

pursue a career when they had positive previous experiences. Some of the participants wanted to pursue careers in which they had a wealth of experience, such as years of participating in sports or taking music lessons. Other participants showed interest in pursuing a career based on a single positive experience, such as a sister's baby being born or a positive experience with a school club. Positive experiences created interest in particular careers.

While these young women had positive science experiences, most participants lacked positive experiences in physics and engineering. This lack of experiences caused misconceptions about careers in engineering, computer programming, etc. The young women relied on stereotypes about people who pursue engineering careers and they did not identify with those stereotypes. The young women wanted to pursue a career that would help society. Since they did not have an accurate understanding of engineering careers, they did not think that they could make the world a better place as an engineer. However, engineering does make the work a safer, better place in many ways. Because the participants lacked experiences, they did not fully understand all of the STEM careers.

Finally, gendered stereotypes about how women and men's interests caused the participants to think that a certain career was not for them. The participants had ingrained ideas about what types of careers are for men and what types of careers are for women. They may not have been able to give an example of how they had seen the stereotype played out in their lives but they were still influenced by the gendered stereotypes present in society. A theme among the participants was that women do not like to get dirty and therefore would not want to pursue a

career outdoors like park ranger. Also a man wanted to be a nurse was described as weird and creepy. The stereotypical roles of woman being caregiver and man being an adventurer played out in their explanations about what career was best suited for women or men.

Girls and young women have proven that they are capable of competing in higher level math and science careers (AAUW, 2010). However, because of a lack of experience, misconceptions about STEM careers and the implicit gendered messages about women and men in society, these young women did not perceive that all STEM careers were for them. This study has shown that to engage more young women in positive perceptions of STEM courses and careers, educators need to provide positive experiences in STEM and provide young women with the skills to push back against gendered stereotypes.

RECOMMENDATIONS

Career interests develop over a lifetime and tend to solidify during late adolescence and early adulthood (Lent, Brown, and Hackett, 2002). Government educational initiatives, like "Educate to Innovate," are mandating educators provide students opportunities in STEM in hopes of students pursuing STEM careers (Educate to Innovate, n.d.). However, the AAUW reported that one reason that women do not pursue STEM careers is because of the "perceptions and unconscious beliefs about gender in mathematics and science" (AAUW, 2010, 90).

In my interpretations of the interviews, I found that the participants are influenced by gendered stereotypes that are present in society and their learning

environments. I also found that these participants do not have solid strategies for pushing back against these stereotypes. For young women to be prepared to pursue STEM careers, they need to develop strategies they can use to critique the gendered messages they receive from society. One way these strategies can be learned is through teachers providing learning opportunities that allow them to practice pushing back against negative stereotypes.

In order to encourage young women to pursue STEM careers, teachers need to provide meaningful work that allows students to construct knowledge, nurture a growth mindset about academic progress, provide opportunities to disrupt gendered discourses surrounding young women and STEM, and broaden young women's horizons about STEM careers. Meaningful work is the basis of transforming a classroom from status quo to providing students with opportunities to envision new scenarios. Meaningful work allows students multiple entry points to a task so that all students can be successful in content areas. Meaningful work is created from a desire to get students involved in the learning process by working with materials, working with others, challenging their beliefs about a subject, and being reflective about the learning process.

Meaningful work also allows students to examine how they learn and how intelligence grows over time as they push through challenges in their learning. Nurturing a growth mindset about intelligence in students provides students with strategies to cope with difficult situations rather than avoid hard learning experiences. Growth mindset also allows students to pushback against negative stereotypes they may encounter while pursuing a career.

Students also need to be taught how to challenge gendered stereotypes. Classrooms that provide students meaningful work are looking for a variety of answers rather than just one right answer. Students are being taught to critique what they are learning. They can then critique the gendered messages that they are subject to rather than accepting them as fact. When students are learning about asexual reproduction, they will have the tools to critique the gendered messages that are being sent with the term "daughter cells." Students will have an opportunity to examine how language influences gender roles in society by critiquing the use of daughter cells as a way to describe clones.

Finally meaningful work will provide students an opportunity to broaden their horizons. Students are given opportunities to delve deeper into subject matter and learn more about content than surface material. Experts can be brought in to show students that people of all races, classes, and genders can compete in STEM careers. By providing students opportunities to see stereotypes disrupted, students can begin to see their place in STEM.

SUMMARY

Chapter One, *Do Today's STEM Curriculum & Pedagogy Continue to Shortchange Girls?,* of this dissertation provides an overview of my study and the reasons why understanding how young women perceive STEM careers will provide important information to the field of mathematics and science education. Chapter One points to the ways in which we, as educators, may encourage young women, but also how we may discourage young women in their pursuit of STEM careers. By

using a Feminist research methodology, the present study will seek to the uncover the gendered messages created by "objective" science; how these gendered messages influence females and their participation in STEM careers; and the ways in which females can be encouraged to pursue STEM careers. By uncovering gender stereotypes that hinder girls from pursuing STEM careers and provide educators with understandings of how to disrupt gender stereotypes in STEM classes.

Chapter Two, *The Growing Gender Gap in STEM*, reviews the relevant literature that frames my study. The topics of the literature review are history of science education in the U.S., education of girls and young women in the U.S., and feminist critiques of science, and the construction and deconstruction of gender stereotypes.

Chapter Three, *Methodology,* outlines the methodology and methods of the present study.

Chapter Four, *Patterns in Data,* presents the data collected from the present study.

Chapter Five, *Understandings and Implications*, provides a discussion of the results from the present study and recommendations that arise from the present study.

CHAPTER TWO

The Growing Gender Gap in STEM

> *[We must] account for the fact that it is spoken about, to discover who does the speaking, the positions and viewpoints from which they speak, the institutions which prompt people to speak about it and which store and distribute the things that are said.*
>
> Foucault, 1978, 11

INTRODUCTION

According to Foucault (1978), discourse is not just the words that are said about a topic. Examining the discourse that is used to express scientific knowledge is one way that the implicit messages can become unearthed in STEM curriculum. When the STEM discourse is critically analyzed the language, power, and knowledge associated with the curriculum and pedagogy and assessments can be examined. By deconstructing the implicit messages in STEM, Feminist educators can understand how language, power, and knowledge are interacting in their local and particular classroom.

One implicit message that influences young women's perception of STEM is the active male/passive female stereotype. A common word that is used in STEM to describe objects and/or processes is 'daughter.' For example, clones are described as 'daughter cells' and 'daughter plants.' A careful examination of the word, 'daughter,' reveals that one definition of daughter is belonging to the first generation of offspring, organelles, or molecules produced by reproduction. The opposite of a daughter is a son. In Western culture, sons are formative agents and daughters are considered reproductions of formative agents. Daughters are passive and sons are actives. Boys are encouraged to take science classes and actively pursue science careers while girls are passive in this schooling process.

By deconstructing the implicit gendered messages in the STEM curriculum, Feminist educators can understand how language, power, and knowledge are situated and they ways in which they interact in the classroom vis-à-vis curriculum, pedagogy, and assessment strategies. In this study, I seek to understand how eighth-grade, young, southern, women perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) courses and careers. The purpose of the present study is to understand these young womens' "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. Since 1992, the numbers of girls taking higher-level mathematics and science classes have increased. (AAUW, 2010). However, the number of girls pursuing STEM careers has

not increased and many women who pursue STEM careers leave STEM after a few years (Fouad and Singh, 2011).

STEM has become an important factor in developing curriculum for students (Executive Summary, 2009). The "Educate to Innovate" campaign has been launched by the Obama administration to "improve the participation and performance of America's students in STEM." (Anonymous, Retrieved November 12, 2013 from http://www.whitehouse.gov, *Educate to Innovate*). "Educate to Innovate" will incorporate companies, foundations, non-profits, and professional societies to meet the campaign's goals. The goals of the campaign are to increase STEM literacy, increase student achievement to lead globally, and include underrepresented groups like women and girls. (Anonymous, Retrieved November 12, 2013 from http://www.whitehouse.gov).

In his recent State of the Union Address (2013), President Barack Obama outlined his ideas on improving public education. Obama (2013) stated that better preparing students in STEM will prepare students for better jobs and improve the American economy. He described providing students and opportunity to receive a high school diploma along with the equivalent of a technical degree from a community college (Obama, 2013). His example was P-TECH school in Brooklyn, New York where students graduate with a technical degree in computers or engineering. Obama declared, "We need to give every American student an opportunities like this" (Obama, 2013, para. 42).

Obama (2013) also described a new initiative that accompanies his administration's Race to the Top, a competition for federal dollars between states to

standardize curricular materials, pedagogy, and high-stakes testing (Executive Summary, 2010) for public schools. "Educate to Innovate" mandates high schools create classes that focus on science, technology, engineering, and mathematics. Obama declared:

> [W]e'll reward school that [sic] create classes that focus on science, technology, engineering and math, the skills today's employers are looking to fill the jobs that are there right now and will be there in the future. (Obama, 2013, 43)

With these current initiatives, schools must provide STEM opportunities for students.

STEM careers are available during the current economic down turn and there are job shortages in non-STEM careers (Obama, 2013). However, STEM courses and careers are stereotypically male (AAUW 1992; 2010). Women who do pursue STEM careers often leave the career (Fouad and Singh, 2010). Therefore, the norms surrounding STEM should be deconstructed so that all students can participate in STEM (Harding, 1991). This literature review will examine relevant research regarding the history of science education in the U.S., the history of the education of women in the U.S., the feminist critique of science, and how gender norms create stereotypes.

HISTORY OF SCIENCE EDUCATION IN THE UNITED STATES

SPUTNIK I – THE SATELLITE THAT CHANGED PUBLIC EDUCATION

Prior to World War II, the primary importance of education was to educate the voter, teach the 3R's (reading, writing, and arithmetic), and provide a moral education for the masses (Spring, 2008). After World War II, education became a matter of national security and STEM became an important part of curriculum planning when the U.S. entered into the Cold War with the Union of Soviet Socialist Republics (USSR) (Spring, 2008). The Cold War was characterized as a race between the two countries based on technological capabilities (Neal, Smith, and McCormick, 2008). The USSR wanted to expand communism and the U.S. wanted to stop the spread of communism because communism was viewed as a threat to national security. (EUCOM History Office, 2012).

Nikita Khrushchev led the USSR during the Cold War and during his leadership the Soviet Union led the U.S in technological advances. The United States European Command (EUCOM) chronicles the timeline of technological events that occurred during the beginning of the Cold War.

1. In 1955, the USSR tested an airborne hydrogen bomb 20 times more powerful than the first atomic bomb;
2. In 1957, the USSR launched the world's first intercontinental ballistic missile; and
3. On October 4, 1957 the USSR launched the first of three earth-orbiting satellites called *Sputnik I*. (EUCOM, 2012)

The launch of *Sputnik I* satellite unofficially began the "Space Race" and created fear that the U.S. was no longer technologically and scientifically superior to the USSR. (Garber, 2007). Support for science and educational initiatives had a sense of urgency that had not been seen before this time (Neal, Smith, and McCormick, 2008). The launch of *Sputnik I* created mass hysteria because the U.S. media perpetuated the belief that a Soviet nuclear attack would be easier with *Sputnik I* in the sky (Dow, 1991).

During this time, U.S. public education was under attack for lacking rigor and the content necessary in the fields of mathematics and science to protect America from the USSR and Communism (Dow, 1991). Peter Dow (1991) describes the conundrum in *Schoolhouse Politics.* While John Dewey based his theory of Progressive Education on the scientific method and scientific thinking, many of his followers watered down his beliefs causing his opponents to accuse his progressive methods of instruction of lacking rigor (Bagley, 1938). Some schools at this time were also using the Life Adjustment Movement curriculum to provide vocational training and life problem solving skills (Kliebard, 2005). These skills tended to be trivial and did not challenge the intellectualism of students. (Dow, 1991).

THE MANHATTAN PROJECT

During World War II, scientists collaborated in the Manhattan Project to build atomic bombs and provide scientific and technological advances to be used in national security. (www.nuclearfiles.org, n.d.) When the USSR quickly and successfully launched the *Sputnik* satellites, the scientists pushed for changes in the

public education system. In *Science –The Endless Frontier,* Vannevar Bush (1945) outlined the changes that would create students who would excel in mathematics and science and would be able to create a world where democracy would be secure. These intellectuals used the collaborative model of the Manhattan Project to reform the education system (Dow, 1991). Scientists began collaborating with educators to create students who were successful in science and mathematics.

NATIONAL DEFENSE EDUCATION ACT

The launching of *Sputnik I* was a turning point for American education (Dow, 1991; Spring, 2008). The focus shifted from educating the voter to guaranteeing national security. Government funding of education became an open faucet and money poured into schools because of the passing of the National Defense Education Act (NDEA) in 1958 (Spring, 2008). According to Joel Spring (2008), the NDEA was a five-part plan that included increased funding for national science foundation, provided grants to improve testing programs, improve science and mathematics education by hiring qualified teachers and purchasing appropriate ancillary materials, provide fellowship to prepare students for college teaching careers, and improve foreign language curriculum in schools. (Spring, 2008).

NATIONAL SCIENCE FOUNDATION

In 1950, the National Science Foundation (NSF), a government agency, was created to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" (www.nsf.gov/about/,

2009). Vannevar Bush spearheaded the creation of the NSF in his report to the President Science – An Endless Frontier (1945). Bush saw science as a way of thinking that would solve problems by using a collaborative method (Bush, 1945). Bush (1945) wanted federal support for science research and the NSF would promote research and education in the sciences to promote a strong national security. Prior to the launching of *Sputnik* the NSF's budget was $34 million (Neal, Smith, McCormack, 2008). After NDEA was passed, the budget was increased to $134 million by 1968, the NSF's budget was $500 million. (Neal, Smith, McCormack, 2008). After *Sputnik*, a sizable portion of the NSF budget was spent on pre-college education reform:

> These programs were designed to promote scientific literacy, encourage young people to enter scientific engineering careers, and to make the substance and method of science more central to the process of schooling." (Dow, 1991, 3).

With the launch of *Sputnik*, science and mathematics became priorities in educating students and these priorities are still evident in the "new" campaigns for public education, like "Educate to Innovate."

THE EDUCATION OF WOMEN IN THE UNITED STATES

REPUBLICAN MOTHERS TO COLLEGE GRADUATES

Throughout history, women have made many gains in their access to education. Ford (2010) describes the purpose of women's education. In the 17th

century, elite women were educated in the arts so the status quo would be reinforced and keep women in their place rather than empowering women (Ford 2010). By educating women like men (mathematics, sciences, literature, etc), the dominant social structure would change and women's primary position of taking care of the home and children would be challenged (Ford, 2010).

In the United States, women were first educated to be republican mothers, that is to say, mothers who were prepared to enable their sons to participate in the representative republican democratic governmental processes and capitalist economy of the US (Spring, 2008). The education that women received was to support their primary responsibilities of caring for the home and raising their sons to be able to read, write, and participate in a democratic society (Spring, 2008). Over time women's opportunities in education expanded. In the 1800's, women's colleges and some co-educational colleges were founded to educate women after high school (Ford, 2010). These colleges prepared women to be teachers and homemakers. The coursework offered to women fell under "(t)he assumption that women's primary function was to marry and raise children remained dominant even as women entered higher education in greater numbers" (Ford, 2010, 238). After World War II, the number of women enrolling in college dipped but has steadily increased so that currently women's enrollment in colleges and universities exceed men's enrollment (Ford, 2010).

LEGISLATING EQUALITY

As women have entered the unwelcoming world of education, laws have been passed to ensure that women have equal access to education. Title IX, an educational amendment to the *Civil Rights Act*, was passed in 1972 to prevent gender bias in schools. The law 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. (http://wwww.dol.gov/oasam/regs/statutes/titleix.htm, n.d, Section 1681.Sex).

Title IX also encompasses the issues of "sexual harassment, pregnancy, parental status and marital status" (Ford, 2010, 239). Title IX is used mainly to ensure that girls have equal access and funding in athletics.

The *Women's Educational Equity Act* (WEEA) was passed in 1974 to "authorize funds to promote bias-free textbooks and curriculum, support research on gender equity, and revamp teacher training programs" (Ford, 2010, 256). The WEEA attempts to help teachers prepare a learning environment that welcomes genders equally.

HOW SCHOOLS SHORTCHANGE GIRLS

Even with the gender equity legislation of Title IX and WEEA, girls have not received an equitable education in schools. In 1992, the American Association of University Women (AAUW) published *How Schools Shortchange Girls* to identify the

issues that girls face in school, the importance of educating girls, and recommendations on how to provide students an education that incorporates gender equality.

The Report (1992) states that while boys and girls start school academically equal by the time they graduate high school; girls are academically behind boys. The Report (1992) found that teachers were using teaching strategies were not inclusive to all students as the learning environments were very competitive instead of cooperative. Even though girls - and boys - "learn better when they undertake projects and activities cooperatively rather than competitively" (AAUW, 1992, 2). According to the AAUW (1992) girls also were not developing strong confidence and self-esteem in school and teachers were recommended to provide students with opportunities to challenge gender roles. Girls' and minorities' experiences and societal issues are often left out of the learning discourse (AAUW, 1992). By incorporating gender equality and multiculturalism in the classroom opportunities to challenge the dominant societal norms will create opportunities for acceptance of others (AAUW, 1992).

The Report (1992) also found that while girls and boys scored similarly on standardized mathematics tests, girls were not pursuing higher-level mathematics courses. The researchers found that girls often lack confidence in their abilities to do mathematics and their performance suffers (AAUW, 1992). Also boys are given preference in the mathematics and science classroom because boys often have more background knowledge in mathematics and science and are viewed as experts and given more opportunities to expand their knowledge (AAUW, 1992). Even when

girls are successful in higher-level mathematics and science courses they do not pursue careers in mathematics and science (AAUW, 2010). Teacher support is critical in closing the gender gap in STEM careers. "Studies report that girls rate teacher support as an important factor in decisions to pursue scientific and technological careers." (AAUW, 1992, 4). Ultimately, the researchers recommend that classrooms should not prefer one gender to the other but provide opportunities where all students can learn in a rigorous environment (AAUW, 1992).

WHY SO FEW?

Since 1992, girls' access to science and mathematics education has improved. In 2010, the AAUW released the report *Why So Few?* to examine the new dilemma facing women and science and mathematics education. The Report (2010) discusses that although more high school girls are participating in science and mathematics classes and are successful in science and mathematics classes, these same girls are not pursuing STEM careers. STEM careers are a key component of the U.S. participating in the global economy, as they are essential to a strong U.S. national economy and strong national security because STEM careers help to create solutions to problems that are created by new technologies (AAUW, 2010). STEM careers also create opportunities for women to close the wage-gap between women and men because STEM careers offer better monetary incentives than non-STEM careers as they are viewed as professional (AAUW, 2010). The AAUW notes:

> Women and children are the most impoverished members of our society. Inadequate education not only limits opportunities for women but jeopardizes their children's – and the nation's – future. (AAUW, 1992, 5)

STEM careers give women options to transcend stereotypical roles and create a more prosperous life for themselves and their families.

The report (2010) proposes commonly held beliefs about why women do not choose STEM careers. Some believe that women have an ability difference compared to men in mathematics and science. Others believe that because of social construction, girls perceive STEM careers as male and do not believe that they "fit in" these careers. Bias is also an issue, especially for women who pursue STEM careers (AAUW, 2010). Encouraging students to pursue STEM careers is priority for many schools and educators (Educate to Innovate, n.d.). What is keeping girls from pursuing these highly lucrative careers? In this debate, some blame biology that boys are born with an innate ability to be successful in mathematics and science. However, brain research and test score comparisons have not given researchers a clear link that boys are biologically equipped to do better at mathematics and science than girls (AAUW, 2010). Society has taken this "biological belief" and gendered careers. STEM careers are seen as male while humanities and art careers are seen as female. So when girls do show interest in mathematics and science, along with the challenges of their careers, they must face down the stereotypes that say girls don't belong in STEM careers (AAUW, 2010). Some girls internalize these stereotypes and do not think that STEM careers are an option for them.

WHY WOMEN LEAVE ENGINEERING

Fouad and Singh examine why women leave engineering in their 2011 report *Stemming the Tide: Why Women Leave Engineering.* Fouad and Singh (2011) found that 20% of engineering graduates are women while only 11% of practicing engineers are women. In their study (2011), they found that some women left engineering, some women never entered engineering and many women were currently engineers.

> Women's decisions to stay in engineering can be influenced by key supportive people in the organization, such as supervisors and co-workers. Current women engineers who worked in companies that valued and recognized their contributions and invested substantially in their training and professional development, expressed greatest levels of satisfaction with their jobs and careers. (Fouad and Singh, 2011, 6)

Fouad and Singh (2011) reported that women who left engineering stated working conditions, work environment, and family responsibilities as reasons. Women who did not enter engineering stated a perceived unsupportive workplace culture and lack of interest in engineering as reasons for leaving the field (2011). Fouad and Singh's report points to workplace climate and workplace culture as key factors for women to stay or leave engineering.

