Abstract

TULLOS, KIMBERLY C. Educators Who Work in Science: The Narratives of Women Negotiating Careers in Academic Science. (Under the direction of Julia Storberg-Walker).

The purpose of this life story narrative study was to explore how women scientists develop views of self that enable them to negotiate careers within academic science. I framed the study using feminist standpoint theory as my theoretical foundation, and used possible selves theory as my conceptual framework. Eight women scientists working in academe described their journey regarding their views of self and career-related experiences. The study produced two key findings. First, seven themes emerged from my data analysis; these themes suggest that these women shared significant experiences in their quest to become scientists. Second, my feminist analysis of the participants' narratives indicates that distinct, but submerged gender-related tensions shaped their views of themselves as scientists and their science career decisions. These tensions include career choice and advancement constrained by family obligations, work environments that do not recognize or undervalue their skills and contributions to the profession, and perceived pressure to de-feminize their behavior to blend in to their work environment. Not unlike other women negotiating careers in academic science, they generally accepted their status as women to be an inherent part of their career pursuits and viewed workplace challenges as an opportunity to prove their competency. Seven of the eight women did not attribute their challenges to gender differences. However, the combined narratives revealed underlying conflicts between their views of self as women and as scientists resulting from their experiences in, and perceptions of, academic science environments.

The study's principal theoretical contribution, from the feminist standpoint perspective, highlights the pervasive and unseen influence of gender dynamics. In this study, the participants developed views of themselves, not as scientists, but as "educators who work in science." This critical distinction enabled these participants, perhaps unknowingly, to accommodate conflicting gender /role demands and establish meaningful, but arguably 'less than' status within the academic scientific community. Future studies could examine the accommodation/legitimization process to increase our understanding of how women may negotiate gender perceptions and roles within a science career. Additionally, research and educational practice that actively disrupt constraining gender beliefs may be an integral piece of helping women expand their vision regarding what it is possible for them to achieve in their academic science careers.

Educators Who Work in Science: The Narratives of Women Negotiating Careers in Academic Science

by
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Dedication

I am more fortunate than words can express to have the unconditional support of a remarkable family and wonderful friends.

To my mother, Elaine – Thank you for teaching me about strength and commitment, and for raising me to believe in my own capabilities.

To my father, George – Thank you for teaching me the power of imagination and creativity, and to value learning in all its forms.

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To my sisters of the heart, Christine and Nikkole – Thank you for teaching me how much can be accomplished by women who use their intelligence, talents, and compassion for the benefit of others.

Biography

Kimberly C. Tullos has a life-long interest in helping others identify and apply their skills and talents for effective use in the workplace. In her current role as an educator and Housing administrator at UNC Charlotte, she has had the opportunity to design and implement a variety of educational interventions to support the workplace learning of undergraduate, graduate, and professional staff members. Kimberly has served as an executive board member of the North Carolina Housing Officers (NCHO), and has served on both host and program committees for the Southeastern Association of Housing Officers (SEAHO) and the Association of College and University Housing Officers – International (ACUHO-I). She has a B.S. in Management from the University of South Alabama and a M.Ed in Student Personnel in Higher Education from the University of Georgia.

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Chapter One: Problem Statement

This study sought to identify the significant experiences that shape women's beliefs regarding the possibility of pursuing and succeeding in academic science careers. Specifically, the purpose of the study was to explore how women create views of themselves as scientists enabling them to negotiate careers within the academy. By highlighting the meaningful experiences and views of self that have shaped and guided their professional careers, I believe women scientists currently working in higher education can provide insights to women who aspire to follow them into academic science careers. This chapter will provide background and context for the issue under study, clarify the specific research problem being addressed, and outline the guiding research questions. Additionally, this chapter will present the theoretical frameworks positioning the study and how the selected frameworks align with my assumptions as a researcher.