FEMINIST CRITIQUE OF SCIENCE

SITUATED KNOWLEDGE AND A STRONG OBJECTIVITY

One way that stereotypes surrounding girls and science can be disrupted is by critiquing how knowledge is constructed through science. Harding (1986) and Haraway (1988) critique "truth" in science that is grounded in Enlightenment epistemology. Specifically, the way that knowledge is constructed through scientific processes, and the privileged status of science knowledge construction is of interest to their critique. These feminist theorists argue that science is often thought of as "gender-free" and that science is often promoted as an objective entity where scientist put aside their biases, opinions, and experiences, and use the "scientific method" to test theories and discover scientific law. Harding (1986) and Haraway (1988) reconceptualized the word objectivity for use in feminist theory in their influential works of Standpoint Theory and situated knowledges, respectively.

In Feminist epistemologies that are used to critique science, the word objectivity causes great debates. Objectivity in a traditional sense means expressing or dealing with facts or conditions as perceived without distortion by personal feelings, prejudices, or interpretations. Traditional science uses the scientific method to create objectivity in scientific research. To Feminists (Harding, 1986; Haraway, 1988), objectivity is seen as keeping the male-dominated social structure in place. Haraway characterized "masculinist" objectivity as a disembodied gaze. She notes

> This gaze signifies the unmarked positions of Man and White, one of the many nasty tones of the word 'objectivity' to feminist ears in scientific and technological, late-industrial, militarized, racist, and male-dominant societies (Haraway, 1988, 581).

Objectivity used in the traditional science sense reinforces stereotypes because the scientist's experiences and viewpoints are not critiqued with respect to the conclusions they make regarding their research.

Pateman defines patriarchy as the "concept that refers specifically to the subjection of women, that singles out the form of political right that all men exercise by virtue of being man" (1988, 20). Following this definition of patriarchy, I will consider patriarchy as the focus on men, men's interests, and how men respond to science and by proxy how they ignore or devalue women, women's interests, and how women respond to science. How can the practice and processes of science move from "masculinist," patriarchal objectivity to feminist objectivity? Harding argues (1991) that a scientist should identify her standpoint so that the public will understand how her conclusions are interpreted. Haraway (1988) argues that 'situated knowledges and partial perspectives provide scientists with a way to understand specific sites of study rather than totalizing experiences and categorizing differing people together.

Harding (1991) and Haraway (1988) proposed that objectivity be used in feminist theory about science to critique how knowledge is created and to create new meanings. Harding (1991) describes using feminist standpoint theory with strong objectivity to critique and construct science knowledge. Feminist standpoint

theory begins in the experiences of women's lives. There are experiences that are common to women and out of these common experiences a standpoint is created. Using this standpoint in science research allows for women's experiences to be incorporated in science research that is typically male-dominated. Harding (1991) also argues against relativistim; where experience outweighs the objectivity. Harding argues for a strong objectivity in science where a researcher identifies her standpoint as basis of knowledge that creates the lens that data will be analyzed.

Haraway (1988) characterizes "masculinist objectivity as the "the god trick" where a scientist is "seeing everything from nowhere" (Haraway, 1988, 581). In order to move away from "disembodied" objectivity, she creates a metaphor between vision and objectivity to create a new way of understanding objectivity on feminist terms. Vision, she argues, allows for an embodied gaze that "shatter(s) any idea of passive vision" and is "building on translations and specific ways of seeing, that is, ways of life." (583). Vision is a highly personal experience based on the position of the person and the lens through which what is seen is interpreted.

Haraway (1988) also defines the middle space between essentialism and relativism. When scientists account for their positionality in their research, the research is labeled relativism. One reason that "masculinist" objectivity is highly prized by patriarchal forces in science is that is allows for conclusion to be essentializing. Haraway explains that relativism and essentialism are both "god tricks" because "both deny the stakes in location, embodiment, and partial perspective; both make it impossible to see well" (584). Haraway describes the middle ground, or feminist objectivity, between relativism and essentialism as

"partial, locatable, critical knowledges sustaining the possibility of webs of connections" (584). "This feminist objectivity means quite simply situated knowledges" (581).

Haraway (1988) argues for using "situated knowledges" in science research and calls for an investigation into the hybrid space between essentialism and relativism in order to provide a construction of knowledge that incorporates different perspectives, instead of just the hegemonic patriarchal perspective. She writes:

> I want to argue for a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of systems of knowledge and ways of seeing. (585)

It is through these feminist standpoints and situated knowledges that a more complex story can be told which incorporates feminist standpoints in science.

SCIENCE QUESTION IN FEMINISM

It is in this feminist critique of "masculinist" objectivity that holds the importance of more women being represented in STEM careers. First women bring another perspective to science research. "With a diverse workforce, scientific and technological products, services, and solutions are likely to be better designed and more likely to represent all users" (AAUW, 2010, 3). Harding (1986) wrote that it is not good enough for women to be pseudo-male scientists.

Instead of asking the "Woman Question in Science" she suggests we should ask the "Science Question in Feminism." Examples of asking the "Woman Question in Science" include researching the lack of women in science positions; identifying how science research and technology has supported the sexist, racist, classist, and heterosexist dominant society structures; and arguing that "pure science" does not exist but in fact is shaded by personal opinion and positionality. Examples of the "Science Question in Feminism" include identifying how science constructs gender symbols in society and how these symbols are used in society; and using feminist epistemologies to determine the social construction of beliefs and how those beliefs influence the construction of knowledge. The former addresses gender equity issues in science while the latter questions how male-dominated science can be used for "emancipatory ends" (396). When women are included in science, they can shape science research. When women's standpoints are used in the analysis of science research then different meanings will emerge and therefore shape the construction of knowledge and possibly disrupt gender norms.

GENDERED NORMS

How does the scientific processes of "masculinist" objectivity influence the careers that girls choose? When scientists do not acknowledge how their location, position, and experiences affect their research, stereotypes can be essentialized instead of being challenged. Gender norms often influence scientific research, to reinforce the social, economic, and political inequality between men and women.

The idea that certain careers are for boys and other careers are for girls is an example of a gendered norm. In Francois Ewald's (1990) article, *Norms, Discipline and the Law,* he defined a norm as a set of rules that are valued and reproduced by society. The way in which families are structured is an example of a socially constructed norm. Two heterosexual parents and their biological children stereotypically create families. In these "normal" families (Western, white, middle-class families), boys tend to have active and visible roles like outside chores while girls' roles tend to be passive and hidden like cooking and cleaning.

Gender is socially constructed through norms that regulate the ways that people perform masculinity and femininity. According to Butler (2004) who theorized that gendered performances are repeated acts that appear to be natural since these performative acts are unconscious to the person performing them. While norms can be very powerful, Ewald and Butler both advocated that norms are not static and can be challenged by individuals. Butler (2004) describes the power of individuals to challenge norms. Norms are temporary construction by groups of individuals. The groups that subscribe to the norm have the power to challenge its meaning. Ewald (1990) describes normalization not as a reflex where there is no control but as a carefully managed path where the end result is forecast. If normalization is under the power of the group, then the group can challenge the norm.

Society is dominated by the male's experience. One of the foundations of feminist research is to base research in the lives of women. Women do not experience situations the same way as men. Often medicines are created and tested

for men and assumed that women will respond to the medicines in the same way. These assumptions have led to dire results. Likewise, women will experience STEM in ways different from men. It is important to study women's experiences to create understanding from women's experiences.

GENDER-FREE SCIENCE

Science is often thought of as objective, removed of outside influences. (Haraway, 1988; Harding, 1991). However, social norms are thoroughly ingrained in a person's everyday actions. (Butler, 1994; Ewald, 1990). Feminists argue when scientists interpret data, these "unconscious understandings affect their conclusions (Butler, 1994; Ewald, 1990; Fausto-Sterling, 200; Haraway, 1988; Harding, 1991). In *Sexing the Body,* Fausto-Sterling (200) discusses how science knowledge is interpreted through a gendered lens. She deconstructs the scientific analysis of the corpus callosum that some scientists use to demonstrate gender differences of the human brain. (The corpus callosum is a bundle of nerves that connects the right and left sides of the brain). By measuring the corpus callosum, scientists have "proven" that men and women have different sized corpus callosum; these size differences are used to explain cognitive differences between men and women. Fausto-Sterling (2000) argued that society's beliefs about gender are influencing the scientists' results. Fausto-Sterling (2000) writes,

> I continue to insist that scientists do not simply read nature to find truths to apply in the social world. Instead they use truths taken from our social relationships to structure read, and interpret the natural. (115-116)

Scientists are looking for differences in the brains of men and women to explain the differences created between men and women by socially constructed gender norms.

ACTIVE SON/PASSIVE DAUGHTERS

After the AAUW published *How Schools Shortchange Girls,* schools began to encourage girls to take higher-level math and science classes. While educators have been more encouraging of girls pursuing mathematics and science courses (AAUW, 2010), the gendered science knowledge often excludes girls with its implicit messages of gender norms.

Examining the discourse that is used to express scientific knowledge is one way that the implicit messages can become unearthed in the science curriculum. When the discourse is critically analyzed the language, power, and knowledge associated with the curriculum can be examined. According to Foucault (1978), discourse is not just the words that are said about a topic. Deconstructing discourse allows for an individual

> [T]o account for the fact that it is spoken about, to discover who does the speaking, the positions and viewpoints from which they speak, the institutions which prompt people to speak about it and which store and distribute the things that are said. (Foucault, 1978, 11)

By deconstructing the implicit messages in the science curriculum, Feminist educators can understand how language, power, and knowledge are interacting in the classroom.

One implicit message of the science curriculum that may be conveyed to girls is the active male/passive female stereotype. A word that is used in the science curriculum to describe objects and/or processes is 'daughter.' For example, clones are also described as 'daughter' cells and 'daughter' plants. A careful examination of the word daughter reveals that one definition of daughter is belonging to the first generation of offspring, organelles, or molecules produced by reproduction. The opposite of a daughter is a son. In Western culture, sons are formative agents and daughters are considered reproductions of formative agents. Daughters are passive and sons are actives. Boys are encouraged to take science classes and actively pursue science careers while girls are passive in this schooling process.

Simone deBeauvoir (2008) in her introduction to *The Second Sex*, deconstructed the man/woman dichotomy. de Beauvoir argued that the masculine is the essential universalist subject and the feminine is only understood in relation to the masculine. She writes:

> She is defined and differentiated with reference to man and not he with reference to her; she is the incidental, the inessential as opposed to the essential. He is the Subject, he is the Absolute – she is the Other. (89)

By being defined in relation to man, woman is not viewed as autonomous. "Thus humanity is male and man defines woman not in herself but as relative to him; she is not regarded as an autonomous being (88). According to de Beauvoir, women are not considered autonomous because society relies on women's relationship to men to construct the woman identity.

IGNORANCE IS OPPRESSION

Another way that the active son/passive daughter stereotype is reproduced in science research is through the lack of research about women. The active son/passive daughter dichotomy has deep philosophical roots that can be traced to Aristotle who described the female as having a lack of qualities:

> The female is a female by having a virtue of a certain lack of qualities . . . We should regard the female nature as afflicted with natural defectiveness. (as quoted in de Beauvoir, 2008, 88)

Tuana (2008) theorized that this lack of qualities is ignorance. Ignorance is what is not known. Tuana theorized that it is important to understand what is known, and it is also important to understand what is not known. For instance, ignorance can be interpreted as an omission but Tuana argued that it can be an active process. "Ignorance is frequently constructed and actively preserved" (766). Ignorance can be used in oppressive practices. Tuana (2008) writes:

> Tracing what is not known, and the politics of such ignorance should be a key element of epistemological and social/political analyses for it has the potential to reveal the role of power in the construction of what is known and to provide a lens for the political values at work in our knowledge practices. (766)

By positioning women as having a lack of qualities, men are seen as having the qualities that are to be studied and understood. By not researching women, the importance of women is not understood and women's continued oppression can be unchallenged.

REINFORCING GENDER NORMS

In, *Gender Trouble,* Judith Butler (1999) details an example of how women are excluded in scientific research in present day because their role in biological processes is seen as passive. Butler contests the idea that sex and gender are biologically determined. Butler (1999) used the example of scientific research of a master gene for sex determination to show how scientists are influenced by gender norms that surround the active male/passive female stereotype. In 1987, David Page provided "evidence" that sex was biologically determined and claimed to have found the master gene for testes determining factor (TDF) by examining the DNA of individuals who had XX chromosomes but were medically classified as male and individuals who had XY chromosomes but were medically classified as female. Page hypothesized that the gene for TDF was able to translocate from the Y chromosome to the X chromosome, resulting in a XX male. However, the stretch of DNA dubbed the master gene that determined the male sex was also found on the X chromosome. To explain this finding, Page suggested "perhaps it was not the presence of the gene sequence in males versus its absence in females that was determining, but that is was active in males and passive in females." (as quoted in Butler, 1999, 146, *italics mine*). The gendered norm of passive female and active males influences the scientific conclusion about sex determination.

Butler (1999) argued that while the majority of sex determining research is done about testes determination, little to no research is done about ovary-determination

> (O)vary determination is never considered in the literature on sex-determination and the femaleness is always conceptualized in terms of the absence of the male-determining factor of the passive presence of that factor. (147)

Maleness is privileged over femaleness because of the gendered assumptions that society has about sex. Butler uses Eicher's and Washburn's argument that "a set of gendered assumptions about sex, and about what might make such an inquiry valuable, skew and limit the research into sex-determination." (as quoted in Butler, 1999, 147). Scientists being ignorant about how ovaries are determined privileges maleness over femaleness and reinforce the active male/passive female stereotype.

Butler argues that Page's examination of inter-sexed individual's DNA reinforces commonly held beliefs about sex categories. Page researched the "behavior" of DNA to create individuals who do not fit neatly into the categories of sex rather than critiquing the binary sex categories. By not critiquing commonly held beliefs about sex determination, Page reinforce the active male/passive female stereotype:

> [T]he concentration on the 'master gene' suggests that femaleness ought to be understood as the presence or absence of maleness, or at best, the presence of a passivity that, in men would invariably be active. (as cited in Butler, 1999, 148)

Butler also argues that it is cultural assumptions that shape the scientific conclusions of sex determination:

> The conclusion here is not that valid and demonstrable claims cannot be made about sex-determination, but rather that cultural assumptions regarding the relative status of men and women and the binary relations of gender itself frame and focus the research into sex-determination. (148)

Butler (1999) and Fausto-Sterling (2000) provided two examples of how scientific research is shaped by gender norms. These gendered scientific knowledge trickle down into the science curriculum. If they remain un-criticized, their implicit message may deter girls from pursuing STEM careers. By using the gendered messages, the science curriculum reinforces the faulty idea that scientific research is objective. Rather than the reality that the conclusions made in scientific research are often influenced by the scientist's experiences and beliefs. Also by teaching these gendered messages, girls receive mixed messages. On the one hand, girls are being encouraged to break gender norms by studying subjects that are believe to be "boy" subjects. On the other hand, "girl" subjects are being taught that they are passive, reproductions of an original.

Using Harding's (1991) theory about the Science Question in Feminism, Feminist educators need to examine how science constructs gender symbols. Using Feminist epistemologies to deconstruct how these gender symbols influence the construction of knowledge, we can deconstruct how stereotypes are created to reinforce the active son/ passive daughter gender norm. The use of the phrase 'daughter cell' for instance, can be addressed in the Feminist classroom. For instance we could replace the word 'clone' with 'daughter cell' but replacing the word does not change the norms that create the role of passive females in society.

Students need to be provided opportunities to challenge the dominant discourses and to deconstruct them.

CAREER INTEREST AND CHOICE

SOCIAL COGNITIVE CAREER THEORY

Lent, Brown, and Hackett (2002) outline Social Cognitive Career Theory (SCCT) in Brown's Career Choice and Development. To understand why a young woman chooses the career that she chooses, SCCT provides a framework for understanding her choice. SCCT is grounded in Bandura's social cognitive theory, Krumboltz's social learning theory of career decision-making and Hackett and Betz's application of the self-efficacy construct to women's career development (Lent, Brown and Hackett, 2002). SCCT examines: 1. how self-efficacy determined by personal performance accomplishments, vicarious learning, asocial persuasion, and physiological and affective states impact outcome expectations; 2. personal beliefs about the consequences or outcomes of performing particular behaviors and personal goals derived from people's appraisal of the outcome; 3. observations of the outcomes produced by other people; and 4. attention to self generated outcomes and reactions of others; and sensitivity to physical cue during task performances that interact and influence each other as a person is deciding on a career. For example:

> [S]elf-efficacy and outcome expectations affect the goals that one selects and the effort expended in their pursuit. Personal goals, in turn, influence the

development of self-efficacy and outcome expectations (for example, goal attainment enhances self-efficacy). (Lent, Brown, and Hackett, 2002, 263)

Using SCCT as a framework, studying the interactions of self-efficacy, personal goals, and outcome experiences can provide understanding to career choices.

Lent, Brown, and Hackett (2002) propose three models for organizing career-related interest, choice and performance – interest development model, choice model, and performance model. These models allow for examination of how self-efficacy, outcome expectations, and personal goals interact and the interactions of race, class, gender, environments, and learning experiences influence career choice (2002). The interest development model "holds that self-efficacy and outcome expectations regarding activity involvement exert an import direct effect on the formation of career interests" (265). Girls will form an interest in STEM if they view themselves as having the skills to produce positive outcomes. This model also takes into account how gender and race affect career choice. Lent, Brown, and Hackett write:

> SCCT regards gender and race from a social constructivist position in which these attributes are interwoven features of the person's socially constructed world, not simply inherited biological properties of the person. We believe their relevance to career development stems largely from the reactions they evoke from the social-cultural environment and from their relation to the structure of opportunity within which career behavior transpires. (268)

The interest development model allows researchers to understand how young girls view their career choices.

The choice model of SCCT "holds that interests are typically related to the choices that people make and to the actions they take to implement their choices (276). The choice model also "highlights the intermediate role of personal agency" (via goals) (273). The choice models posits that young women will choose STEM careers if young women are interested in STEM and young women view STEM as a way to accomplish their goals. The performance model of SCCT "is concerned with the level of people's accomplishments, as well as with the persistence of their behavior in career-related pursuits" (277). The individual's performance is affected by self-efficacy, outcome expectations, and personal goals. How a young woman perceives her performance in STEM will influence her choosing a STEM career.

SCCT as proposed by Lent, Brown, and Hackett examines how self-efficacy, outcome expectations and personal goals interact with each other and also race, class, and gender of individuals (2002). SCCT "emphasizes the means by which individuals exercise agency in their own career development, as well as those influences that promote or constrain agency" (2002, 302). By understanding the interactions of self-efficacy, outcome expectations, and person goals along with the personal agencies of individuals, career interventions can be employed to help individuals make career decisions (2002).

FEMINIST CLASSROOM

CONSTRUCTIVIST APPROACH TO SCIENCE LEARNING

In science classes, students are expected to learn abstract concepts and show mastery of these concepts. A constructivist approach can provide students opportunities to learn these abstract concepts successfully. Constructivism "refers to the idea that learners construct knowledge for themselves – each learner individually (and socially) constructs meaning – as he or she learns" (Hein, 1991, 1). There are many different types of constructivist approaches in the science classroom. Hein argues that a constructivist pedagogy will include opportunities for learners to "a) interact with sensory data, and b) construct their own world" (Hein, 1991, 2).

Using constructivist theory to provide meaningful work to students means giving students opportunities to interact with materials and construct their own meanings (Hein 1991). Instead of the teacher imparting knowledge to the student through lectures, teachers provide students opportunities to grapple and make meaning out of learning situations. Constructivism has key principles that guide the philosophy and will be present in constructivist learning opportunities.

Constructivist learning opportunities will be an active process where students are doing something to make meaning (Hein 1991). Students will be classifying rocks based on observations or categorizing plants based on their structures. While the students are manipulating these objects they are "learning to learn as they learn" (Hein, 1991, 3). If the learning outcome is for students to

classify, then they should be classifying objects. Along with the hands-on activities, reflection is necessary for students to be able to make meaning (Hein 1991). The content that students are learning should use the language that is related to that content. "The language we use influences learning" (Hein, 1991, 3). Therefore scaffolding from basic descriptions to complex scientific language should be created to help students learn and use scientific language.

Learning does not occur in isolation but is a social process that is enhanced when learners can interact with one another (Hein 1991). Meaningful group work can be created that allows students to talk with their peers to create meaning and apply their learning to new situations. Traditional learning experiences where students complete book work are not as effective. Constructivism acknowledges that students learn from their positionality. Students bring to the learning environment a host of experiences and beliefs. Therefore, learning will be influenced by what we live. Background knowledge is imperative to successful learning (Hein 1991). Students must be given an opportunity to activate previous learning about a topic or address misconceptions about a topic before learning new information.

Learning takes time and students need time to grapple, reflect, ponder, and question while they are learning content (Hein 1991). Finally for learning to take place, students must be motivated to learn. If students are provided opportunities to learn through meaningful work tasks, they will understand the purpose of their learning and be more willing to put forth the effort to do the work necessary to learn (Hein 1991). There are many different types of strategies that fit under the

constructivism umbrella, such as inquiry learning, student centered learning, problem based learning, authentic learning, etc. Meaningful work can be produced out of any of these strategies. Moving toward these types of learning strategies will move away from teacher imparting knowledge in a "sit and get" environment to an environment where students are constructing their own meaning through tasks that are authentic and will provide students the experiences necessary to gain interest in STEM careers.

ROLE OF TEACHER

Teachers can influence students through their attitude about science, their capacity to teach science and their role in perpetuating or disrupting stereotypes (Christidou 2011). Christidou (2011) discusses the role of teachers in her research of student's attitudes of science. Christidou (2011) has found that the attitude that teachers have about science will influence their students' attitudes about science. Teachers who lack confidence in their abilities to teach science will rely on teacher-centered, lecture-based science lessons, which can negatively impact students' interest in science (2011). Teachers who understand the nature of science and are more confident in their ability to teach science are able to prepare and present lessons that allow students to make connections between science content and how science is practiced in the work place (2011). When teacher provide ways for their students to experience science processes, students often have a more positive view of science and will be more interested in science (2011).

Christidou (2011) also describes the role that teachers can play in perpetuating gendered stereotypes in science. If teachers believe the male-dominated stereotype of science, then girls will receive less attention from teachers. Girls will have less power in the science classroom and will be turned off to science (2011). Often textbooks reproduce gendered messages about who is best suited for science by picturing males in science roles. If teachers do not disrupt these gendered messages, then the girls in science classes are discouraged from pursuing science classes or careers (2011). Teachers will influence students in a negative or positive way, with respect to science interest.

GROWTH MINDSET

In *Why So Few*, the AAUW recommends teaching students "that intellectual skills can be acquired" (AAUW, 2010, 35). This recommendation is based on the work of Dweck and her mindset theories. In the article, *Even Geniuses Work Hard*, Dweck describes the different between a fixed mindset and a growth mindset. "Individuals with a fixed mindset believe that their intelligence is simply an inborn trait. In contrast, individuals with a growth mindset believe that they can develop their intelligence over time" (Dweck, 2010, 16). Promoting a growth mindset in class provides students with the skills necessary to cope with challenging learning situations.

Students who demonstrate a fixed mindset are less likely to persevere through difficult learning situations than students who demonstrate a growth mindset.

> (S)tudents who believe that intelligence is a fixed quantity are particularly vulnerable to decreased performance when they realize they are at risk of failing, whereas students who view intelligence as acquirable appear better able to remain effective learners. (Mangels et al, 2006, 75).

In order to combat the more prevalent view of fixed mindset, Dweck (2010) discusses how to cultivate a growth mindset in students by having teachers create a growth mindset culture in their classroom, emphasize challenges, and highlight the journey of learning rather than the outcomes.

In creating a classroom environment that cultivates a growth mindset, Dweck (2010) posits that teachers can do this by teaching students how the brain grows and develops, goal setting, and having students support other students in their learning journey. Dweck (2010) also describes the importance of deep learning and that when students learn fast they may not be learning at the deep levels that will be necessary in future studies. "Teachers should also emphasize that fast learning is not always the deepest and best learning and that students who take longer sometimes understand things at a deeper level" (77). The participants in my study valued students who could learn content quickly and when they struggled or took longer to learn they felt incompatible with the content area. These beliefs align with the fixed mindset and when they received pushback in learning, be it from the length of time it took to master a concept to a teacher having a funny reaction to them, they believed that they could not learn the concept. Cultivating a growth mindset in the classroom will help teacher convey the message to students that they can learn difficult concepts and they can overcome challenges.

Dweck (2010) recommends that teachers place the emphasis on the challenge rather than the outcome. Teachers need to plan meaningful assignments that have multiple entry points. In this way, students of all abilities can have a meaningful task to do with varying degrees of support from the teacher or their peers. Dweck (2010) also suggests that students who are struggling can explain which strategies they have tried and why they may not have worked. In this way, students can explain their reasoning and figure out what next step they should try. This tends to be more meaningful to students because they can look back and reflect on what has worked and what has not worked in their learning.

To highlight students' progress through their learning journey, Dweck (2010) recommends that teachers allow students to reflect on where their learning was at the beginning of a unit and how they progressed and mastered the material. Tracking progress can be done through pre and post-tests with time to reflect on learning growth after the post-test (Dweck 2010). Meaningful learning tasks that provide students tasks that build on one another also provide students ways to reflect on their learning progress. These types of tasks also allow teachers the ability to praise students for their efforts. Dweck (2010) and the AAUW (2010) both recommend praising students for their efforts not necessarily for being smart. By pointing out students' hard work, the teacher reinforces growth mindset and the idea that intelligence and success comes from hard work not raw talent alone.

CRITIQUING GENDERED STEREOTYPES

One way to provide students the opportunity to critique gendered stereotypes is to provide students opportunities to challenge these dominant discourses. Jennifer Gore (1992) writes about how teachers in their classrooms can use "empowerment" in liberating oppressed peoples. Teachers are often encouraged to "share power" with their students in an attempt to empower students. Power is seen as zero-sum; one must give up power so another can gain power. Gore suggests that instead of sharing power, teachers should allow students to exercise power in "sites of practice." (Gore, 1992, 68). This exercise will provide students with the skills necessary to "practice power" when they are in situations that are oppressive.

Teachers and students can practice power through agency. Norms can be challenged through agency. Agency begins by a person understanding that they are oppressed. After the realization of oppression, a person may decide to do nothing or they may begin to move toward activism. Mollie Blackburn (2004) argues that agency can be asserted through language. Language can allow marginalized people to develop a sense of self in an environment that does not accept them. By creating an understanding of self and coping mechanisms, marginalized people can begin to challenge and disrupt dominant discourses.

Science teachers can provide their students opportunities to challenge gendered stereotypes by incorporating feminist strategies in their classroom. This can be accomplished by moving away from Traditional Learning Experiences to centering learning around the student and providing the student ways to construct

meaning. Maher and Tetreault (2001) describe characteristics of a feminist classroom in their book, *The Feminist Classroom.* Mastery, voice, authority, and positionality are the four characteristics of a feminist classroom (Maher and Tetreault 2001). Mastery is the content that is taught in the classroom. In traditional classrooms, students master standards that are determined by the teacher or "master of the knowledge". Students train under these masters so that they can master the knowledge presented. In a feminist classroom, the content learned is a collaboration of students' questions or experiences and the teacher's goals for the class. The teacher uses questioning to guide students to view the content in a new way. By challenging the students to interpret readings with varying perspectives, the students can then transfer this practice of viewing literature from multiple perspectives to viewing the world around them through different perspectives.

Voice in a feminist classroom is the connection of the students' learning to their experiences. Voice represents the students' place in dominant culture and how the students negotiate their place in society when race, class and gender intersect. Maher and Tetreault describe students forming their voice instead of finding their voice. "As students brought their own questions and perspectives to the material, they used relevant personal experiences to shape a narrative of an emerging self" (Maher and Tetreault, 2001, 19). The use of journals allowed students to grapple with their learning and provide opportunities of sharing their thoughts in class. Feminist classrooms value student experiences and show how the process of learning allows for student growth (2001). Whereas in traditional classrooms,

students often assume a voice that is taught to them by the teacher rather than forming a voice by connecting to the learning and growing as learners.

Maher and Tetreault (2001) describe authority in a feminist classroom as being concerned with creating opportunities for students to take control of their learning. Moving from a traditional classroom's authority of "sit and get," authority in a feminist classroom allows for students to make decisions about their learning by positioning themselves as authorities of knowledge in different disciplines. For this transfer of power to take place, the teacher must establish relationships with students. Through these relationships, the voices of marginalized students will be recognized and challenge the patriarchal view of authority that is present in classrooms. When authority is shared between teacher and students, the students can then look to other students as sources of knowledge. By working together as groups to define their place in social structures or learn from the experiences of marginalized students, all students can begin to understand how position affects the learning process.

Maher and Tetreault (2001) explain postionality as the process "in which people are defined not in terms of fixed identities, but by their location within shifting networks of relationships which can be analyzed and changed." (Maher and Tetreault, 2001, 64). Maher and Tetreault (2001) credit the positionality of the students and teachers having the greatest influence on student learning. Since knowledge is constructed in group dynamics, positionality calls for students to share their beliefs with others, listening to others' beliefs, and deconstruct those beliefs to find how the two positions relate to one another. Positionality allows for

marginalized students an opportunity to share their viewpoints and also allows for students who identify with the dominant social structures an opportunity to deconstruct those structures and view ideas from new perspectives.

The feminist classroom has an important place in education because these classrooms are organized to allow for students to challenge the dominant social construction. If in classrooms students are taught what to think, then the students begin to think, "How do I fit into this definition?" instead of "How do I define myself?" The characteristics of the feminist classroom allow for self-definition, which is the key to empowerment. Patricia Hill Collins discusses the importance of self-definition in her book *Black Feminist Thought.* "Self-definition is key to individual and group-empowerment, ceding the power of self-definition to other groups, no matter how well-meaning or supportive of Black women they may be, in essence replicates existing power hierarchies" (Collins, 2000, 40). By sharing mastery and authority with students, providing opportunities for students to form their voices and identify their positionality, then students can resist the definitions placed upon them by society.

SITUATING THE PRESENT STUDY IN PREVIOUS RESEARCH

In my study, I seek to understand how eighth grade young women in a southern middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is to understand young women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and

unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. Career interests develop over a lifetime and tend to solidify during late adolescence and early adulthood (Lent, Brown, and Hackett, 2002). Government educational initiatives, like "Educate to Innovate," are mandating educators provide students opportunities in STEM in hopes of students pursuing STEM careers (*Educate to Innovate*, n.d.). However, the AAUW reported that one reason that women do not pursue STEM careers is because of the "perceptions and unconscious beliefs about gender in mathematics and science" (AAUW, 2010, 90). Using a critical feminist frame that asks the "Science Question in Feminism" (Harding, 1991), my study will explore the perceptions young women have about STEM careers in hopes of uncovering the gendered stereotypes that influence their perceptions.

The present study will add to the research of women and STEM because it focuses on middle school age young women and their perceptions of STEM careers. Of the related research reviewed (AAUW, 2010; Fouad and Singh, 2010), researchers have focused on high school, college, and career women and how these women perceived their accessibility to STEM. These research studies have used quantitative research methodologies focusing on how girls and women have been represented in STEM. These studies have identified the participation gap between girls and boys and women and men in STEM courses and careers.

The present study will provide data regarding middle school young women and their perceptions of STEM through a qualitative, feminist research methodology. The present study will uncover the experiences of young women in

STEM and the perception they have about STEM careers. Building on the information about the quantity of women in STEM, the present study will focus on the meaning that young women attribute to STEM. By understanding their perceptions of STEM, we can provide support by using the career counseling models to support young women in their pursuit of STEM careers. Also the gendered stereotypes uncovered can be deconstructed so that young women can find a welcoming place in STEM.

CONCLUSION

The presence of women in mathematics and science careers is important. First, successful women in male-dominated careers will challenge gender norms that certain careers are for men and other careers are for women. Second, women's experiences will allow for a broader range of voices and viewpoints in science research. For more women to be successful in mathematics and science careers, the Science Question in Feminism must be explored so that the gendered messages in science can be challenged so that girls' and women's experiences are welcomed as valued and vital to science knowledge construction.

CHAPTER THREE

METHODOLOGY

Most important to me in terms of feminist social research and dealing with its dilemmas, though, is that this method of writing/research sparks identification. It offers an expanded feminist consciousness and a method for other feminists to make sense of their worlds in ways that connect us to one another in common cause.

(Richardson, 2007, 466)

INTRODUCTION

The present study is an investigation of how eighth grade, young women, in a southern, public middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is to understand these young women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how their "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future.

Career interests develop over a lifetime and tend to solidify during late adolescence and early adulthood (Lent, Brown, and Hackett, 2002). Government educational initiatives, like "Educate to Innovate," are mandating educators provide

students opportunities in STEM in hopes of students pursuing STEM careers (Educate to Innovate, n.d.). However, the AAUW reported that one reason that women do not pursue STEM careers is because of the "perceptions and unconscious beliefs about gender in mathematics and science" (AAUW, 2010, 90).

Using Feminist Standpoint Theory, I explored Harding's "Science Question in Feminism" (1991), in this study and I explored the perceptions that these southern, young women have about STEM careers that may uncover the gendered stereotypes that influence their perceptions. The present study will contribute to the research of women and STEM because it focuses on middle school age young women and their perceptions of STEM careers. Of the related research reviewed (AAUW, 2010; Fouad and Singh, 2010), researchers have focused on high school, college, and career women and how these women perceived their accessibility to STEM. These research studies have used quantitative research methodologies focusing on how girls and young women have been represented in STEM. These previous studies have identified the participation gap between girls and boys and women and men in STEM courses and careers.

The present study provided data regarding middle-level, young, southern women and their perceptions of STEM through a qualitative, Feminist research methodology and will uncover the experiences of young women in STEM and the perception they have about STEM careers. Building on the information about the quantity of women in STEM, the present study focused on the meaning that young women attribute to STEM courses and careers.

RESEARCH PURPOSE AND LEARNING OBJECTIVES

The present study is an investigation of how eighth grade, young women, in a southern, public middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is to understand young, southern women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. The young women's perceptions helped me, as an educator, to understand how to encourage and include young women in my STEM courses. Since STEM is being touted as one way to improve education and incentives given to students pursuing STEM (Obama, 2013), it is important that STEM is an equal playing field (AAUW 1992; 2010). One way to equalize the playing field is to provide curriculum developers information so they can write STEM curriculum and create and implement STEM pedagogy that addresses the challenges that young women encounter as the pursue STEM careers.

MAJOR RESEARCH QUESTIONS

The following research questions are posed:

1. How do eighth-grade, female, southern students, who are identified as "successful" (i.e. maintained a consistent A or B+ average in science classes during their sixth and seventh-grade years) perceive the STEM courses they took or are presently taking?

2. What are these students' perceptions of STEM careers (e.g. stereotypes, accessibility, gender equity)?
3. What are these students' perceptions of STEM as a career option for themselves?

DESIGN AND METHODOLOGY

QUALITATIVE RESEARCH

I used qualitative research methods in this study. This study will be from a feminist research perspective as I try to understand my participants' "perception and unconscious beliefs about gender" in STEM courses and careers. Hesse-Biber writes that Feminist research is

> Research that gets at an understanding of women's lives and those of other oppressed groups, research that promotes social justice and social change, and research that is mindful of the researcher-researched relationship and the power and authority imbued in the researcher's role are some of the issues that engage the feminist researcher. (2007, 117)

By situating the research study in young women's lived experiences, better understanding of young women's experiences in STEM courses can be obtained (Hesse-Biber and Leavy, 2007).

Qualitative research finds understanding and explains meaning of phenomenon of interest. In Merriam's *Qualitative Research and Case Study Applications in Education* (1998), qualitative research is described as "inquiry that

helps us understand and explain the meaning of social phenomenon with as little disruption of the natural setting as possible" (Merriam, 1998, 5). Qualitative researchers view reality through lived experiences. As individuals and groups of people interact with their communities, the experiences they have can be researched to explain the various ways of being. Merriam (1998) explains that qualitative research examines how parts work together to create the whole experience.

Since one of qualitative research's goals is to understand and explain the world. Merriam (1998) describes the methods of qualitative research as "flexible, evolving, and emerging" (9). Merriam (1998) describes five characteristics that exemplify qualitative research.

1. The researcher makes sense of the world through experiences.
2. The researcher filters data through his or her experiences, beliefs, and standpoints.
3. Research must take place where the phenomenon happens. Researchers must go to where the action is taking place and do their research. The observations, inferences, analysis and conclusions must take place where the phenomenon happens.
4. Qualitative research builds knowledge so that new theories can be created. Qualitative researchers often look for what is missing in theory and do research to bring more understanding to the phenomenon of interest.

5. The results of qualitative research are "richly descriptive" (Merriam, 1998, 8).

Since qualitative research is based on individual experiences and filtered through the researcher's standpoint, the data must be positioned according to these standpoints.

Merriam (1998) describes qualitative research as focusing on participant's perspective so as to give voices to groups that may not have a voice. Another aspect of qualitative research that Merriam (1998) describes is qualitative research is about the present not about making future predictions. Also by focusing on the present, transformative action can take place. Since qualitative research provides new ways of knowledge creation, researchers can position themselves with regard to their research to understand and make meaning of everyday life.

FEMINIST RESEARCH

This study is framed by Feminist Standpoint Theory to understand one way that girls experience STEM courses and the perceptions these girls have about pursuing STEM careers. As outlined in Hesse-Biber and Leavy *Feminist Research Practice* (2007), feminism is described as being concerned with women's viewpoints of how women experience life; feminism is a rejection of an essentialized experience; and feminism also recognizes that the researcher brings certain viewpoint that color the way the researcher's data are interpreted. Standpoint Theory provides feminists a way to explore knowledge claims, knowledge

production, and power relations by beginning with a researcher's particular experience and working out toward society's experiences (Harding, 2007). Naples (2007) discusses three different approaches to standpoint theory. She identifies these areas as "embodied in women's social location and social experience, as constructed in community, and as a site through which to begin inquiry" (Naples, 2007, 581). My study will approach standpoint theory as a site through which to begin inquiry.

Richardson (2007) shows how standpoint theory can be used as a site through which to begin inquiry in her research method, "Writing for Another." She discusses how second wave feminism and post-structural theory intersect when researchers use experiences from their lives and connect them with other people's experiences. To better understand her mother's experiences she uses a strategy called Reading for Another. She uses the novel, *Too Late for Phalarope* by Alan Paton, to read for her mother to better understand her mother and her mother's life by connecting the characters in the story to her mother (2007). By doing this, she views her mother in a new perspective. Richardson (2007) theorizes that this type of research allows for feminist ways of knowing and the ability to construct knowledge. As new experiences are had she can reconstruct knowledge. She can present her experiences and allow others to connect with her experiences.

Richardson (2007) also writes about how experiences can create connections. By using a qualitative method like "Reading for Another," the researcher can use reading and writing to create connections. When researchers

write about their personal experiences, others can create understanding about their own experiences. She writes:

> Most important to me in terms of feminist social research and dealing with its dilemmas, though, is that this method of writing/research sparks identification. It offers an expanded feminist consciousness and a method for other feminists to make sense of their worlds in ways that connect us to one another in common cause. (466)

Small pieces are not presented as the whole in this type of research but as ways to connect to the whole. This study will provide opportunities to eighth grade young women at a suburban middle school to explain their experiences with STEM that will provide connection points for other young women as they pursue STEM courses and careers.

One critique of standpoint theory is that it is essentializing (Naples, 2007). A small group's experiences is deemed the norm and applied to anyone who may fit into that group. Collins (2000) writes that not all Black women suffer oppression in the same way but that all Black women are oppressed. By using Black Feminist thought, Black women can create definitions of themselves instead of being defined with respect to the dominant group.

> Through the lived experiences gained with their extended families and communities, individual African-American women fashioned their own ideas about the meaning of Black womanhood. When these ideas found collective expression, Black women's self-definitions enabled them to refashion African-influenced conceptions of self and community. (Collins, 2000, 13)

Collins does not try to generalize Black women's experiences. Her writing allows Black women to connect to similar and different experiences that they may face due to oppression. Likewise, this study will not provide a universal young woman's experience in STEM. However, this study will uncover how eighth grade young women from a suburban middle school self-define themselves in STEM to contribute to the "collective expression" of how young women identify with STEM.

Standpoint theory includes the experiences of marginalized groups. These experiences are not meant to be essentializing but "situated knowledges" (Haraway, 1988). She writes:

> I want to argue for a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of systems of knowledge and ways of seeing. (585)

It is through these feminist standpoints and situated knowledges that a more complex story can be told and knowledge can be created through multiple perspectives.

Science is often thought of as "gender-free." Science is promoted as objective, where scientists put off their biases, opinions, and experiences and use the scientific method to test scientific theories and discover scientific law. (Hawkesworth 2007). Feminists, like Sandra Harding, question the authority of science and its patriarchal heritage. Harding (1986) questions scientists' objectivity in their choices of what to study. She positions science as being subject to scientists' biases, opinions and experiences. Because of a lack of objectivity, science is gendered and these gender

meanings have affected our "belief systems (and) institutions" (Harding, 1986, 390). The feminist critique of science challenges the dominant social structure and challenges the knowledge construction that occurs from male-dominated science.

Harding (1986) writes that it is not good enough for women to be included in science like a pseudo-male scientist. Instead of asking the "Woman Question in Science" she suggests we should ask the "Science Question in Feminism." Examples of asking the "Woman Question in Science" would be researching the lack of women in science positions; identifying how science research and technology has supported the sexist, racist, classist, and heterosexist dominant society structure; and arguing that "pure science" does not exist but in fact is shaded by personal opinion and positionality. Examples of the "Science Question in Feminism" would be identifying how science constructs gender symbols in society and how these symbols are used in society; and using feminist epistemologies to determine the social construction of beliefs and how those beliefs influence the construction of knowledge.