Overview of the Problem

Although many studies have focused on gender and its affect on adolescent women's participation in math and science courses, there seems to be a gap in exploring the experiences and beliefs of adult women in regard to their pursuit of, or failure to pursue, academic science careers. Much of the research on women in science, technology, engineering and math fields is concerned with K–12 students while only a small percentage of the research focuses on undergraduate or graduate women (Sonnert, 1996; Buck et al., 2006). However, in his review of this literature, Blickenstaff (2005) identified several factors

related to the experiences of girls or young women that have been shown to negatively influence their pursuit of science careers. These factors include: 1) girls' poor academic preparation for science, 2) girls' negative attitude toward science, 3) girls' lack of same-gender role models, 4) girls' beliefs about the relevance of science curricula, 5) women students' experiences of chilly climates in the science classroom, and 6) women students' experiences negotiating science pedagogy that favors men. While these factors are viewed as important barriers, the study population (e.g., girls and young women) and the intention of the research (to change the classroom environment) is limited. As noted by Blickenstaff and others, the goal of this research literature appears to be to identify the reasons why women are underrepresented in science fields and then to create educational environments which will encourage and support adolescent women's interest in science and math disciplines (Frome et al., 2006; Miller, Blessing & Schwartz, 2006; Weisgram & Bigler, 2006). This focus on adolescent women is critical to increasing the overall number of women who participate in math and science, but I suggest that a focus on *adult* women working in science may also provide information essential to increasing women's participation and satisfaction in pursuing science careers in the academy.

Enhancing our understanding of the experiences of women who choose science disciplines and persist in them while others leave is an important, often overlooked, approach to increasing women's representation in science (Kinzie, 2007). A focus on adult women who are persisting in academic science careers expands our ability to understand how women move from student to professional, and create their scientific identity. With regard to

occupational pursuits, women and men may develop their science careers in disparate ways that require different approaches to understand their career interests and choices. For example, scholars suggest that women struggle to view science careers as possible within their work lives.

Particularly in the arena of math, science, and technology careers, Zeldin, Britner and Pajares (2007) noted that women tend to have lower self-efficacy beliefs for nontraditional careers than for traditional careers. Despite little existing empirical evidence supporting gender differences in math and science ability, the persistent belief that men are better at the tasks associated with math and science affects women's perceptions about their own ability to achieve in an academic science career (Correll, 2001). Further, Chalk, Meara, Day, and Davis (2005) suggested that while both men and women tend to select occupations based on whether the job is traditional for their gender, women's career goals and achievements seem to be lower than their ability level demonstrates.

Perhaps women's perceptions of their role in society serve to reinforce their beliefs that math and science interests are for men. Gottfredson (1981) asserted that gender is the aspect of self-concept that is most sensitive to the perceived traditional or nontraditional nature of a potential occupation. She described career development as a process of matching self (including gender) to an occupation, considering and weighing options, and then searching for an appropriate position within the chosen field. Seymour (2006) found evidence that women often operate with assumptions that discourage their pursuit of math and science careers. Using gender as a filter, women may not see themselves in scientist roles

and may disregard entire segments of science career options without deeper exploration or further academic study. Ultimately, beliefs about their own competence in math and science domains along with a desire to perform traditional gender roles discourage women from actively pursuing academic science careers.

Despite gendered views of traditional and nontraditional careers, some women manage to create and maintain views of self compatible with careers within math, science and technology occupations. A central goal of this study was to explore women's science career narratives by inviting women to discuss the significant experiences and beliefs they define as meaningful to their self-concepts and career pursuits. Exploring these views of self was integral to understanding why some women demonstrate the persistence necessary to resolve personal, social, and academic challenges in their pursuit of academic science careers. Based on existing literature regarding women and science careers, I collected stories related to gender identity, significant interpersonal relationships, and math or science-related self-efficacy. Additionally, I gathered stories that described each participant's unique science career journey.

Statement of Purpose and Research Questions

The purpose of the study was to explore women's descriptions of how they create a scientist identity or "possible self" and use this self view to negotiate, on an ongoing basis, careers within the academic science, technology, engineering, or mathematics disciplines. Intentionally highlighting their meaningful experiences and views of self revealed some of the unique qualities shaping women scientists' career paths in academia.

Women who work in academic science continue to negotiate an environment that is populated predominately by men (Fox, 2001; Ginther & Kahn, 2006; Xu, 2008). Further, they pursue careers that are largely considered nontraditional for their gender (Gottfredson, 1981; Correll, 2001). This study focused on how women scientists describe their experiences negotiating work environments in academia despite well-documented barriers to their success. The following questions guide my inquiry: 1) how do women scientists develop views of self? and 2) how do women scientists negotiate their careers? The answers to these questions revealed the ways some women are able to visualize and believe in their own success as academic scientists. Further, the answers to these questions contribute to our understanding of the distinctive elements shaping women's careers within the academy.

Background and Historical Context

Women and Science

Before World War II, women scientists in the United States were frequently unemployed, underemployed and dependent on male principal investigators, or teaching at poorly-equipped women's colleges (Fox, 1999). The civil rights movement in the 1960s and early 1970s persuasively presented the inequity of gender discrimination and inspired legal measures, such as Title IX of the Education Amendments of 1972. Further, the civil rights movement paved the way for increases in the number of women pursuing science professions (Sonnert, 1999). These early efforts broadened access opportunities, but did not address all of the important issues constraining women's advancement in science and technology, including the persistent belief that men are more proficient in math and science domains

(Chalk, Meara, Day, & Davis, 2005) and the tendency for men and women to select careers historically viewed as traditional for their respective genders (Correll, 2001). By the end of the twentieth century, the engagement and advancement of women in science had become a focus of concern in the United States (Fox, 2008).

Three driving forces generated enhanced opportunity and access within the sciences for women. These forces included 1) a projected shortage in the science and technology labor pool identified by the federal government; 2) an awareness of the need to improve the status of women in science; and 3) an emerging legitimacy of feminist critiques of science epistemologies (Rayman & Brett, 1995). The federal government identified a need to increase the number of qualified scientists in the labor pool to remain competitive in the global economic market and also recognized formal education as a critical mechanism to prepare individuals for careers in science and technology (Fox, 1999). Specifically, the government recognized that increases in women's participation in math and science through science education could have a direct impact on the number of scientists available in the overall workforce (Sonnert, Fox, & Adkins, 2007).

In the wake of the federal government's efforts to promote the participation of women in mathematics, science and technology, feminist scholars posited critiques of science education framed by feminist epistemologies of science (Roychoudhury, Tippins & Nichols, 1995). Concerned with increasing women's participation in science as well as improving women's experience in science, feminist critiques of science education raised questions regarding the role of women in the practice of science, gender bias in the nature of

science, and culturally-situated claims of knowledge within the study of science (Harding, 1986). From a feminist perspective, increasing the number of women scientists is more complex than simply increasing the number of women who participate in advanced levels of formal education.

Science and the Feminist Standpoint Critique

Feminist theory provides an alternate way of understanding women's underrepresentation in the study and practice of science. By challenging the underlying assumptions of traditional science, feminist theory aims to reveal the social structures and historical practices that have discouraged and excluded women from science (Safarik, 2003). In particular, feminist standpoint theory asserts that because knowledge is socially constructed and society is stratified by gender, men and women have different experiences of the world (Harding, 1986). In science, women's perspectives and experience of the world have been neglected creating science disciplines that are incomplete (Harding, 1991). From a feminist standpoint theory perspective, women have been largely left out of the development of traditional science and therefore, the study or practice of science does not hold a compelling attraction or value for women.

Consequently, feminist standpoint scholars challenge the notion that increasing the number of women who participate in math and science courses will lead directly to increases in the number of women scientists. They argue that science, as it is generally understood, has evolved in man's image and does not reflect the experiences and understandings of women (Roychoudhury, Tippins & Nichols, 1995). Feminist standpoint scholars challenge that

science, as a discipline of academic study and professional practice, represents particular opinions about the physical world within which science exists (Brickhouse, 2001). These opinions include a particular belief in an objective reality (Keller, 1985), a belief that scientific objectivity and neutrality are possible and desired (Harding, 1991), and a belief that men are naturally 'better at' or 'stronger in' scientific disciplines (Sonnert, 1996). Combined, these opinions or assumptions have shaped the academic environment within which women scientists seek to produce new knowledge, teach, and gain status and tenure. Given the historical relationship between women and science, women are faced with particular challenges when they choose to pursue a career in academic science.