The "Woman Question" addresses gender equity issues in science while the "Science Question" questions how male-dominated science can be used for "emancipatory ends" (Harding 1986, 396). When women are included in science, women can shape science research. When women's standpoints are used in the analysis of science research then different meanings will emerge and therefore shape the construction of knowledge. This "new" knowledge can then be used to challenge and change the dominant social structure.

RELATIONSHIP OF STUDY TO SITUATED KNOWLEDGE

As a white, female middle-level science educator, I am interested in girls and young women in STEM because my life was shaped by science. Both of my parents pursued science careers. My mother is a nurse and my dad is an engineer. My parents valued formal education, post-secondary schooling, and hard work and instilled the importance of education and hard work in me. My father especially placed science and mathematics classes in high regard. As a young woman in high school, this value on science and mathematics classes encouraged me to pursue higher-level classes and because I was successful in these classes and because I was taught that it was necessary to take these classes in order to prepare for college, I believed I could be a medical doctor and majored in biology during college. As a sophomore in college I decided to take science teacher preparation courses as a "back-up plan" in case I did not get into medical school. That choice changed my career and now I am a middle level science teacher.

My sister is a professional civil engineer and she and I frequently discuss the challenges that she faces as being a woman in a male-dominated STEM career. Her experiences added to my curiosity about how women can be success in male-dominated STEM fields. These life experiences have shaped my curiosities about STEM and the ways in which I prepare my female students for STEM challenges. I also actively work to provide opportunities for historically marginalized groups of students to look at their lives in new ways and in particular access and equity in STEM. For instance, I challenge their beliefs that certain opportunities are only for

certain people and I strive to provide hands-on science activities for all students regardless of race, class or gender.

My role as researcher has also been influenced as my role as a teacher. My goal as a teacher is to help students meet their goals by providing an encouraging learning environment that challenges their thinking. I teach at Columbia County Middle School, the school where I did my research. CCMS is currently implementing Expeditionary Learning, a framework that guides faculty in developing curriculum and school culture. I have attended many professional development seminars in our journey as an EL school. During one professional development seminar, the faculty took a survey to determine how we individually viewed learning – through a growth mindset or fixed mindset. After the survey, we read a brief article written by Carol Dweck. I remembered that the AAUW recommended teaching students to have a growth mindset rather than a fixed mindset.

I researched Carol Dweck's publications to determine if her published work had been peer reviewed. So often teachers are asked to read and implement strategies that are not based on research or theory. To my delight, Dweck's work is based on sound research practices and theory and I respected her work rather than someone who may have written a book to espouse the latest trend in teaching that is based on assumptions or to make money for the latest "fix" for education. My dissertation conclusions and recommendations rely heavily on the work of Carol Dweck. My respect for her work comes from the recommendations of the AAUW, further introduction through professional development given at my school, and my own personal research and reading of her work.

MONITORING STRATEGIES

The monitoring strategies that I used during my study are bracketing, peer review, and journaling. By bracketing, writing down everything I think I know about the study, the participants, and their experiences, I was able to identify areas that I may make assumptions about what I am observing. Peer review allowed me to have others look at my interpretations of the participants' experiences to identify areas that I may have left out of or misidentified my conclusions. Throughout the process, keeping a journal to reflect on what I am experiencing allowed for reflexivity and a constant critique of myself as a researcher. These methods allowed me to identify how power affects the relationship between researcher and participant (Hesse-Biber and Leavy, 2007).

CONTEXT FOR STUDY

Columbia County, South Carolina provides a study site that allows this researcher to "learn the most" (Patton, 2002, 233) about southern young, women in STEM careers in a suburban middle-school. Patton describes extreme sampling sites as information rich because of the uniqueness of the site.

> The logic of extreme case sampling is that lessons may be learned about unusual conditions or extreme outcomes that are relevant to improving more typical programs. (Patton, 2002, 232)

Columbia, SC is a unique site for studying women in STEM careers for the following reasons:

1. The University of South Carolina (USC) is located in Columbia, SC.

2. The University supports different initiatives to get students interested in STEM.
3. There are many continuing education opportunities for teachers with respect to STEM offered through the University.
4. There is a strong engineering program at the University that can be a resource for my study.
5. Columbia Columbia, SC also has one of the best school districts in South Carolina – Columbia County School District (CCSD) (pseudonym)
6. CCSD is interested in building STEM programs in their schools.
7. STEM programs draw on mathematics and science process skills for problem solving rather than memorizing content.
8. These STEM programs prepare students to compete in careers that require problem-solving skills.

To gain access to the CCSD site, I applied for permission to conduct research in the school district through the proper channels. Then, I contacted the principal for permission to conduct my research study in his school. Then I identified participants by discussing the criteria with the guidance counselor and science teachers (procedure is outlined in next section). To establish a researcher-participant working relationship, I met with the participants before the interviews begin so that the participants can ask questions and we were able to get to know each other.

PARTICIPANT SELECTION, CRITERIA, AND JUSTIFICATION

I used criterion sampling to determine my participant selection. Criterion sampling allows for specific phenomenon to be studied by choosing participants that "meet some predetermined criterion of importance" (Patton, 2002, 283). Patton (2002) describes criterion sampling as useful for program monitoring systems.

> The point of criterion sampling is to be sure to understand cases that are likely to be information-rich because they may reveal major system weaknesses that become targets of opportunity for program or system improvement. (283)

By using criterion-based sampling to choose my participants, I was able to study young women who are successful in science classes. Understanding their perceptions about STEM courses may identify strengths and weaknesses in science curriculum that can lead to improvements in science curriculum.

The purpose of the present study is to understand young, southern women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. Participants were selected by identifying eighth grade girls who have maintained an A or B+ average in science classes during middle school (grades 6 – 8). From this group, girls will be subdivided:

Group A, "Interested in Science"

Girls who have expressed an interest in pursuing STEM courses in high school;

Group B, "Somewhat Interested in Science"

Girls who have expressed an interest in pursuing some STEM courses in high school;

Group C "Uninterested in Science"

Girls who are not planning on pursuing STEM courses in high school.

Participants were chosen by results from a careers survey taken in 7th grade, high school course selection, and science grade averages. Demographic make-up (race and SES) was similar to the demographic make-up of the school. Nine girls, three from each group, were invited to participate in this study.

Demographic make-up (Race and Socioeconomic Status SES) was similar to the demographic make-up of the school. Nine girls, three from each group, will be invited to participate in this study. This small sample will allow for understanding of the participants' experiences. "The goal is to look at a "process" or the "meanings" individuals attribute to their given social situation, not necessarily to make generalizations" (Hesse-Biber, 2007, 119). The present study is an investigation of how eighth grade, young women, in a southern, public middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers.

THE SETTING

Columbia County School District is located near Columbia, the Capital City of South Carolina. Traditionally, one of the more conservative areas of South Carolina, Columbia County has seen many changes to its demographics and landscape over the past twenty years. Columbia County is a desired place to live with high performing public schools. Many of the professionals that work in Columbia make their home in Columbia County. Because of the influx of people living in Columbia County, businesses have moved into the area and the school district has also grown.

Columbia County Middle School (CCMS) is one of the top middle schools in the state with respect to standardized test scores. More than 80% of the students scored Met or Exemplary on the South Carolina Palmetto Assessment of State Standards (SCPASS). Parents and students are excited to be a part of the CCMS family; 90% of surveyed parents and students were satisfied with the school's learning environment.

The school's population is made of mainly white, middle-class students. This school seemed the best place to conduct my study because the school presented a "best-case scenario" view of the research I wanted to conduct. The students and families at CCMS are well-educated and hard-working. The parents want their children to be successful and find education to be important. Most discipline issues at CCMS are solved with a parent phone call. When I thanked the mother of one of the participants for allowing her daughter to be a part of my study, she told me that she had an ulterior motive for letting her daughter participate. She wants her daughter to be an engineer and she thought that being a part of my study would

encourage her to pursue being an engineer. It would seem that because of the experiences of the participants, gendered messages would have less influence on them.

CCMS is also in the process of becoming an Expeditionary Learning School. Expeditionary Learning (EL) is a framework that teachers use as a guide when creating curriculum and school culture. EL strives to create learning environments where students are engaged in their learning and are supported to achieve at high levels (Learning 2011). These learning environments are created by implementing ten design principles that honor the student's individuality and curiosity, promotes responsibility for learning, fosters empathy and caring, takes pride in success and learns from failure, provides opportunities for collaboration with other students and competition to show their best work, celebrates diversity and fosters inclusion, respects the natural world, provides time for reflection, and celebrates service to the community (Learning 2011).

While implementing EL, teachers have participated in professional development to be prepared to plan lessons that align with the design principles of EL. During these professional development seminars, the philosophy of EL and EL protocols or learning strategies has been taught.

Expeditionary Learning's focus is to move away from traditional learning experiences to providing students with real-world opportunities to connect their learning with helping out their community (Learning 2011). If implemented fully, teachers can use EL's guiding principles to provide students with learning experiences that could shape their interests in STEM careers. In science, when

learning about simple machines, students could be assigned the task of using simple machines to create a model house. This assignment requires multiple skills including planning (architecture), budgeting (accountant) and building (engineering). Experts in the fields of architecture, accounting, and engineering could visit the classroom and show the students how to do these tasks. If the experts of are various race, class, and gender, then the students will be able to broaden their view of who does these careers. Students could be given the opportunity to see that women are also engineers, if women engineers are invited to participate as an expert. The stereotype that STEM is for white, middle-class males could be disrupted if people of different races, classes, and gender are invited to the classroom to share their expertise with the students.

CCMS is not a perfect school. While it has many positive attributes, the influence of standardized testing, the reinforcement of gendered stereotypes, and the competition among students to be the best can hinder the progress that CCMS wants to make by implementing EL.

With the rise of accountability, teacher and administrator's report cards are talked about being based on how well students do on standardized state testing. Some teachers are motivated to have the highest standardized test scores that can stifle innovative instruction that often leads students to having positive experiences in core content areas. Gendered stereotypes permeate our society and these stereotypes are present at CCMS. Teachers and administrators often talk about how boys act in a certain situation or label actions as a girl thing to do. While these stereotypical clichés are embraced by society, there has not been opportunities to

critiques these stereotypes. When the stereotypes are not critiqued, students work to fit into the stereotype.

The community that CCMS is located is a very competitive place where many people try to "keep up with the Jones's." When a grading policy that was focused on learning was implemented, a group of parents protested because they were afraid that their children would not be able to receive scholarships because all students would be required to perform at high levels and thus receive good grades making scholarships even more competitive. This spirit of competition permeates the community and can stifle collaboration among students.

However, CCMS is committed to educating students to be 21st century citizens that are critical thinkers that care about their community. With the implementation of EL, recommendations from this study could also be implemented using the guiding principles of EL.

PARTICIPANTS

Table 3.1 Overview of Participants

Participant Pseudonym	Race	Group	Future Career Aspiration
Rose	Hispanic	Group A – Interested in STEM	Zoology
Sally	White	Group A	Air Force Pilot
Elizabeth	Asian	Group A	Medical Field
Jane	White	Group B – Somewhat Interested in STEM	Physician Assistant or Music Promoter

Participant Pseudonym	Race	Group	Future Career Aspiration
Ashlyn	White	Group B	Lawyer or Physical Therapist
Mia	African American	Group B	Nurse
Jessica	African American	Group C – Uninterested in STEM	Preschool Teacher
Barbara	White	Group C	Sports Commentator for ESPN
Ariel	Asian	Group C	Physical Therapist

ROLE OF RESEARCHER

I was a privileged insider at CCMS because I am also a teacher at the school. I teach 7th grade science and some of the participants had been in my class the year before the study was conducted. I had established a good relationship with the participants the previous year but I held a lot of power over the participants. Ariel especially wanted to please me with her answers and during the interview she was trying to figure out what I wanted her to say. When I told her that I was just interested in what she had to say, and that even if she did not know the answer, that was acceptable because meaning could be found in any answer that she gave. Once I explained this to her, she seemed to relax and speak more from her experience rather than trying to give me the right answer.

As a teacher, interviewing these young women gave me new insights into their thinking and experiences as a student. The way that they spoke about good

experiences in science class and how they best learn was enlightening. As a teacher, I was changed by what they had to say because I was beginning to understand what it was like to be a student in science class and how they felt they learned science best. Beyond the data that I collected for my dissertation, talking to these young women has allowed me to reflect on my teaching practices and what is best for the students in my class.

DATA GATHERING METHODS AND JUSTIFICATION

The data collection methods that I used in my research study are in-depth interviews. I conducted in-depth interviews that allowed for a deep understanding of the participants experience with STEM (Hesse-Biber, 2007). Using the approach outlined by Hesse-Biber (2007) in *Feminist Research Practice*, I used a semi-structured approach with a specific interview guide. These questions will be important to answer but the order in which they are ask are not as important. By using this approach, I can focus on the participants' responses and ask probing questions or allow the participant to talk about experiences that they feel are important.

INTERVIEW METHODS

I followed a similar structure for each of the participants. We would meet before or after school, depending on the participant's schedule. The interviews before school would take several days because we had a fixed time to meet since school began at 8:00. At the before school interviews, I would bring the participants

breakfast from McDonald's. For the participants who stayed after school to be interviewed, we would plan to do the interview from 3:45 – 5:00. Most of the interviews would be completed during this time. One participant was especially talkative and we met several days to complete her interview. I provided snacks and drinks for the participants after school and we would take breaks during the natural breaks in the interview protocol or whenever the participant asked to take a break. One participant stayed after school to be interviewed even though her mother's work schedule had changed. At the end of the interview, I walked the participant home, as she lived very close to school. I did not want the participant's participation in my study to negatively affect them. The participants were very excited to be asked to be a part of my study and they seemed to enjoy being able to discuss their thoughts about science class and science careers.

INTERVIEW PROTOCOL

Using an occupational card sort as explained by Lent, Brown, and Hackett (2002) participants were asked to sort cards with different careers (for example Pharmacist, Engineer, Computer Programmer, Astronaut, Doctor, Meteorologist, Nurse, Astronomer, Park Ranger, etc.) on them into three stacks – *Might Choose*, *In Question*, and *Would Not Choose*. The careers that participants put in the *Would Not Choose* stack will be analyzed to determine if there is a lack of self-efficacy, lack of outcome expectation, lack of interest or other. (Lent, Brown, and Hackett, 2002). The following interview guide will be used depending on how the participants sorted the Would Not Choose cards.

Introductory Questions:

1. What is your name and grade level?
2. What are your best classes? Why?
3. What classes do you not like? Why?
4. Do you like science class?
    a. What has been the best experience you have had in your science class?
    b. What is the worst or least interesting experience you have had in science class?
5. On a scale of 1-7, how do you rate yourself as being good at science?
6. How do you rate yourself among your classmates?
7. What type of science experiences have you had outside of school?
8. What career do you imagine pursuing? Why is this career your "dream job?"
    a. What skills or experiences do you have that make you feel you would be successful in this career?
    b. What traits do you have that would make you good at this career?
    c. How does this career help you reach goals for yourself?
    d. What is interesting about this career to you?

Card Sort:

Let's sort these career cards into some categories – Might Choose, In Question, Would Not Choose. (After the students have sorted the cards, I asked the students the following questions depending on how they sorted the cards).

Table 3.2 Card Sort Interview Guide

Might Choose	In Question	Would Not Choose
Self-Efficacy: 1. Have you ever seen someone do this career? 2. What skills do you think you need to do this particular career? 3. What experiences would you need to feel that you could do this career? 4. What experiences have you had that make you feel that you would not be suited for this career? 5. Has anyone told you that you would be good at this career? Outcome Experiences: 1. How does this career contribute to society at large? 2. What goals do you have for your career? 3. How does this career work for your goals? Lack of Interest 1. Why are you interested in this career? 2. What type of person do you think would enjoy this career?	Self-Efficacy: 1. Have you ever seen someone do this career? 2. What skills do you think you need to do this particular career? 3. What experiences would you need to feel that you could do this career? 4. What experiences have you had that make you feel that you would not be suited for this career? 5. Has anyone told you that you would be good or bad at this career? Outcome Experiences: 1. How does this career contribute to society at large? 2. What goals do you have for your career? 3. How does this career work against your goals? Lack of Interest 1. Why do you feel you could be interested in this career? 2. What type of person do you think would enjoy this career?	Self-Efficacy: 1. Have you ever seen someone do this career? 2. What skills do you think you need to do this particular career? 3. What experiences would you need to feel that you could do this career? 4. What experiences have you had that make you feel that you would not be suited for this career? 5. Has anyone told you that you would be good or bad at this career? Outcome Experiences: 1. How does this career contribute to society at large? 2. What goals do you have for your career? 3. How does this career work against your goals? Lack of Interest 1. Why are you uninterested in this career? 2. What type of person do you think would enjoy this career?

Wrap-Up Questions

1. What do you think could help students in deciding on careers?
2. What do you think could help students in pursuing careers?
3. Is there anything that you feel needs to be said that you have not had an opportunity to say?

DATA ANALYSIS PROCEDURES

After the interviews, I coded the data to allow the major themes to emerge from the data. The purpose of the present study is to understand young women's perceptions of STEM careers, but also the larger stereotypes they hold about STEM and how these stereotypes impact their perceptions of career selection. I used InVivo codes and dramaturgical codes to code the interviews. The InVivo codes allowed for my respondent's voice to come through and use her words to describe her experience. Saldana (2010) describes dramaturgical codes as viewing life as a performance. These codes allowed me to think about her experience in 6 ways (for this coding exercise I only used 4). I coded for OBJectives, or motives, CONflicts the participants faced, TACtics to dealing with obstacles and their ATTitudes toward the setting, others, and the conflict. By using two coding strategies, I was able to better understand my participant's experiences. The InVivo Codes allowed their story to come forward while the set codes of the dramaturgical codes allowed for viewing their experiences in a different way that will add depth to their stories.

In the present study, a discrepant case may be that a young girl perceives STEM as a welcoming career. I do not think this is a discrepant case because we can

learn from the experiences or supports have allowed her to perceive STEM in a positive light. Because there are women currently pursuing STEM careers, it is possible for women to perceive STEM as a career that they would enjoy pursuing and understanding how these women have arrived at these perceptions would be helpful in supporting other young women in their pursuit of STEM careers.

ETHICAL ISSUES

The participants discussed their educational and personal experiences. Some participant shared experiences that cast their teachers, parents, or other authority figures in a negative light. Providing confidentiality to the participants was essential in building a trusting relationship.. Also providing confidentiality to the educational institutions that the participants are affiliated with will be important. This study is not about pointing out the "bad places" to go to school but how the participants' experiences encouraged or discouraged them in their pursuit of STEM.

CONCLUSION

By using a qualitative, Feminist research design, the present study uncovered the subjugated knowledge that young women have about STEM careers. In-depth interviews allowed for young, southern womens' experiences to be explored and understood. The perceptions that young women have of STEM courses and careers are influenced by their experiences, gendered messages, and knowledge of STEM careers.

CHAPTER FOUR

PATTERNS IN THE DATA

Males like to work with numbers. They like to work on computers and working with technology. For example, the robotics team – it's more males than females, obviously. So I think males are just generally geared for technology and number and working with codes and stuff.

Ariel

INTRODUCTION

The purpose of the present study is to seek to understand how eighth grade young women in a southern middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is to understand young women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future.

This chapter is organized into three sections as I discuss the meaning that I made from the interviews I conducted with nine eighth grade young women. Those sections are Perception of Science Courses, Perceptions of STEM Careers, and

Perceptions of STEM as a Career Option. These meanings are unique to the participants and my hope is that the reader can find connection points to what Idiscovered after talking with these young women. The following themes are included in this chapter: 1. Perceptions of Science Courses; 2. STEM Careers and Gender; and 3. Perceptions of STEM as a Career Option.

In theme one, Perceptions of Science Courses, there are three subthemes: 1. Hands-on activities; 2. Traditional learning experiences; 3. Clicks with Them and 4. Role of the Teacher. In theme two, STEM Careers and Gender there are two subthemes 1. Gender Representation and 2. Gender Stereotypes. In theme three Perceptions of STEM as a Career Option, there are three subthemes; 1. Self-efficacy; 2. Outcome Expectations and 3. Goals.

THEME ONE: PERCEPTIONS OF SCIENCE COURSES

The first theme to emerge was Perceptions of Science Courses. The participants were asked to describe their best experiences and worst experiences in science classes. Four categories represent the theme Perceptions of Science Courses. The first category, Hand-On Activities, is defined as opportunities where the participants had to make connections with the science content by experiencing the phenomenon though their five senses. Examples of these opportunities were described as dissections, field studies, interacting with materials, and labs. The second category, Traditional Learning Experiences, emerged as learning engagements where the participants took notes, completed bookwork, or memorized information.

The third category Clicks With Them describes the ease at which the participants were able to learn content material. If the participants were able to learn the material quickly, they felt successful. Likewise, if they struggled with the content, then they assumed it was not for them. The fourth category is the Role of the Teacher. The participants looked to their teachers for encouragement and support as they were learning. Teachers who were enthusiastic and encouraging piqued the participants' interests in the content. On the other hand, teachers who were dry or uninterested in the students, discouraged the participants from learning the content.

SUB-THEME ONE: HANDS-ON ACTIVITIES

The participants described Hands-on Activities as their best science experiences. Participants described hands-on activities as opportunities to manipulate materials or make observations to understand the broader concept or concepts that was being taught. The participants perceived labs as a way to learn abstract science concepts and expressed that science class was easier when they could see first-hand what they were learning. The participants also believed that during hands-on activities they were able to make connections to the content being learned, thereby remembering the content, and hands-on activities provided a way to participate in authentic learning engagements. The participants also described working in groups during the hands-on learning activities provided a way to discuss and construct meaning through the activity.

Hands-on activities are described as ways that the participants could make connections and remember the content more successfully. Ashlyn described dissecting pig hearts in the fifth grade as her best experience because she actually got to see inside of a heart instead of just looking at it on the board.

> *The best experience was in fifth grade when we dissected pig hearts. It was gross but it was cool too. I liked studying the body. That was one of my favorite units: biology and anatomy. Like instead of just seeing it on a board we actually got to open it up and look at it for ourselves and see things.*

Along with being able to experience for herself, Barbara described labs as being able to help her understand what she is learning about in science class, in particular a rocks and minerals lab she had completed this year.

> *My best experience. . . probably doing like labs because . . . I think it helped me understand more of what they were talking about. Because I'm more of a visual learner. So I could actually see and hold what it looks like and what's it's made up of.*

Along with being able to make connections through the lab, participants explained that hands-on activities helped them remember the information. Jessica described being able to interact with materials as helping her remember the content. "I like the interaction with the materials because I'm a hands-on person. And a visual person. So when I can touch it and look at it, it helps me remember." Being able to experience the content through hands-on activities helped participants make connections to the content and remember it better.

Hands-on activities allowed the participants to experience the science content in authentic ways. Ariel viewed labs as ways to do science in ways that professionals do science. She described a soil lab that she did the previous year.

> *I love doing hands-on experiences. I liked sifting the dirt. That was fun. It was just fun to use my hands for other than writing and using my iPad. It was fun to do actual things that we could probably do in real life."*

Rose talked about going on a field trip as her best experience because it gave her opportunities to experience what they were learning about in ways that she may not normally get to experience. "Well, I guess when we went to the swamp. That was really fun because I got to see animals that I usually don't see. So that was really cool. And I got to touch animals too." Hands-on activities allowed the participants to have authentic, meaningful science experiences.

Hands-on activities allowed the participants to construct meaning through group activities. Elizabeth described how hands-on activities often lend themselves to group activities and how being able to interact with materials and other students helped make connections easier. "I like more hands-on activities where we get to work with a group and give out opinions." By working with other group members, Elizabeth was able to make meaning about science concepts.

SUB-THEME TWO: TRADITIONAL LEARNING EXPERIENCES

The category Traditional Learning Experiences exemplifies the participants' worst experiences in science classes. Traditional Learning Experiences include taking notes, bookwork or memorizing information. The participants described

that the concepts they struggled with were concepts in which the only learning engagements were Traditional Learning Experiences.

When students struggle in a content area, they express their frustration as not liking the content. Barbara described a year that she struggled in science class.

> *One year, I think, we didn't really do like a whole lot of labs so it was more of taking notes and reading from a book. And I feel that doesn't help anyone. Because if you're just reading it and you don't show examples or anything it doesn't help at all. And that was the year I struggled a lot with science. I didn't really like it because of that.*

Elizabeth described a similar experience that she had when she had to learn science through packets. "In sixth grade we had packets of information where we had to read through it and study it and highlight stuff. And that wasn't really interesting as much as if you do projects and hands-on activities." The participants perceive science as uninteresting when the only learning engagements are Traditional Learning Experiences.

When science learning is dependent upon Traditional Learning Experiences, students may have to rely on weak academic skills to learn the content. Sally described having to memorize a lot of information as her worst science experience. "We had to learn about cells and stuff. There were so many parts that you have to remember. Then some things are almost exactly the same but you always get that confused." Without having strategies to memorize similar concepts, students struggle. Reading tends to be a weak area for some students and when students are required to learn concepts through packets of work, it is difficult for some students.

Jessica described learning about astronomy as her worst science experience because she had to do packets and mainly read about the topic.

> *I think learning about astronomy was the worst experience because I couldn't remember it. She just gave us projects. We had to do a booklet on the planets and comets. And that's how I learned or tried to learn. It was a lot of reading and I don't like to read.*

Jane described a learning engagement where Hands-On Activities and Traditional Learning Experiences are varied. She had a better experience in science when there were activities to go along with note-taking instead of just note-taking by itself.

> *This year it's kind of hard to learn stuff. Because of the way we learn it. Last year, we had notes and from the notes we did quizzes and tests and things like that. And we also did activities to go with the notes. But this year the teacher's kind of all about learning it yourself not really learning from notes. So she'll have a discussion with us and we'll have to write notes from it. And I think because it's different it's a little bit harder.*

Students in the study described feeling successful when Traditional Learning Experiences are used with Hands-On Activities.

SUB-THEME THREE: CLICKS WITH THEM

Another sub-theme that emerged when participants were talking about their perceptions of their Science classes is described as Clicks With Them. This category was exemplified by how quickly a participant learned concepts from a class. Participants seemed to suggest that there was an innate ability to do certain content

areas. This idea is epitomized by a fixed mindset belief rather than a growth mindset. A growth mindset is epitomized by the belief that through hard work and dedication a person can improve or learn concepts that may be hard for them at first (Dweck, 2006). If a content area was easy, they assumed they had a natural ability to learn that content area. If a content area was difficult, they assumed they did not possess the natural ability to learn the content area.

Participants, who do well in math class, described their success in math class in terms of how quickly they could learn the material. Mia explained that she is good at math because it clicks for her and she gets good grades. "(Math)'s kind of easy and I get things very clicky and easy. Every time I come home with a report card I have like an A or B in math." Jessica also described her math experience as being able to learn quickly from the teacher. "My best classes are math and science because they come easily to me. In math, if a teacher writes or if a teacher teaches us something I get it like quick." By being able to learn the content quickly, students feel successful in the content class.

Participants also described a natural ability in math class. Ariel stated that her favorite class was math because numbers make sense to her. "My best classes would be math just because I like working with numbers. And they make sense to me. And I can logically figure them out." Ashlyn explained that she was good in math because her innate ability to understand math concept. Science was also easy for her because of the connections that the two content areas have. "Math comes really easy to me. Numbers. And science is closely related to it."

One participant discussed how she did not like math because it was not an easy subject for her. Barbara described her difficulties in math, as math just didn't click for her. Because she did not feel that she had a natural ability in math, math was not her thing. "I do not like math because I just struggle with math. I think that's the only reason why I don't like it. Math just doesn't click with me. I don't know . . . it just isn't my thing." Participants tend to view learning in science and mathematics content areas as something they can learn naturally or something that is not suited for them.

SUB-THEME FOUR: ROLE OF THE TEACHER

The fourth category to emerge in Perceptions of STEM classes was Role of the Teacher. Their teacher influenced the participants' perceptions of science content. If a teacher was helpful and encouraging, participants had a greater interest in the class. If a teacher was discouraging, participants felt that they were not suited for the content being learned.

I asked the participants what would help students when they were choosing or pursuing a career. The participants talked about the role that teachers played in their life. Ariel discussed how teachers played a role inspiring students in positive and negative ways. "Students need to have a good teacher that will inspire them to keep going. Like a teacher… a bad teacher could easily discourage them from ever doing it again. You need to have really good, inspiring teachers." According to the participants, teachers play a role in influencing students' future lives.

Elizabeth also discussed how teachers play a role in selecting careers. Elizabeth believes she is able to do well in classes that she may not have done well in before if she has a good teacher who engages the class. In Elizabeth's opinion, she believes that teachers play a big role when it comes to students choosing careers.

> *I think teacher play a really big role in figuring out people, helping people decide their careers. Because I know in the past, if I've had a good teacher then I'm like, 'Oh, I love this subject' because that's a huge part of it. So I think if you love a subject and you're like, 'Oh, what jobs are in this subject because it seems like a really interesting topic.' So you'd want to go more into that kind of subject. Because I know history, it's just not interesting because of the teacher mainly and the way I'm learning. And just last year I didn't really like science because of the teacher but this year, I'm like, 'Oh. Science isn't that bad.' So it just depends on the teacher and the learning environment you're in to know if you're interested in that.*

Teachers can encourage students to think differently about their talents.

Jane talked about how a teacher had discouraged her when learning about computer programming. Students were peer teaching each other on how to write a program for a class. Jane was struggling with the precision of writing a computer program. She felt like the teacher did not think Jane could do this task. "She was encouraging to other kids but not really so much me. She was more of just 'that kid has no hope.' But she didn't say that." When asked if Jane felt if she had been stereotyped, Jane explained,

She saw how we did it and then kind of made her judgments but also she probably made judgments a little bit before. Like 'these kids are not going to be good at this' you know. Because I guess I'm not very techy. I'm not that kind of person. And people know that. So I guess her judgments were correct though. I mean I don't feel like there was a stereotype. But I feel like she kind of made judgments before I did anything. Those judgments were correct so I don't blame her.

When asked if Jane thought she could learn computer programming, she said that she could but that it would take her time. "I could learn it if my life depended on it. It'd just be tough for me." The teacher in the instance probably did not realize the effect she was having on Jane. However, encouraging students when they are struggling with learning new concepts can help students push through the struggle and feel successful at a task.

SUMMARY OF THEME ONE: PERCEPTIONS OF SCIENCE COURSES

Students felt successful when they had hands-on activities learning engagements and teachers who encouraged them to learn the science content. Participants believed that they were more suited for content the faster they could learn the content. Teachers can help students feel more successful when the teachers stress a growth mindset in learning rather than a fixed mindset. (AAUW, 2012).

THEME TWO: STEM CAREERS AND GENDER

The next theme that emerged from the interviews was STEM Careers and Gender. The categories that characterize the theme are Gender Representation and Gender Stereotypes. Gender Representation is used to describe how the participants discussed a career, if it was predominantly male or predominantly female. Gender Stereotypes is used to describe how the participants characterized the ways in which "normal" men or women would act in a given situation. Gender Stereotypes were represented by statements that could be classified as exhibiting the active male/passive female dichotomy and women are maternal.

SUB-THEME ONE: GENDER REPRESENTATION

During the card sort, I asked the participants to sort the careers in three columns – Men Careers, Women Careers, or Both Men and Women Careers. The main reason that the participants put a career in a column was based on the gender representation in that career.

When explaining why they put certain careers in the Men Careers Column, two participants made up statistics to give support to their reasoning. Mia explained why she put the majority of the STEM careers in the men column, "Because I see a lot of men working in these jobs. No women. Probably a little bit of women but probably four times as many men." Ariel expressed the same reason for why she put certain STEM careers (accountant, statistician, park ranger and computer programmer) in the men column,

I've seen a couple of females (in those careers). Generally, there are more males than females, though. Like males overwhelm the females. Like I'm just going to make it up . . . like the ratio is like 10 to 1.

Ariel and Mia were fairly certain that these careers were male-dominated.

Ariel also stated that because there are more males in a particular field it must mean that males are more compatible in that field than females.

Males like to work with numbers. They like to work on computers and working with technology. For example, the robotics team – it's more males than females, obviously. So I think males are just generally geared for technology and number and working with codes and stuff.

Ariel thinks that males are better suited for technology careers because historically there have been more males in that field.

The participants also pointed to whether a career has been male dominated or female dominated in the past. Sally described why she put nurses in the women column because nurses are historically female. "Usually nurses are women. Like it's what traditionally is . . . I mean, there are male nurses but you don't see like a bunch of them." The effect that certain careers are female or male had a profound impact on one participant. Elizabeth explained that when she imagines people doing certain careers she sees men doing these careers.

Computer programmer, I've never pictured a woman making software. And I've never seen one in my experiences. I've never seen a woman programming computers and fixing computers or anything. Also for engineer, I've never really seen a woman who came up with a plan for anything. When I picture an

engineer, I picture a guy doing it. I don't know how to explain it. In my mind, it's just like, 'Oh engineering. That's a guy's job.'

Even though Elizabeth knows that women can be engineers, because she's only seen men be engineers it is hard for her to imagine that women can be engineers too.

Finally, what the participants see in their daily life effects how they classified the careers. Ashlyn described why she put pharmacists in the women column because of what she sees when she goes to the pharmacy. "Because whenever you go to the counter, it's always a woman. Like you almost never see a man up there." Jessica also sorted the careers based on what she has seen in her daily life. "I put the ones in the men category because I feel like learning about these different things the most gender that I've seen in these, the ones that I've seen are mostly male or men." By seeing mainly men or mainly women in certain careers, has created norms in the participants' minds that influence how they think of careers.

SUB-THEME TWO: GENDER STEREOTYPES

The participants were asked to place the STEM careers in three categories, Men Careers, Women Careers or Both Men and Women Careers. While most of the careers were put in the Both Categories, the discussion about why they put certain careers in the Men Careers or Women Careers brought to the surface the gender stereotypes that had been ingrained in their thinking about what men and women can do in a career. Statements that were coded as active male/passive female dichotomy and women are maternal described the Gender Stereotypes sub-theme.

Category One: Active Male/Passive Female Dichotomy. The active male/passive female dichotomy was a major theme in the discussion as the young women discussed how they viewed the roles of women and men in careers. In our discussions about the careers, the participants talked about how men are risk-takers, get dirty in their jobs, and are dominant over women while women were characterized as being grounded, helpers, and neat. These ideas about the roles of men and women in society shape what career the participants think is acceptable for a man or woman to pursue.

When sorting the careers based on gender, the active male/passive female dichotomy was evident when the participants talked about how willing men and women are to get dirty in their jobs. Women were viewed as wanting to stay clean while men were viewed as being willing to get dirty in their everyday jobs. This idea of dirty and clean was used to explain why they put the park ranger career in the men category. Jane described men as more willing to work outside so they would do better at being a park ranger. "There are some really outdoorsy girls but I feel like most of the people that are outdoorsy are men." Barbara described men as being willing to get dirty in their jobs while describing a park ranger. "Boys are just dirty. I like being outside but I'm not going to get down and dirty and I feel they would be more comfortable fishing and killing animals and that type of thing." Mia also described men as willing to get dirty for their jobs. "Men like nasty. Women like to be clean and sassy." Ariel knew her reason for why women would not want to be part rangers was problematic. "Normally a female, I'm not trying to be sexist, they don't like to deal with outside. They would rather work in a house or just inside,

generally." The participants viewed males as wanted to be outside and get dirty, while women work inside and stay clean.

The dichotomy of male as breadwinner and female as homemaker became evident when Ashlyn described why she put being an astronaut as a male career. Ashlyn described why men were better suited at being an astronaut because of their willingness to take risks and better athleticism. "For astronaut, it daring and more risk taking and men are usually more inclined to taking those risks. Not always but they are usually more athletic also." I asked Ashlyn why she thought men could take more risks than women. She explained that it was because women have to be available to the home and cannot take as many risks as men. It was acceptable for men to take risks because they needed to provide for their families.

> *Because women think through things. And men a lot of times just go for it and don't really think at all about the consequences. Because women, they take care of the household and so they have to run everything so they can think things through. While men usually had to work for the money so they were used to having to do some dangerous jobs.*

Ashlyn is aware that historically women have had to be ready to take care of the home while men could take risks to provide for the family.

Women as Helper was the reason why Elizabeth put certain careers in the Men Category or the Women Category. When Elizabeth was describing why she put nurse in the Women Category, she said, "being a helper is more of a woman's job." When I asked her to tell me what she meant by that she gave this example,

When I think of things that are male, like the Presidency, all the past presidents have been males which is unfair to me but that's just how it is. The women are in the House of Representative or in the Cabinet; they just do jobs that help contribute to that one main role. Whenever I picture it, I just think of woman as like helpers. They can be helpers to other women or men.

Elizabeth connects women to being helpers because of the roles that women have not yet been able to play in society.

Rose also described how society views males when she discussed why boys are sometimes viewed as smarter than girls. "Even though when boys are small they might be really silly but men get more responsibility than women in a way. I guess it could be untrue since women become the Mom and they take care of the babies. But I guess men are treated like a more powerful human being." When asked if she thought men were more powerful, she said, " Not really. I guess women and men are different but that does not men that men are always more strong or intelligent. Even though society treats them as stronger or smarter." Rose has identified that society plays a part in determining what men and women can do.

One participant spoke back to the active male/passive female dichotomy. Jessica acknowledged that men often think they are stronger than women but she dismisses the idea, which a different viewpoint than other participants. "I think that men think that they have to be stronger and dominate over women. I don't think that because women and men are equal." When asked where men get the idea that they dominate women, she answered, "Their ego." Jessica does not accept that men are dominant to women.

Category Two: Women Are Maternal. Another way the genders role theme was described was women were viewed as maternal. Rose connected women as mothers to why women are viewed as more caring than men. "Women are the ones that carry babies, motherhood might have something to do with it. Since they're the ones that see the children grow and they're just different from men." Because women have babies and take care of them, women are more caring and softer than men are viewed.

Jane description of why women don't want to be doctors was different from the other participants. "I put doctor for men because it takes a long time in college and most women are worried about having kids. And they probably want to take care of the kid and doctors have a more difficult time finding time for their kids." In Jane's mind, women have children and take care of them, so to put a lot of time preparing to be a doctor just to stay home with children, seems contradictory to her.

A more extreme view of women are maternal was discussed when two participants described women as emotionally fragile. When discussing how they categorized "Doctor," two participants talked about how women were emotionally fragile and not capable of being in high stress situations. Rose explained why men would be better doctors than women. "Women sometimes can be afraid of blood or they are too open a person and would react by saying, "Oh my gosh. Fainting." It's just women are the fragile human beings. They're the ones that are caring and if they see someone dying they may freak out or start crying." Rose believes that because women are maternal or caring, they cannot handle the harsh realities of life.

Barbara explained why men would make better doctors than women in this way, "I don't want to say that men are better doctors but I feel like they would have better control of situation and they could handle it better. I think women would get too panicked. Some women are just soft and they panic easily if something's like really major. I feel like men are a little bit more stern in that area."

It was difficult for Barbara to explain why she put certain careers in the Men and Women category. But one idea that she kept coming back to is how women are seen as care-takers and men are seen as protectors.

When she discussed why men are doctors and women are nurses, she talked about how women have children and fall into that maternal role naturally. While men are intimidating and stern and have authority, so people take men more seriously. She gave the example of going to a woman doctor who was caring and it was hard for her to take the doctor seriously because she was showing her caring side instead of a more authoritative side.

> *I've always had a male doctor and sometimes had a woman doctor. I feel the male doctors that I've to they're really confident in what they say and I feel like they can handle the situation better. Sometimes I go to a woman doctor and they say, 'Oh. You need this' and they are not very confident in what they're saying because they are being caring.*

Since Barbara views women as caring or maternal, she does not take them seriously in an authoritative role. Later she described why she felt this way,

> *Men over time in general, have dominated over women. I think that they just automatically think, 'Oh. I'm the man so I'm in charge and I tower over*

everyone else.' It's how it's been for a long period of time until women's rights were put into place.

She also explained that some women need to be told what to do by men if they get off-track.

I think some women kind of get off track in like what they're doing. And then other times it's like completely different. I guess it all just depends on who the person is really.

When I asked her if she had every seen an example of this in real life, she said no, but maybe on TV.

Well on TV, definitely. But like my parents, no. Not really. I mean my parents . . . like my mom listens to my Dad and my Dad listens to my Mom. So it's half and half. If you have a true marriage it's like a partnership. One reason why people get divorced is because the guy's always telling you what to do and you don't want them doing that. I see men telling women what to do all the time on TV.

Barbara is receiving mixed messages about the roles of men and women in relationships from her parent's gender equal relationship to the more male dominated relationships that are depicted on television.

SUMMARY OF THEME TWO: STEM CAREERS AND GENDER

While the participants discussed their thoughts about Gender and STEM Careers, they realized that their statements were problematic. Many of the participants believed that anyone could do any career but when they were given an

opportunity to reflect on particular situations, gendered stereotypes emerged in their thinking.

THEME THREE: PERCEPTIONS OF STEM AS A CAREER OPTION

The third theme that emerged from the data was Perceptions of STEM as a Career Option. The categories that describe this theme are self-efficacy, outcome expectations, and goals.

SUB-THEME ONE: SELF-EFFICACY

The sub-theme Self-efficacy was presented when the young women discussed the careers that they put in the "Might Choose," "In Question," or "Would Not Choose" categories. The participant's interests and experiences influenced self-efficacy.