Women Scientists and Academia

Women face many obstacles when pursuing careers in academic science including isolation from male colleagues, slower progress to promotion, fewer opportunities to demonstrate leadership, and significantly less representation at top levels of their disciplines (Settles, Cortina, Stewart, & Malley, 2007). Women scientists receive less mentoring and report fewer opportunities for collaboration with their colleagues (Davis, 2001). In addition to a lack of mentoring, women scientists also report experiencing overt discrimination, sexual harassment, and little support in obtaining funding for their independent research projects (Miller, Blessing, & Schwartz, 2006). As a group, women scientists are noted as being less productive in their publishing efforts and number of research grants received (Corley & Gaughan, 2005). Organizational factors that improve productivity for men do not seem to provide the same benefit for women, who demonstrate more sensitivity to the presence of

organizational constraints (Corley & Gaughan, 2005). Despite efforts to increase the number of women scientists, gender inequity in the academic science workplace continues.

Federal legislation has removed the *prima facie* barrier of gender discrimination, yet sex segregation within the science disciplines seems to remain (Sonnert, Fox & Adkins, 2007). For example, while the majority of women with doctorates in science fields are employed in educational institutions, the proportion of women working in academic science is not representative of the number of women in the workforce as a whole (Fox, 2001). Women scientists who pursue careers in academia are less likely than men to have tenure track positions within five years of completing their doctorates (Ginther & Kahn, 2006). Additionally, they are less likely to receive tenure or be promoted to a full professorship in science disciplines (Fox, 1999). Further, women comprise less than one-fourth of the full time faculty at research universities and are less likely than their male colleagues to maintain a commitment to pursuing academic science careers (Graziano, 2007). Fox (1999) asserted that women scientist's experiences working in academia are limited by where they will find work, what rank they can expect to achieve, and what rewards they may be eligible to earn.

To succeed in science careers within the academy, women, like men, negotiate years of advanced coursework, survive multiple academic selection processes and demonstrate competence as researchers. Like men, women will eventually have the credentials for academic work, yet men are far more likely than women to attain the highest career achievements in academe (Fox, 2001). In addition to being underrepresented in the senior, tenured ranks of the professoriate, women are disproportionately represented in part-time and

adjunct positions (Corley & Gaughan, 2005). Research on the science careers of women has revealed a system of social stratification that continues to depress women's career success (Corley & Gaughan, 2005).

Theoretical Perspective and Analytical Framework

Aligned with Lips (2007), I believe women construct views (either explicit or implicit) of gender that guide their behaviors and personal interests throughout their lives. And similar to Gottfredson (1981), I find it plausible that women's gendered life experiences constrain their understanding of available career options and ultimately limit their career choices. However, some women seem able to expand their views of self and gender identity to encompass nontraditional roles. Arguably, women scientists are individuals who have not been limited by traditional expectations for their gender and have developed strategies which allow them to actively negotiate an improbable career path. By linking concepts regarding gender and women's career development and framing them within a feminist standpoint perspective, my research goal was to trace how women navigate views of self, gender, and personal context to pursue and sustain careers in academic science.

Theoretical Perspective

My theoretical perspective implicitly informs my research questions, review of extant literature, and choice of qualitative methodology. I identify my theoretical perspective as feminist standpoint. Feminist standpoint theory informs my understanding that the experiences of women scientists are different from the experiences of men. Further, because the disciplines of math and science evolved within a culture that privileges the experiences

and preferences of men (Keller, 1985), I understand that academic science does not always recognize or support the experiences and preferences of women. Proponents of feminist standpoint theory assert that science, having developed from Enlightenment epistemology, produces knowledge that is steeped in culturally-defined meanings (Brickhouse, 2001). Identifying the underlying values of science and connecting those values to the historical dominance of men is critical to understanding the existing social structures that have historically disadvantaged women within academic science. Guided by Harding's (1986) work outlining the problems of male-dominated science, I assert that the study and practice of science suffers by not valuing women's experiences and preferences as essential and necessary. As a result, women are less likely to participate in science because they do not see their own likeness in the study of science.