Category One: Interests. Interest in a field and the desire to learn more about that field is an impetus to pursue a career. Rose has been interested in animals since she was a young girl in the Dominican Republic when she would find lizard eggs and catch turtles to be pets. While some animals scare Rose, her interest in animals and wanting to learn more about them help her overcome any fears she may have in her pursuit of wanting to be a zoologist. "I have seen some interesting animals and even though I am scared of some animals I still think they are pretty amazing." Elizabeth described why she put doctor, nurse, or pharmacist in the might choose category this way, "I want to be any of those three because I think it's

really interesting. And I think it'd be fun to explore something like that. The human body is amazing to me because of how everything works and fits together." The interest these two participants have fuel their desire to learn more about topics related to animals and the human body.

Barbara is interested in a career in sports. She would like to be a sports commentator for ESPN. However, her interest in sports and wanting to have a career that deals with sports make other opportunities feasible for her.

> Engineer's such a broad topic. If you're talking about sports engineering then I would have said yes because it's dealing with what I love. But if you're talking about any other type I don't think I would very interested. And if I'm not interested, then I don't think I would be very good at it.

Barbara believes that she can be successful at any career that she has an interest.

Mia's dream job is to work with babies. She would like to be a pediatric nurse. When we discussed why she put certain careers in the Would Not Choose Category, she continually repeated, "Because it doesn't have to do with babies." So if a career did not have an obvious tie-in to working with babies, she did not want to do it.

Participants did not have to be told that they would be successful at a career to have an impetus to pursue a career. As long as there was an interest, participants would at least like to know more about a career. Ariel described that her interest in meteorology would be impetus to pursue meteorology even if she had not been encouraged by others to become a meteorologist. I asked her if anyone had ever

told her if she would be a good meteorologist. She said no but that she liked weather.

> *I like knowing. I like working with weather and figuring out and interpreting signs and knowing what will happen. And I like to know about hurricanes and tornadoes. I think that's interesting to see how it'll affect us across the world.*

An initial interest is often enough to motivate a person be interested in pursuing a career.

A lack of interest or perception that a career was boring, was enough reason to dismiss a career as an option. Sally could explain why computer programmers are important and what contribution to society they give but when asked why she was not interested in becoming a computer programmer she stated, "I'm just not big into computers and it sounds like a boring job." Jessica put pharmacist in Would Not Choose Column even though she thinks that she could do the job because she finds the career boring. "I think that I would be good because I'm a people person but I don't like to be behind a solid place. I think it's a boring job to be behind a sort of desk all day." Even if a career serves a greater purpose to the world or matches personality traits, if the interest is not there, participants did not want to pursue careers they did not hold an interest.

Category Two: Experiences. The second category in the theme STEM as a career option is experiences. Some of the participants had extensive personal experiences in science that informed their career aspirations or they had a single event that made them want to pursue a particular career.

Mia's sister having a baby inspired Mia's career aspiration. Mia was able to be with her sister when her sister had a baby and then Mia had to baby-sit her niece. These experiences changed Mia's mind from wanting to be a cosmetologist to become a pediatric nurse. As she explained,

> *I wanted to be in cosmetology. Well I want to still do that but then I wanted to be a pediatric nurse. Cosmetology will just be on the side if I don't get into pediatric nursing. When my sister was telling me I had to baby-sit my niece, sometimes it was hard and stressful. Then it was getting kind of easy because you have to know how to take care of a baby. So then I started thinking I want to take care of babies and stuff.*

Her experiences with her niece changed Mia's career aspiration from cosmetologist to pediatric nurse.

Ariel and Ashlyn's experiences as athletes have influenced their decision to become physical therapist. Ariel wants to pursue a career in physical therapy when she graduated from college. Her impetus to pursue this career comes from her experiences as an athlete. "I'm an athlete myself. And I think it's unfortunate when people get injured and they can't get back to their career. And being a physical therapist I can help them get back on their feet. And push them through . . . push their limits to become the athlete they use to be and maybe even better." Ashlyn's experience with injuries in sports is what has led her to want to become a physical therapist. "I love doing sports but I can't play them professionally. But I also have been on the injury side, with my plantar fasciitis, so I know what it's like. And I find it really cool. Not for athletes to get hurt but through their recovery process." First-

hand experiences with physical therapists have motivated these participants to want to become physical therapists.

Parents' interest in science and providing opportunities for their children help their children dream big for themselves. Sally's father is very interested in science and Sally and her family take science related vacations every year. They also go to special events that highlight scientists in the community. "My Dad is a big science buff so he takes us all these places." Sally wants to go into the Air Force and fly C-17 Globemaster 3's which are large cargo planes. "I like flying in planes. We went to the Air Force Museum in Dayton, Ohio and it was just so cool. And we also visited the Air Force Academy. We did an actual college visit. And just them talking got me really interested into it." By having experiences that break down the unknown, Sally has been able to see for herself that going to the Air Force Academy is a possibility because she has seen for herself what it is like to go to the Air Force Academy.

In Ashlyn's family, they watch education science television shows together and discuss them as a family. They also debate science trivia together. Ashlyn discussed how she discusses science with her family. "My brother likes to ask, especially my Dad because he got his degree in some sort of science, trivia questions that he finds. Then we'll get into a discussion about why it's like that or why we disagree with whatever the answer is." Ashlyn's mother also told me that she had an ulterior motive for allowing Ashlyn to be in my study, she told me that she wants Ashlyn to pursue a career in STEM. Sally's and Ashlyn's parents have provided opportunities for their children to have experiences in STEM.

Elizabeth hasn't decided on a career she would like to pursue but through experiences she has had she wants to continue learning about biology and chemistry. "I went to two science camps at the Governor's School. It was for chemistry and pre-med. And I really enjoyed pre-med because it had a bunch of dissections and studies and research. And I also enjoyed chemistry because we had a bunch of experiments every single day. And just like learning with other people that are interested in the same thing. It just makes me want to learn even more and just work with them." These experiences at summer camp have fueled Elizabeth's love of learning and exposed her to new areas of interest.

Rose's experiences as a young child with animals around her home in the Dominican Republic have influenced her into wanting to be a zoologist when she gets older. "I used to live in the Dominican Republic so every summer I went to this countryside and we have a house there because my Grandmother lives in it. Every time we went to the river we would find new animals like frogs. There are beaches there since it's an island so I get to see animals that I usually don't get to see. It's really cool." By having these experiences as a young child, Rose has been able to foster her love of animals and learning up through her adolescence.

SUB-THEME TWO: OUTCOME EXPECTATIONS

The sub-theme in the STEM as Career Option theme is outcome expectation. Outcome expectations are defined as what a person hopes to get out of a career (Lent, Brown, and Hacket, 2002). The expectations that the participants wanted to

get from their career are that they would be able to help others and to have an exciting career.

Category One: Helping People. The participants expressed an interest in helping people live healthier lives. Ashlyn wants to help people stay healthy with her career as a physical therapist, which can sometimes mean tough love.

> As a physical therapist you are encouraging people and showing people different way to stay healthy and continue doing their sport. You may need to put your foot down and say, "No. You can't do that." You need to be strong and not be a pushover.

Mia described her main interest for becoming a pediatric nurse is to help others. "I just want to help other people get better." Ariel talked about helping others have a miracle through physical therapy. "Someone is paralyzed and they can't walk. But through physical therapy a year later they can walk as normal as any other person. And I think it's amazing how they've through that much and they've pushed themselves because of physical therapy. And they can walk now. And it's a miracle." The participants expressed a desire in making other people's lives better by helping them.

The participants also expressed a desire to give back to their communities. Rose talked about being able to return to her native Dominican Republic to help the people there if she became a doctor. "I could go to my and country and help them and I could teach them what I've learned before. I would help my family too if they ever needed medical help or I can help them financially. I would help because I

would probably feel very happy that I could make someone smile or have them be happy again." Sally talked about being able to serve her country in the career that she wants to purse, going into the Air Force, "First it's serving your country." Being able to give back is a desire the participants want to accomplish.

The participants' personalities express a caring trait. Helping others makes them happy. Elizabeth talked about being able to work in groups and focusing on helping others. "I like doing stuff where you have a group of people and a teach where you're with and everyone just like the same thing and you're just helping other people." Jessica wants to be a teacher so that she can help others. "In teaching, you help others. And I like helping others." An outcome expectation for careers that the participants described was to help others.

Category Two: Exciting Career. While helping others was important to the participants, the other outcome expectation the participants described was to have an exciting career that they could be passionate about. Ashlyn discussed how she wants a career that she will love. "I want to have a good job, a job that I'm going to enjoy and love. I don't want to come to work every morning and hate my job. I want to love my job." Jane talked about how she wants her job to be different every day and to be able to travel so she can develop an open mind about people in different circumstances than her.

I think my main goals' just to see the world. And I guess become more open minded through seeing the world. I think that's important that you don't want

to judge a group of people before you get to know more than one person from that group.

Sally made a promise to herself that she would have an exciting job. "One goal I've promised to keep is that I'm not going to have a boring job. I do not want to sit at a desk all day and drone away. I want to be out there and travel and do stuff exciting." Having a career that was stimulating and purposeful was another outcome expectation for the participants.

SUB-THEME THREE: GOALS

The third sub-theme in the STEM as Career theme was goals. The goals that the participants have for themselves will dictate what type of career they will pursue. The participants' goals can be grouped as wanting a comfortable lifestyle and a having a family.

Category One: Comfortable Lifestyle. The participants overwhelming wanted to have a career that would afford them a comfortable lifestyle. Barbara discussed how she wants to have a good job that has a decent wage. "I want to live in a nice house or apartment. I want to get a good job at first, that's maybe not or is involved with sports that pays decent so I could start off pretty good." Being rich was not important to Jessica but she wants to have a comfortable amount of money. "I want . . . not like a lot of money but a comfortable amount of money." Mia also described wanting a good life. She described her mom and grandma's lives as being good because they had their own homes. Mia wants her own house where she can

live by herself. Ashlyn described a comfortable lifestyle as being able to provide for herself. "I want to be able to provide for myself." Having a career that would allow them to be able to live comfortably was important to the participants.

Category Two: Having a Family. Participants also discussed having a family as a goal for themselves. Barbara said she would like to have a family but at least be married. "I would want a family or at least be married. I plan on having a family." Rose also discussed the importance of family to her long-term goals. "I would like to help out my family and maybe make my own family I guess." Ariel wants to a house and a family so she can be surrounded by love. "I want an actual house and having a family so I could it was . . . love and stuff." When I asked her what she meant by family, she replied, "Kids and a husband." When Mia is looking at her long-term goals, she would like to have a family. "I want to get married and have a family." Having a family is important to the participants as they set goals for their lives.

SUMMARY OF THEME THREE: PERCEPTIONS OF STEM CAREERS AS AN OPTION

Lent, Brown, and Hacket (2002) posit that career aspirations are based on self-efficacy, outcome expectations, and goals. The participants self-efficacy was improved when the participants had interest in the content and experiences that reinforced their interests. Participants outcome expectations of helping others and having an exciting career could easily be met in STEM careers. By providing students with a broader view of STEM careers so they can better understand how

their outcome expectations can be met through STEM careers, more students may be willing to pursue STEM careers.

CONCLUSION

STEM courses and careers are a major emphasis in education today. Increasing the numbers of Americans who pursue STEM careers is a government priority, as these careers will strengthen the economy (AAUW 2010). The present study seeks to understand young women's perceptions about STEM courses and careers. These young women are highly motivated, talented students who have big dreams for themselves. Their perceptions of STEM courses and careers are influenced by their experiences, gendered messages, and knowledge of STEM careers.

The young women's experiences have influenced their interests in their future career choice. Participants spoke of wanting to pursue a career in which they had previous experience. Whether this experience was being an athlete, helping with family, or vacation experiences, the participants were more likely to want to pursue a career when they had positive previous experiences. Some of the participants wanted to pursue careers in which they had a wealth of experience, such as years of participating in sports or taking music lessons. Other participants showed interest in pursuing a career based on a single positive experience, such as a sister's baby being born or a positive experience with a school club. Positive experiences created interest in particular careers.

While these young women had positive science experiences, most participants lacked positive experiences in physics and engineering. This lack of experiences caused misconceptions about careers in engineering, computer programming, etc. The young women relied on stereotypes about people who pursue engineering careers and they did not identify with those stereotypes. The young women wanted to pursue a career that would help society. Since they did not have an accurate understanding of engineering careers, they did not think that they could make the world a better place as an engineer. However, engineering does make the world a safer, better place in many ways. Because the participants lacked experiences, they did not fully understand all of the STEM careers.

Finally, gendered stereotypes about how women and men's interests caused the participants to think that a certain career was not for them. The participants had ingrained ideas about what types of careers are for men and what types of careers are for women. They may not have been able to give an example of how they had seen the stereotype played out in their lives but they were still influenced by the gendered stereotypes present in society. A theme among the participants was that women do not like to get dirty and therefore would not want to pursue a career outdoors like park ranger. Also a man wanted to be a nurse was described as weird and creepy. The stereotypical roles of woman being caregiver and man being an adventurer played out in their explanations about what career was best suited for women or men.

Girls and young women have proven that they are capable of competing in higher level math and science careers (AAUW, 2010). However, because of a lack of

experience, misconceptions about STEM careers and the implicit gendered messages about women and men in society, these young women did not perceive that all STEM careers were for them. This study has shown that to engage more young women in positive perceptions of STEM courses and careers, educators need to provide positive experiences in STEM and provide young women with the skills to push back against gendered stereotypes.

Table 4.1 Results of the Career Card Sort

Participant	Career Aspiration	Might Choose	In Question	Would Not Choose
Ashlyn	Physical therapist or lawyer	Nurse, Doctor, Materials Manager	Pharmacist, Meteorologist, Accountant, Statistician	Engineer, Geologist, Computer Programmer, Park Ranger
Jane	Physician Assistant or Music Promoter	Doctor Pharmacist	Nurse, Astronaut, Accountant, Engineer, Materials Manager	Geologist, Meteorologist, Park Ranger, Computer Programmer, Statistician
Mia	Pediatric Nurse	Doctor, Nurse,	Pharmacist, Accountant	Meteorologist, Astronaut, Geologist, Materials Manager, Park Ranger, Statistician, Computer Programmer, Engineer
Ariel	Physical therapist	Doctor, Nurse, Meteorologist, Astronaut, Materials Manager	Engineer, Computer Programmer, Park Ranger, Geologist	Pharmacist, Statistician, Accountant
Sally	Air Force Pilot	Park Ranger, Geologist, Astronaut, Meteorologist	Engineer	Statistician, Accountant, Materials Manger, Computer Programmer, Doctor, Nurse, Pharmacist
Elizabeth	Pursue a career in the medical field	Pharmacist, Doctor, Nurse, Meteorologist	Park Ranger, Accountant, Geologist, Materials Manager	Engineer, Astronaut, Statistician, Computer Programmer
Rose	Zoologist	Nurse Park Ranger	Doctor, Engineer, Astronaut, Geologist	Meteorologist, Pharmacist, Computer Programmer, Accountant, Statistician, Materials Manger
Barbara	Sports Commentator for ESPN	Meteorologist, Geologist	Engineer, Nurse, Computer Programmer, Astronaut, Pharmacist	Accountant, Statistician, Doctor, Park Ranger, Materials Manager
Jessica	Pre-K Teacher and run a hair salon on the side	Doctor Nurse Engineer Computer Programmer	Accountant, Statistician, Meteorologist, Materials Manager	Astronaut, Pharmacist, Park Ranger, Geologist

Table 4.2 Results of the Gender Card Sort

Participant	Career Aspiration	Men Career	Women Career	Both
Ashlyn	Physical therapist or lawyer	Nurse, Doctor, Materials Manager	Pharmacist, Meteorologist, Accountant, Statistician	Engineer, Geologist, Computer Programmer, Park Ranger
Jane	Physician Assistant or Music Promoter	Park Ranger Doctor Computer Programmer Engineers Pharmacist	Nurse	Meteorologist Geologist Astronaut Materials Manager Statistician
Mia	Pediatric Nurse	Meteorologist, Astronaut, Geologist, Materials Manager, Park Ranger, Statistician, Computer Programmer, Engineer	Pharmacist, Accountant	Doctor Nurse
Ariel	Physical therapist	Accountant Statistician Park Ranger Computer Programmer	Pharmacist	Doctor Nurse Materials Manager Engineer Geologist Astronaut Meteorologist
Sally	Air Force Pilot	Engineer Accountant Material's Manager Computer Programmer	Nurse	Doctor Meteorologist Pharmacist Geologist Statistician Astronaut Park Ranger
Elizabeth	Pursue a career in the medical field	Engineer Computer Programmer	Nurse	Doctor Materials Manager Geologist Astronaut Park Ranger Statistician Pharmacist Meteorologist Accountant
Rose	Zoologist	Doctor Engineer Computer Programmer	Pharmacist	Meteorologist Nurse Statistician Geologist Materials Manager Park Ranger Astronaut Accountant
Barbara	Sports Commentator for ESPN	Doctor Park Ranger Computer Programmer	Nurse	Engineer Pharmacist Meteorologist Statistician Geologist Materials Manager Park Ranger Astronaut Accountant
Jessica	Pre-K Teacher and run a hair salon on the side	Geologist Meteorologist Engineer Comp. Programmer Park Ranger	Pharmacist Nurse	Astronaut Materials Manager Statistician Accountant Doctor

CHAPTER FIVE

UNDERSTANDINGS AND IMPLICATIONS

Gender shouldn't matter when you're picking a career. Anybody is eligible to do it as long as they put their mind to it and really accomplish something. ~Elizabeth

INTRODUCTION

In *How Schools Shortchange Girls* (1992), the AAUW revealed that most girls in United States secondary public schooling were not taking higher-level science and mathematics classes such as physics and chemistry. In the twenty years since that study was published, the numbers of girls taking and succeeding in higher-level mathematics and science classes has increased (AAUW, 2010). However, in *Why So Few?* (2010) the AAUW reports that girls who take higher-level mathematics and science classes in high school and college do not necessarily pursue mathematics and science careers.

The AAUW reports that while girls and young women are taking higher level mathematics and science courses with increased frequency in secondary and post-secondary schooling, upon graduation they are not breaking into STEM careers with the same frequency. Some of the reasons for this include:

1. STEM careers are stereotypically viewed as male careers;
2. There is still a strong socially constructed belief that males are better suited for STEM careers;
3. The progress of females in mathematics and science classes (as judged by standardized test scores) has not disrupted the stereotype that STEM is for males (AAUW, 2010).

These reasons lead to the overarching question: After two decades of educators and policy makers encouraging girls and young women to pursue STEM careers, why has there not been a greater influx of female into these careers that tend to pay higher than average salaries?

According to feminist researchers (Harding, 1986; Haraway, 1988; Fausto-Sterling, 2000; Butler, 2004), implicit messages influence girls and the gendered meanings constructed through science research reinforce gendered norms and these implicit messages deter females from pursuing careers in STEM. This present study of nine eighth grade young women describes their perceptions of science courses and STEM careers and how gender affects their perceptions. The young women are successful science students and have the abilities to pursue STEM careers however gendered stereotypes influenced their perceptions. By studying their perceptions, teachers can better understand how to address gendered stereotypes when trying to encourage young women to pursue STEM careers.

FOCUS OF THE STUDY

The purpose of this study is to understand how eighth grade young women in a middle school perceive their accessibility to Science, Technology, Engineering, and Mathematics (STEM) careers. The purpose of the present study is to understand young, southern women's "perceptions and unconscious beliefs about gender in science and mathematics" (AAUW, 2010, 9) and how these "perceptions and unconscious beliefs about gender" in STEM fields impact the careers these young women may choose in the future. In this study, I have interpreted the interviews that I conducted with nine willing participants to better understand their perceptions of science courses and STEM careers. To support my interpretations, I will use quotes from the interviews to provide insight into these young women's perceptions.

American educators strive to provide the best education to their students. This effort includes creating strategies to support underperforming groups. By critically analyzing how these young women perceive their science courses, themselves as learners, and their options for pursuing STEM careers, fellow educators can better understand how to provide support to this group of learners. This study is not intended to be an essentialized view of all young women's experiences in science courses or their perceptions of STEM careers. Rather, these meanings are unique to the participants and my hope is that the reader can find connection points to what I discovered after talking with these young women.

OVERVIEW

In the preceding chapter of this dissertation, I analyzed the interviews that I conducted with nine participants about their perceptions of science courses and STEM careers. The final chapter is divided into three sections, Summary of Major Points, Recommendations, and Future Research.

SUMMARY OF MAJOR POINTS

The section, Summary of Major Points, includes the major interpretations from my research study.

POINT ONE: LEARNING STRATEGIES IN THE SCIENCE CLASSROOM

The best experience was in fifth grade when we dissected pig hearts. It was gross but it was cool too. Instead of just seeing it on a board we actually got to open it up and look at it for ourselves and see things. ~ Ashlyn

In science classes, students are expected to learn abstract concepts and show mastery of these concepts. A constructivist approach can provide students opportunities to learn these abstract concepts successfully. Constructivism "refers to the idea that learners construct knowledge for themselves – each learner individually (and socially) constructs meaning – as he or she learns" (Hein, 1991, 1). There are many different types of constructivist approaches in the science classroom. Hein argues that a constructivist pedagogy will include opportunities for learners to "a) interact with sensory data, and b) construct their own world" (Hein, 1991, 2). Participants in the study described their best learning experiences when

they were given opportunities to interact with objects and work in groups to create understanding.

> One principle of constructivism is that learning is an active process. Learning is an active process in which the learner uses sensory input and constructs meaning out of it. The more traditional formulation of this idea involves the terminology of the active learner stressing that the learner needs to do something; that learning is not the passive acceptance of knowledge, which exists 'out there' but that learning involves the learners engaging with the world. (Hein, 1991, 3)

Participants described these opportunities to "engage with the world" as hands-on activities in science class. Ariel described labs as doing science in authentic ways when she described a soil lab that she did the previous year.

> *I love doing hands-on experiences. I liked sifting the dirt. That was fun. It was just fun to use my hands for other than writing and using my iPad. It was fun to do actual things that we could probably do in real life.*

Another way that participants "engaged with the world" was having opportunities to go on field studies. Rose talked about going on a field study as her best experience because it gave her opportunities to experience what they were learning about in a new way. "Well, I guess when we went to the swamp. That was really fun because I got to see animals that I usually don't see. So that was really cool. And I got to touch animals too." When participants were provided opportunities to construct meaning through "engaging with the world," they identified these opportunities as their best learning experiences.

When participants were expected to learn science through traditional learning experiences of reading and answering questions, participants found the learning difficult and uninteresting. Barbara described a year that she struggled in science class.

> *One year, I think, we didn't really do like a whole lot of labs so it was more of taking notes and reading from a book. And I feel that doesn't help anyone. Because if you're just reading it and you don't show examples or anything it doesn't help at all. And that was the year I struggled a lot with science. I didn't really like it because of that.*

Elizabeth described a similar experience that she had when she had to learn science through packets. "In sixth grade we had packets of information where we had to read through it and study it and highlight stuff. And that wasn't really interesting as much as if you do projects and hands-on activities." The participants perceived science as uninteresting when science was taught through bookwork and packets.

Another principle of constructivism is that learning is a social experience. Hein describes,

> Learning is a social activity: our learning is intimately associated with out connection with other human beings . . . Much of traditional education, as Dewey pointed out, is directed toward isolating the learner from all social interaction, and towards seeing education as one-on-one relationship between the learner and the objective material to be learned. In contrast, progressive education recognizes the social aspect of learning and uses

> conversation, interacting with other, and the application of knowledge as an integral aspect of learning. (Hein, 1991, 3)

The participants described group activities as one way to construct meaning in science class. Elizabeth described how hands-on activities often lend themselves to group activities and how being able to interact with materials and other students helped make connections easier. "I like more hands-on activities where we get to work with a group and give out opinions." By working with other group members, Elizabeth was able to make meaning about science concepts.

In traditional learning experiences, the students have to rely on the teacher to provide the knowledge, which can be difficult for students. Jane described her experience in her current science class,

> *This year it's kind of hard to learn stuff. Because of the way we learn it. Last year, we had notes and from the notes we did quizzes and tests and things like that. And we also did activities to go with the notes. But this year the teacher's kind of all about learning it yourself not really learning from notes. So she'll have a discussion with us and we'll have to write notes from it. And I think because it's different it's a little bit harder.*

Participants described difficulty in having to rely on herself or the teacher to gain meaning in the science classroom but when the participants were allowed to work in group activities, they were able to construct meaning more successfully about science concepts.

POINT TWO: ROLE OF THE TEACHER

Students need to have a good teacher that will inspire them to keep going. ~ Ariel

When the Association of American University Women released the report *How Schools Shortchange Girls* in 1992, they found that girls were not being given the same opportunities to pursue math and science courses as boys. The report found teacher support is critical in closing the gender gap in STEM careers. "Studies report that girls rate teacher support as an important factor in decisions to pursue scientific and technological careers." (AAUW, 1992, 4). Teachers can influence students through their attitude about science, their capacity to teach science and their role in perpetuating or disrupting stereotypes (Christidou 2011).

Christidou (2011) discusses the role of teachers in her research of student's attitudes of science. Christidou (2011) has found that the attitude that teachers have about science will influence their students' attitudes about science. Teachers who lack confidence in their abilities to teach science will rely on teacher-centered, lecture-based science lessons, which can negatively impact students' interest in science (Christidou 2011). Teachers who understand the nature of science and are more confident in their ability to teach science are able to prepare and present lessons that allow students to make connections between science content and how science is practiced in the work place (2011). When teacher provide ways for their students to experience science processes, students often have a more positive view of science and will be more interested in science (2011).

Christidou (2011) also describes the role that teachers can play in perpetuating gendered stereotypes in science. If teachers believe the male-

dominated stereotype of science, then girls will receive less attention from teachers. Girls will have less power in the science classroom and will be turned off to science (2011). Often textbooks reproduce gendered messages about who is best suited for science by picturing males in science roles. If teachers do not disrupt these gendered messages, then the girls in science classes are discouraged from pursuing science classes or careers (2011). Teachers will influence students in a negative or positive way, with respect to science interest.

The participants also recognized the role that teachers play in helping students feel successful in a class or decide on a career. Elizabeth also discussed how teachers play a role in selecting careers. Elizabeth is able to do well in classes that she may not have done well in before if she has a good teacher who engages the class. In Elizabeth's opinion, she believes that teachers play a big role when it comes to students choosing careers.

> *I think teacher play a really big role in figuring out people, helping people decide their careers. Because I know in the past, if I've had a good teacher then I'm like, 'Oh, I love this subject' because that's a huge part of it. So I think if you love a subject and you're like, 'Oh, what jobs are in this subject because it seems like a really interesting topic.' So you'd want to go more into that kind of subject. Because I know history, it's just not interesting because of the teacher mainly and the way I'm learning. And just last year I didn't really like science because of the teacher but this year, I'm like, 'Oh. Science isn't that bad.' So it just depends on the teacher and the learning environment you're in to know if you're interested in that.*

By providing students with different experiences and opportunities, teachers can encourage students to think differently about their talents and open the students up to exploring new possibilities.

POINT THREE: GENDERED NORMS

I don't want to say that men are better doctors but I feel like they would have better control of the situation and could handle it better. ~ Barbara

The participants were asked to place the STEM careers in three categories, Men Careers, Women Careers, or Both Men and Women Careers. While most of the careers were put in the Both Categories, the discussion about why they put certain careers in the Men Careers or Women Careers brought to the surface the gender stereotypes that had been ingrained in their thinking about what men and women can do in a career. Two broad categories emerged in their discussions – Women as Maternal and the Active Male/Passive Female dichotomy.

The idea that certain careers are for boys and other careers are for girls is an example of a gendered norm. In Francois Ewald's (1990) article, *Norms, Discipline and the Law,* he defined a norm as a set of rules that are valued and reproduced by society. The way in which families are structured is an example of a socially constructed norm. Two heterosexual parents and their biological children stereotypically create families. In these "normal" families (Western, white, middle-class families), boys tend to have active and visible roles like outside chores while girls' roles tend to be passive and hidden like cooking and cleaning.

Gender is socially constructed through norms that regulate the ways that people perform masculinity and femininity. According to Butler (2004) who theorized that gendered performances are repeated acts that appear to be natural since these performative acts are unconscious to the person performing them. While norms can be very powerful, Ewald and Butler both advocated that norms are not static and can be challenged by individuals. Butler (2004) describes the power of individuals to challenge norms. Norms are temporary construction by groups of individuals. The groups that subscribe to the norm have the power to challenge its meaning. Ewald (1990) describes normalization not as a reflex where there is no control but as a carefully managed path where the end result is forecast. If normalization is under the power of the group, then the group can challenge the norm.

The participants' explanations of why certain careers are male or female were influenced by gendered norms present in society. The participants' main reason for categorizing Park Ranger as a male career is because men want to get dirty, while women would rather stay clean. Men are viewed as active while women prefer to do jobs that are passive in nature. The active male/passive female dichotomy is a gendered norm that has deep philosophical roots. Aristotle described the female as having a lack of qualities:

> The female is a female by having a virtue of a certain lack of qualities . . . We should regard the female nature as afflicted with natural defectiveness. (as quoted in de Beauvoir, 2008, 88)

It is from these long-held philosophies that women are viewed in a lesser role to men. Simone deBeauvoir (2008) in her introduction to *The Second Sex*, deconstructed the man/woman dichotomy. de Beauvoir argued that the masculine is the essential universalist subject and the feminine is only understood in relation to the masculine. She writes:

> She is defined and differentiated with reference to man and not he with reference to her; she is the incidental, the inessential as opposed to the essential. He is the Subject, he is the Absolute – she is the Other. (89)

By being defined in relation to man, woman is not viewed as autonomous. "Thus humanity is male and man defines woman not in herself but as relative to him; she is not regarded as an autonomous being (88). According to de Beauvoir, women are not considered autonomous because society relies on women's relationship to men to construct the woman identity.

Two participants described women in this lesser role when describing why they put careers in certain gender categories. When Ashlyn described why she put being an astronaut as a male career, she based her explanation on the idea that men are the breadwinners (active) while women are the homemakers (passive). Ashlyn described why men were better suited at being an astronaut because of their willingness to take risks and better athleticism. "For astronaut, it daring and more risk taking and men are usually more inclined to taking those risks. Not always but they are usually more athletic also." I asked Ashlyn why she thought men could take more risks than women. She explained that it was because women have to be

available to the home and cannot take as many risks as men. It was acceptable for men to take risks because they needed to provide for their families.

> *Because women think through things. And men a lot of times just go for it and don't really think at all about the consequences. Because women, they take care of the household and so they have to run everything so they can think things through. While men usually had to work for the money so they were used to having to do some dangerous jobs.*

Ashlyn is aware that historically women have had to be ready to take care of the home while men could take risks to provide for the family.

When Elizabeth discussed why she put nurse in the Women Category, she said, "being a helper is more of a woman's job." When I asked her to tell me what she meant by that she gave this example,

> *When I think of things that are male, like the Presidency, all the past presidents have been males which is unfair to me but that's just how it is. The women are in the House of Representative or in the Cabinet; they just do jobs that help contribute to that one main role. Whenever I picture it, I just think of woman as like helpers. They can be helpers to other women or men.*

Elizabeth connects women to being helpers because of the roles that women have not yet been able to play in society.

Barbara's explanation of why men make better doctors than women positions women as being incapable of taking the active role, as women are emotionally fragile and cannot handle the stress of difficult situations. Barbara explained why men would make better doctors than women in this way, "I don't

want to say that men are better doctors but I feel like they would have better control of situation and they could handle it better. I think women would get too panicked. Some women are just soft and they panic easily if something's like really major. I feel like men are a little bit more stern in that area."

It was difficult for Barbara to explain why she put certain careers in the Men and Women category. But one idea that she kept coming back to is how women are seen as care-takers and men are seen as protectors.

When she discussed why men are doctors and women are nurses, she talked about how women have children and fall into that maternal role naturally. While men are intimidating and stern and have authority, so people take men more seriously. She gave the example of going to a woman doctor who was caring and it was hard for her to take the doctor seriously because she was showing her caring side instead of a more authoritative side.

> *I've always had a male doctor and sometimes had a woman doctor. I feel the male doctors that I've to they're really confident in what they say and I feel like they can handle the situation better. Sometimes I go to a woman doctor and they say, 'Oh. You need this.' And they are not very confident in what they're saying because they are being caring.*

Since Barbara views women as caring or maternal, she does not take them seriously in an authoritative role. Later she described why she felt this way,

> *Men over time in general, have dominated over women. I think that they just automatically think, "Oh. I'm the man so I'm in charge and I tower over*

everyone else. It's how it's been for a long period of time until women's rights were put into place.

She also explained that some women need to be told what to do by men if they get off-track.

I think some women kind of get off track in like what they're doing. And then other times it's like completely different. I guess it all just depends on who the person is really.

When I asked her if she had every seen an example of this in real life, she said no, but maybe on TV.

Well on TV, definitely. But like my parents, no. Not really. I mean my parents, like my mom listens to my Dad and my Dad listens to my Mom. So it's half and half. If you have a true marriage it's like a partnership. One reason why people get divorced is because the guy's always telling you what to do and you don't want them doing that. I see men telling women what to do all the time on TV.

Barbara is receiving mixed messages about the roles of men and women in relationships from her parent's gender equal relationship to the more male dominated relationships that are depicted on television.

POINT FOUR: EXPERIENCES INFLUENCE INTERESTS

We visited the Air Force Academy. We did an actual college visit. And just them talking got me really interested into it. ~ Sally

Social Cognitive Career Theory (SCCT) as proposed by Lent, Brown, and Hackett (2002) examines how self-efficacy, outcome expectations and personal

goals interact with each other and also race, class, and gender of individuals (2002). SCCT "emphasizes the means by which individuals exercise agency in their own career development, as well as those influences that promote or constrain agency" (2002, 302). By understanding the interactions of self-efficacy, outcome expectations, and person goals along with the personal agencies of individuals, career interventions can be employed to help individuals make career decisions (2002).

Lent, Brown, and Hackett (2002) propose three models for organizing career-related interest, choice and performance – interest development model, choice model, and performance model. These models allow for examination of how self-efficacy, outcome expectations, and personal goals interact and the interactions of race, class, gender, environments, and learning experiences influence career choice (2002). The interest development model "holds that self-efficacy and outcome expectations regarding activity involvement exert an import direct effect on the formation of career interests" (265). Girls will form an interest in STEM if they view themselves as having the skills to produce positive outcomes. This model also takes into account how gender and race affect career choice. Lent, Brown, and Hackett write:

> SCCT regards gender and race from a social constructivist position in which these attributes are interwoven features of the person's socially constructed world, not simply inherited biological properties of the person. We believe their relevance to career development stems largely from the reactions they

evoke from the social-cultural environment and from their relation to the structure of opportunity within which career behavior transpires. (268)

The interest development model allows researchers to understand how young girls view their career choices.

Interest was the primary factor in the participants' career choice. Participants' experiences influenced their interests. Rose's experiences as a young child with animals around her home in the Dominican Republic have influenced her into wanting to be a zoologist when she gets older.

> *I used to live in the Dominican Republic so every summer I went to this countryside and we have a house there because my Grandmother lives in it. Every time we went to the river we would find new animals like frogs. There are beaches there since it's an island so I get to see animals that I usually don't get to see. It's really cool.*

While some animals scare Rose, her experiences with observing and interacting with animals has developed a strong interest in animals and wanting to learn more about them. Her interest in animals has helped her overcome any fears she may have in her pursuit of wanting to be a zoologist. "I have seen some interesting animals and even though I am scared of some animals I still think they are pretty amazing." Rose's interest in animals has grown out of her positive experiences with animals.

A single experience is enough to open a person's mind to pursuing new directions. Mia was able to be with her sister when her sister had a baby and then

Mia had to baby-sit her niece. These experiences changed Mia's mind from wanting to be a cosmetologist to become a pediatric nurse. As she explained,

> *I wanted to be in cosmetology. Well I want to still do that but then I wanted to be a pediatric nurse. Cosmetology will just be on the side if I don't get into pediatric nursing. When my sister was telling me I had to baby-sit my niece, sometimes it was hard and stressful. Then it was getting kind of easy because you have to know how to take care of a baby. So then I started thinking I want to take care of babies and stuff.*

Her experiences with her niece changed Mia's career aspiration from cosmetologist to pediatric nurse. Because of her newfound interest in working with babies, when we discussed why she put certain careers in the Would Not Choose Category, she continually repeated, "Because it doesn't have to do with babies." A life changing experience can create a strong interest that a person will want to single-mindedly pursue it.

Personal experiences also provided participants the ability to see multiple facets of an interest. Several of the participants were interested in sports and wanted to pursue a career that involved sports. Being injured or seeing other athletes injured created an interest in helping athletes recover from injuries. Ariel and Ashlyn's experiences as athletes have influenced their decision to become physical therapist. Ariel wants to pursue a career in physical therapy when she graduated from college. Her impetus to pursue this career comes from her experiences as an athlete.

I'm an athlete myself. And I think it's unfortunate when people get injured and they can't get back to their career. And being a physical therapist I can help them get back on their feet. And push them through . . . push their limits to become the athlete they use to be and maybe even better.

Ashlyn's experience with injuries in sports is what has led her to want to become a physical therapist.

I love doing sports but I can't play them professionally. But I also have been on the injury side, with my plantar fasciitis, so I know what it's like. And I find it really cool. Not for athletes to get hurt but through their recovery process.

First-hand experiences with physical therapists have motivated these participants to want to become physical therapists.

POINT FIVE: OUTCOME EXPECTATIONS

In teaching, you help others. And I like helping others. ~ Jessica

The choice model of Social Cognitive Career Theory (SCCT) "holds that interests are typically related to the choices people make and to the actions they take to implement their choices " (Lent, Brown, and Hackett, 2002, 276). The choice model also "highlights the intermediate role of personal agency" (via goals) (273). The choice models posits that young women will choose STEM careers if young women are interested in STEM and young women view STEM as a way to accomplish their goals. One outcome expectation that the participants expressed was helping others.

The participants expressed an interest in helping people live healthier lives. Ashlyn wants to help people stay healthy with her career as a physical therapist, which can sometimes mean tough love.

> *As a physical therapist you are encouraging people and showing people different way to stay healthy and continue doing their sport. You may need to put your foot down and say, 'No. You can't do that.' You need to be strong and not be a pushover.*

Mia described her main interest for becoming a pediatric nurse is to help others. "I just want to help other people get better." Ariel talked about helping others have a miracle through physical therapy. "Someone is paralyzed and they can't walk. But through physical therapy a year later they can walk as normal as any other person. And I think it's amazing how they've through that much and they've pushed themselves because of physical therapy. And they can walk now. And it's a miracle." The participants expressed a desire in making other people's lives better by helping them.

The participants also expressed a desire to give back to their communities. Rose talked about being able to return to her native Dominican Republic to help the people there if she became a doctor. "I could got to my and country and help them and I could teach them what I've learned before. I would help my family too if they ever needed medical help or I can help them financially. I would help because I would probably feel very happy that I could make someone smile or have them be happy again." Sally talked about being able to serve her country in the career that

she wants to purse, going into the Air Force, "First it's serving your country." Being able to give back is a desire the participants want to accomplish.

POINT SIX: GROWTH MINDSET

Math just doesn't click with me. I don't know . . . it just isn't my thing. ~ Barbara

Teaching young women to have a growth mindset about their intelligence is one way to increase a young woman's self-efficacy. Dweck (2006) posited that when middle-school girls believe that their intelligence is a gift, when these girls face struggles in learning they give up and begin to underperform when compared to boys.

> Viewing intellectual ability as a gift (a fixed entity) led students to question that ability and lose motivation when they encountered setbacks. In contrast, viewing intellectual ability as a quality that could be developed led them to seek active and effective remedies in the face of difficulty. (Dweck, 2006, 49)

Girls who have a growth mindset about their intellectual ability do better than girls who view their intellectual ability as a gift (Dweck, 2006).

Dweck (2006) equates thinking about intellectual ability with coping with stereotypes. She claims that if a girl believes that her intelligence is a gift she will be more susceptible to stereotypes. "After all, stereotypes are stories about gifts – about who has them and who doesn't" (Dweck, 2006, 50). Dweck (2006) studied a group of women who were taking a Calculus course in college and she found that the women who viewed their intellectual ability as fixed were more susceptible to the

stereotypes about women in math than those women who viewed their intellectual ability as growth mindset - something that could be developed. Both groups of women were aware of the stereotype and behavior stemming from the stereotype but had different reactions to the negativity. Dweck reports that the women with the growth mindset about learning had little impact to the stereotype.

> In contrast, feeling surrounded by a negative stereotype had a strong impact on women who thought of the math ability as a gift. Over the course of the semester, their sense of belonging eroded and remained low. They no longer felt accepted and comfortable in their math environment, and as a result, we found, many did not intend to pursue math in the future. (Dweck, 2006, 50)

By viewing intellectual ability as a gift, students do not develop the coping mechanisms necessary to push through challenges. While students who view intellectual ability as something that can be developed create coping mechanism that allow them to rise above difficult situations to meet their potential.

Participants described a natural ability in math class. Ariel stated that her favorite class was math because numbers make sense to her. "My best classes would be math just because I like working with numbers. And they make sense to me. And I can logically figure them out." Ashlyn explained that she was good in math because her innate ability to understand math concept. Science was also easy for her because of the connections that the two content areas have. "Math comes really easy to me. Numbers. And science is closely related to it."

One participant discussed how she did not like math because it was not an easy subject for her. Barbara described her difficulties in math, as math just didn't

click for her. Because she did not feel that she had a natural ability in math, math was not her thing. "I do not like math because I just struggle with math. I think that's the only reason why I don't like it. Math just doesn't click with me. I don't know . . . it just isn't my thing." Participants tend to view learning in science and mathematics content areas as something they can learn naturally or something that is not suited for them. The participants exhibited what Dweck described as a fixed mindset when discussing their learning in math and science.

SUMMARY OF MAJOR POINTS

Societal beliefs and learning environments influence young women's perceptions about science courses and STEM careers (AAUW, 2010). The six major points summarize the major interpretations from the study of how eighth grade young women perceive science courses and STEM careers. These interpretations were the impetus of the following recommendations and their discussion.

RECOMMENDATIONS

In this study, the participants' interests, misconceptions of STEM, and gendered stereotypes influenced the participants' perceptions of STEM careers. To engage young women in pursuing STEM courses and careers, educators need to provide students opportunities with meaningful work. Dweck posits meaningful work as promoting academic achievement and nurturing a growth mindset (2010). I will take this idea a step further. I believe that meaningful work in the science classroom can provide students opportunities to master science content, promote a

growth mindset, challenge gendered stereotypes, and broaden students' horizons about STEM careers. Meaningful work are tasks that are authentic in nature, provide opportunities for students to construct knowledge, and provide reflection of the learning process. My recommendations for teachers to engage young women in opportunities that show STEM careers as possibilities for them are 1. Provide meaningful work, 2. Promote a growth mindset, 3. Challenge gendered stereotypes, and 4. Broaden young women's horizons.

RECOMMENDATION ONE: PROVIDE MEANINGFUL WORK

Meaningful work not only promotes learning in the immediate situation, but also promotes a love of learning and resilience in the face of obstacles. . . .Students who are nurtured in such classrooms will have the values and tools that breed lifelong success. (Dweck, 2010, 20)

Incorporating constructivist-learning opportunities into the science classroom is key to providing students the necessary skills to learn and retain abstract science concepts. Barbara described labs helping her understand what she is learning about in science class because she is able to experience the content for herself. In particular she described a rocks and minerals lab she had completed this year.

> *My best experience. . . probably doing labs because . . . it helped me understand more of what they were talking about. Because I'm more of a visual learner. So I could actually see and hold what it looks like and what's it's made up of.*

Along with being able to make connections through the lab, participants explained that hands-on activities helped them remember the information. Jessica described being able to interact with materials as helping her remember the content. "I like the interaction with the materials because I'm a hands-on person. And a visual person. So when I can touch it and look at it, it helps me remember." Being able to experience the content through hands-on activities helped participants make connections to the content and remember it better.

Using constructivist theory to create learning opportunities to provide meaningful work to students, means giving students opportunities to interact with materials and construct their own meanings (Hein, 1991). Instead of the teacher imparting knowledge to the student through lectures, teachers provide students opportunities to grapple and make meaning out of learning situations. Constructivism has key principles that guide the philosophy and will be present in constructivist learning opportunities.

Constructivist learning opportunities will be an active process where students are doing something to make meaning (Hein, 1991). Students will be classifying rocks based on observations or categorizing plants based on their structures. While the students are manipulating these objects they are "learning to learn as they learn" (Hein, 1991, 3). If the learning outcome is for students to classify, then they should be classifying objects. Along with the hands-on activities, reflection is necessary for students to be able to make meaning (Hein, 1991). The content that students are learning should use the language that is related to that content. "The language we use influences learning" (Hein, 1991, 3). Therefore

scaffolding from basic descriptions to complex scientific language should be created to help students learn and use scientific language.

Learning does not occur in isolation but is a social process that is enhanced when learners can interact with one another (Hein,1991). Meaningful group work can be created that allows students to talk with their peers to create meaning and apply their learning to new situations. Traditional learning experiences where students complete bookwork are not as effective. Constructivism acknowledges that students learn from their positionality. Students bring to the learning environment a host of experiences and beliefs. Therefore, learning will be influenced by what we live. Background knowledge is imperative to successful learning (Hein, 1991). Students must be given an opportunity to activate previous learning about a topic or address misconceptions about a topic before learning new information.

Learning takes time and students need time to grapple, reflect, ponder, and question while they are learning content (Hein, 1991). Finally for learning to take place, students must be motivated to learn. If students are provided opportunities to learn through meaningful work tasks, they will understand the purpose of their learning and be more willing to put forth the effort to do the work necessary to learn (Hein, 1991). There are many different types of strategies that fit under the constructivism umbrella, such as inquiry learning, student centered learning, problem based learning, authentic learning, etc. Meaningful work can be produced out of any of these strategies. Moving toward these types of learning strategies will move away from teacher imparting knowledge in a "sit and get" environment to an

environment where students are constructing their own meaning through tasks that are authentic and will provide students the experiences necessary to gain interest in STEM careers.

RECOMMENDATION TWO: PROMOTE A GROWTH MINDSET

What we can say is that many females have all the ability they need to for successful careers in math-related and scientific fields and the idea of the gift that girls don't have is likely to be a key part of what's keeping them from pursuing those careers. (Dweck, 2010, 55 – 56).

In *Why So Few*, the AAUW recommends teaching students "that intellectual skills can be acquired" (AAUW, 2010, 35). This recommendation is based on the work of Dweck and her mindset theories. In the article, *Even Geniuses Work Hard*, Dweck (2010) describes the different between a fixed mindset and a growth mindset. "Individuals with a fixed mindset believe that their intelligence is simply an inborn trait. In contrast, individuals with a growth mindset believe that they can develop their intelligence over time" (16). Promoting a growth mindset in class provides students with the skills necessary to cope with challenging learning situations.

Students who demonstrate a fixed mindset are less likely to persevere through difficult learning situations than students who demonstrate a growth mindset.

Students who believe that intelligence is a fixed quantity are particularly vulnerable to decreased performance when they realize they are at risk of

failing, whereas students who view intelligence as acquirable appear better able to remain effective learners. (Mangels et al, 2006, 75)

In order to combat the more prevalent view of fixed mindset, Dweck (2010) discusses how to cultivate a growth mindset in students by having teachers create a growth mindset culture in their classroom, emphasize challenges, and highlight the journey of learning rather than the outcomes.

In creating a classroom environment that cultivates a growth mindset, Dweck (2010) posits that teachers can do this by teaching students how the brain grows and develops, goal setting, and having students support other students in their learning journey. Dweck (2010) also describes the importance of deep learning and that when students learn fast they may not be learning at the deep levels that will be necessary in future studies. "Teachers should also emphasize that fast learning is not always the deepest and best learning and that students who take longer sometimes understand things at a deeper level" (77). The participants in my study valued students who could learn content quickly and when they struggled or took longer to learn they felt incompatible with the content area. These beliefs align with the fixed mindset and when they received pushback in learning, be it from the length of time it took to master a concept to a teacher having a funny reaction to them, they believed that they could not learn the concept. Cultivating a growth mindset in the classroom will help teacher convey the message to students that they can learn difficult concepts and they can overcome challenges.

Dweck (2010) recommends that teachers place the emphasis on the challenge rather than the outcome. Teachers need to plan meaningful assignments

that have multiple entry points. In this way, students of all abilities can have a meaningful task to do with varying degrees of support from the teacher or their peers. Dweck (2010) also suggests that students who are struggling can explain which strategies they have tried and why they may not have worked. In this way, students can explain their reasoning and figure out what next step they should try. This tends to be more meaningful to students because they can look back and reflect on what has worked and what has not worked in their learning.

To highlight students' progress through their learning journey, Dweck (2010) recommends that teachers allow students to reflect on where their learning was at the beginning of a unit and how they progressed and mastered the material. Tracking progress can be done through pre and post-tests with time to reflect on learning growth after the post-test (Dweck, 2010). Meaningful learning tasks that provide students tasks that build on one another also provide students ways to reflect on their learning progress. These types of tasks also allow teachers the ability to praise students for their efforts. Dweck (2010) and the AAUW (2010) both recommend praising students for their efforts not necessarily for being smart. By pointing out students' hard work, the teacher reinforces growth mindset and the idea that intelligence and success comes from hard work not raw talent alone.

RECOMMENDATION THREE: CHALLENGE GENDERED STEREOTYPES

Why are so few women in science, technology, engineering, and mathematics? The answer lies in part in our perceptions and unconscious beliefs about gender in mathematics and science. (AAUW, 2010, 90).

The stereotypical gendered meanings that the participants used in their interviews to describe why men were better suited for certain jobs and women were better suited for other jobs was surprising to me. The presence of women at the top of their careers is growing but these young women used the same tropes that would have been used 50 years ago. I noticed that some of the participants knew that their reasoning was problematic but they did not know how to explain what they were thinking. When Elizabeth was explaining why she pictured engineering as a men's career it was difficult for her to explain. "When I picture engineer, I picture a guy doing it. I don't know how to explain it. In my mind, it's just like, 'Oh engineering. That's a guy's job.' I don't know." Later when asked if there was anything else she would like to add she stated,

> *I think gender shouldn't matter when you're picking a career. Because I think anybody is eligible to do it as long as they really put their mind to it and they really want to accomplish something then they just set it as their goal.*

Elizabeth believes that any job can be done by anyone but when she has to tease out what that means gendered stereotypes emerge. I believe that if given the opportunity to critique the gendered stereotypes, she would be more likely to see through their façade of truth.

One way to provide Elizabeth the opportunity to critique gendered stereotypes is to provide students opportunities to challenge these dominant discourses. Jennifer Gore (1992) writes about how teachers in their classrooms can use "empowerment" in liberating oppressed peoples. Teachers are often encouraged to "share power" with their students in an attempt to empower students. Power is seen as zero-sum; one must give up power so another can gain power. Gore suggests that instead of sharing power, teachers should allow students to exercise power in "sites of practice." (Gore, 1992, 68). This exercise will provide students with the skills necessary to "practice power" when they are in situations that are oppressive.

Teachers and students can practice power through agency. Norms can be challenged through agency. Agency begins by a person understanding that they are oppressed. After the realization of oppression, a person may decide to do nothing or they may begin to move toward activism. Mollie Blackburn (2004) argues that agency can be asserted through language. Language can allow marginalized people to develop a sense of self in an environment that does not accept them. By creating an understanding of self and coping mechanisms, marginalized people can begin to challenge and disrupt dominant discourses.

Science teachers can provide their students opportunities to challenge gendered stereotypes by incorporating feminist strategies in their classroom. This can be accomplished by moving away from Traditional Learning Experiences to centering learning around the student and providing the student ways to construct meaning. Maher and Tetreault (2001) describe characteristics of a feminist

classroom in their book, *The Feminist Classroom.* Mastery, voice, authority, and positionality are the four characteristics of a feminist classroom (2001). Mastery is the content that is taught in the classroom. In traditional classrooms, students master standards that are determined by the teacher or "master of the knowledge." Students train under these masters so that they can master the knowledge presented. In a feminist classroom, the content learned is a collaboration of students' questions or experiences and the teacher's goals for the class. The teacher uses questioning to guide students to view the content in a new way. By challenging the students to interpret readings with varying perspectives, the students can then transfer this practice of viewing literature from multiple perspectives to viewing the world around them through different perspectives.

Voice in a feminist classroom is the connection of the students' learning to their experiences. Voice represents the students' place in dominant culture and how the students negotiate their place in society when race, class and gender intersect. Maher and Tetreault describe students forming their voice instead of finding their voice. "As students brought their own questions and perspectives to the material, they used relevant personal experiences to shape a narrative of an emerging self" (Maher and Tetreault, 2001, 19). The use of journals allowed students to grapple with their learning and provide opportunities of sharing their thoughts in class. Feminist classrooms value student experiences and show how the process of learning allows for student growth (Maher and Tetreault 2001). Whereas in traditional classrooms, students often assume a voice that is taught to them by the

teacher rather than forming a voice by connecting to the learning and growing as learners.

Maher and Tetreault (2001) describe authority in a feminist classroom as being concerned with creating opportunities for students to take control of their learning. Moving from a traditional classroom's authority of "sit and get," authority in a feminist classroom allows for students to make decisions about their learning by positioning themselves as authorities of knowledge in different disciplines. For this transfer of power to take place, the teacher must establish relationships with students. Through these relationships, the voices of marginalized students will be recognized and challenge the patriarchal view of authority that is present in classrooms. When authority is shared between teacher and students, the students can then look to other students as sources of knowledge. By working together as groups to define their place in social structures or learn from the experiences of marginalized students, all students can begin to understand how position affects the learning process.

Maher and Tetreault (2001) explain postionality as the process "in which people are defined not in terms of fixed identities, but by their location within shifting networks of relationships which can be analyzed and changed." (Maher and Tetreault, 2001, p. 164). Maher and Tetreault (2001) credit the positionality of the students and teachers having the greatest influence on student learning. Since knowledge is constructed in group dynamics, positionality calls for students to share their beliefs with others, listening to others' beliefs, and deconstruct those beliefs to find how the two positions relate to one another. Positionality allows for

marginalized students an opportunity to share their viewpoints and also allows for students who identify with the dominant social structures an opportunity to deconstruct those structures and view ideas from new perspectives.

The feminist classroom has an important place in education because these classrooms are organized to allow for students to challenge the dominant social construction. If in classrooms students are taught what to think, then the students begin to think, "How do I fit into this definition?" instead of "How do I define myself?" The characteristics of the feminist classroom allow for self-definition, which is the key to empowerment. Patricia Hill Collins discusses the importance of self-definition in her book *Black Feminist Thought.* "Self-definition is key to individual and group-empowerment, ceding the power of self-definition to other groups, no matter how well-meaning or supportive of Black women they may be, in essence replicates existing power hierarchies." (Collins, 2000, 40). By sharing mastery and authority with students, providing opportunities for students to form their voices and identify their positionality, then students can resist the definitions placed upon them by society.

RECOMMENDATION FOUR: BROADEN YOUNG WOMEN'S HORIZONS

Thus it is clear that the messages we send in educational settings really matter, and that through our messages we can help females perform up to their potential. (Dweck, 2010, 54)

During my interviews with the participants, misconceptions about STEM careers emerged and participants who lacked personal experiences with STEM were

less likely to be interested in pursuing STEM careers. I recommend that students be given opportunities to explore STEM careers to understand what skills are necessary for the career and how the career may meet their own outcome expectations.

When discussing the career meteorology, participants described the career as a weather reporter. Ashlyn described meteorologist this way, "You would have to be outgoing. You have to talk for a long period of time. You have to be knowledgeable but you also have to know how to talk to the people who aren't." Likewise, pharmacists were viewed as sales people who pass out medicine. Ariel described pharmacists as dull people. "Dull people with no purpose in life want to be a pharmacist. They'd rather stand there and give out medicine." The participants only understand the part of the job that they have seen and have assumed that is the whole of the career.

There was also a misconception about how STEM careers could help people live better lives. Ashlyn described why she did not want to become an engineer as she wouldn't be able to work with people who need help.

> *I know two people who are engineers they sit in an office all day. It's not like they're helping people. They're helping people indirectly but you're not working with people who need help. That's why it doesn't interest me.*

The AAUW (2010) finds that young women are less likely to pursue STEM careers because they do not understand the social contribution that these careers are making. STEM careers such as biomedical engineering or environmental engineering have a larger draw for women because these careers have a clear social

impact. (AAUW, 2010). Engineering is a career that does help people and by better understanding what engineers do, students can get a better idea of how engineering helps make the world a better place.

The AAUW (2010) recommends in their report *Why So Few?* that young women be given the opportunity to understand how they fit into STEM careers by examining the achievements of women in math and science. Teachers can help eliminate the stereotype that boys are better suited for STEM by exposing students to female role models, examining the numbers of women in STEM and analyzing test data that shows that young women and men are performing similarly on high stakes math tests (AAUW, 2010). By pushing back against the stereotype that boys are better suited for STEM through critique of the stereotype, young women will be less likely to believe the stereotype.

In Dweck's work about growth mindset, she posits that providing students with meaningful work will allow students to better understand how they can grow in intelligence. Meaningful work will also allow teachers to give their students opportunities to critique the gendered stereotypes. In science, when learning about simple machines, students could be assigned the task of using simple machines to create a model house. This assignment requires multiple skills including planning (architecture), budgeting (accountant) and building (engineering). Experts in the fields of architecture, accounting, and engineering could visit the classroom and show the students how to do these tasks. If the experts of are various race, class, and gender, then the students will be able to broaden their view of who does these careers. Elizabeth, who stated that she envisions engineers as males, could be given

the opportunity to see that women are also engineers, if women engineers are invited to participate as an expert. The stereotype that STEM is for white, middle-class males could be disrupted if people of different races, classes, and gender are invited to the classroom to share their expertise with the students.

By having a diverse group of experts work with students, misconceptions about the tasks associated with STEM careers and the ways that STEM careers help society could be addressed. Students would leave with a better understanding of STEM careers and may find the careers more interesting and worth pursuing in the future.

SUMMARY OF RECOMMENDATIONS

The recommendations are my ideas of how to engage young women in science courses providing them the positive experiences necessary to spark an interest in STEM careers. For young women to be successful in pursuing STEM careers they will need strategies to cope with the negative stereotypes that they will be subjected (Dweck 2006, 2010; AAUW 2010). By providing a classroom that celebrates growth and provides ways to construct meaning, young women can learn the strategies necessary to be successful in pursuing STEM careers.

FUTURE RESEARCH

The third section of this chapter includes suggestions for future research in young women's access to STEM. Dweck's theories about growth mindset and meaningful work provide a basis for future research.

RESEARCH SUGGESTION ONE: THE EFFECT OF GROWTH MINDSET ON THE PERCEPTION OF STEM

In the present study, the participants exhibited a fixed mindset about their intellectual abilities. Data collected from participants who exhibit a growth mindset would allow researchers to understand how beliefs about intelluectual ability influence perceptions about STEM. Future research could collect data on young women's perceptions of STEM careers from participants who have a growth mindset and from participants who have a fixed mindset. This data would be helpful in understanding if a growth mindset is a strategy that can pushback against negative stereotypes.

RESEARCH SUGGESTION TWO: THE EFFECT OF MEANINGFUL WORK ON THE PERCEPTION OF STEM

Future studies that help to understand which types of learning environments encourage students to pursue STEM careers would be helpful in encouraging young women to pursue STEM careers. Data collection about could include how learning strategies influence perceptions of STEM and how the philosophy of the teacher influences participant perception of STEM. Understanding this data could provide educators and curriculum writers information about how to create a learning environment that positively influences young women in their pursuit of STEM courses.

RESEARCH SUGGESTION THREE: HOW YOUNG MEN PERCEIVE WOMEN'S ACCESS TO STEM CAREERS

By replicating the present study with young men as participants, a better understanding of how young men view women's access to STEM courses and careers. By understanding young men's perceptions, educators would be able to identify if gendered stereotypes affect young men's perceptions of young women and women in STEM.

CONCLUSION

At the beginning of the study, I wanted to understand the perceptions that young women have about science courses and STEM careers. Career interests develop over a lifetime and tend to solidify during late adolescence and early adulthood (Lent, Brown, and Hackett, 2002). Government educational initiatives, like "Educate to Innovate," are mandating educators provide students opportunities in STEM in hopes of students pursuing STEM careers (Educate to Innovate, n.d.). However, the AAUW reported that one reason that women do not pursue STEM careers is because of the "perceptions and unconscious beliefs about gender in mathematics and science" (AAUW, 2010, 90).

In my interpretations of the interviews, I found that the participants are influenced by gendered stereotypes that are present in society and their learning environments. I also found that these participants do not have solid strategies for pushing back against these stereotypes. For young women to be prepared to pursue STEM careers, they need to develop strategies they can use to critique the gendered

messages they receive from society. One way these strategies can be learned is through teachers providing learning opportunities that allow them to practice pushing back against negative stereotypes.

In order to encourage young women to pursue STEM careers, teachers need to provide meaningful work that allows students to construct knowledge, nurture a growth mindset about academic progress, provide opportunities to disrupt gendered discourses surrounding young women and STEM, and broaden young women's horizons about STEM careers. Meaningful work is the basis of transforming a classroom from status quo to providing students with opportunities to envision new scenarios. Meaningful work allows students multiple entry points to a task so that all students can be successful in content areas. Meaningful work is created from a desire to get students involved in the learning process by working with materials, working with others, challenging their beliefs about a subject, and being reflective about the learning process.

Meaningful work also allows students to examine how they learn and how intelligence grows over time as they push through challenges in their learning. Nurturing a growth mindset about intelligence in students provides students with strategies to cope with difficult situations rather than avoid hard learning experiences. Growth mindset also allows students to pushback against negative stereotypes they may encounter while pursuing a career.

Students also need to be taught how to challenge gendered stereotypes. Classrooms that provide students meaningful work are looking for a variety of answers rather than just one right answer. Students are being taught to critique

what they are learning. They can then critique the gendered messages that they are subject to rather than accepting them as fact. When students are learning about asexual reproduction, they will have the tools to critique the gendered messages that are being sent with the term "daughter cells." Students will have an opportunity to examine how language influences gender roles in society by critiquing the use of daughter cells as a way to describe clones.

Finally meaningful work will provide students an opportunity to broaden their horizons. Students are given opportunities to delve deeper into subject matter and learn more about content than surface material. Experts can be brought in to show students that people of all races, classes, and genders can compete in STEM careers. By providing students opportunities to see stereotypes disrupted, students can begin to see their place in STEM.

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