Aligned with a feminist standpoint perspective that acknowledges scientists approach their subjects of study from their own subjective worldview (Keller, 1985), I understand that women scientists cannot separate who they are from what they do in the study and practice of their disciplines. From this understanding, science study is both enabled and constrained by the same social contexts which inform gender beliefs, values and roles. Although these social contexts take various forms, they often create barriers which become work environment stressors for women that male scientists do not experience and contribute to women's underrepresentation in the academic science workplace (Gupta et al., 2005). To develop strategies for increasing women's participation in academic science, the issues

surrounding why some women are able to persist in their science careers while many others are not should be considered.

Critics of feminist standpoint theory challenge the concept of gender and therefore, a universal woman's experience (Roychoudhury, Tippins & Nichols, 1995). Further, an argument could be made that by focusing on a particular "standpoint," I am ignoring or denying the validity of other perspectives (Jorgenson, 2002). While I too question the construct of gender, I recognize that gender identity is a widely accepted way of positioning one's self in the world. For example, my female friends and family members accept their designation as "women" without question. By accepting existing constructs of gender, I situated my research within the perspectives of the women scientists who participated in the study.

The selection of feminist standpoint theory as the theoretical framework for this study guided my understanding of science as an area of study and practice with particular knowledge claims that can be challenged from different perspectives. The work of feminist standpoint scholars, such as Hartsock (1981) and Harding (1991), specifically address the historical context for understanding women's place in science and provided me with a structure for articulating differences between what science claims to be, and what it is, for the participants in this study. By using a feminist standpoint lens for the purposes of this research project, I utilized a theoretical framework that selects a long-neglected perspective (i.e. women's contributions to science) and holds it up for exploration and discovery. Thus, my

study was designed to foreground the experiences of women scientists and contribute to our understanding of women's engagement and participation in the practice of science.

Analytical Framework

Within my ontological and epistemological standpoint perspective, I identified an analytical framework that was aligned with my beliefs and relevant to the phenomenon of interest. The theoretical concept referred to as "possible selves" offered an effective framework and tool for data analysis. Possible selves is a social-psychological construct that describes how women's images of their future selves guide their current career behavior (Packard & Nguyen, 2003). Markus and Nurius (1986) first introduced the domain of possible selves as a form of self-knowledge pertaining to the beliefs individuals hold in regard to their potential endeavors. Since its introduction, researchers have used the possible selves construct to study areas including career theory, sex differences, adolescent development, adult development, social construction of the self, motivation, and self-regulation (Anthis, 2006; Chalk, Meara & Day, 1994; Hoyle & Sherrill, 2006; Kerpelman, 2006; Markus & Nurius, 1986, 1987; Oyserman, Bybee, Terry, & Hart-Johnson, 2004).

Markus and Nurius suggested that women are able to create many possible selves with each self emerging from their most salient sociocultural and historical contexts. Alfred (2001) agreed, asserting that life-long experiences managing overt and hidden sociocultural expectations greatly impact women's views of self and their attitudes regarding potential educational and career opportunities. Although women may feel capable of carrying out many of the tasks associated with science and technology occupations, they tend to view

these career options as too masculine to pursue (Chalk et al., 2005). Additionally, women continue to limit the career possibilities they see for themselves despite demonstrating the ability to negotiate years of formal education, personal and family responsibilities, and work responsibilities. Critical to women's persistence within the science professions is the ability to envision positive outcomes for their career aspirations (Lips, 2007). In this way, possible selves theory is a complementary framework for supporting women scientists' career development and also a mechanism for exploring their persistence within academic science.

Specifically, possible selves theory offers a way to explore women's meaning making processes with regard to external and internal messages about gender roles and career aspirations. Constructed, in part, through social interaction, possible selves are vulnerable to biases and distortions present in an individual's sociocultural context (Markus & Nurius, 1986). Achievement of a particular possible self can be inhibited when a woman does not recognize, or understand how to achieve, the goals associated with that self (Norman & Aron, 2003). The ability of women to persist on their career paths despite external discouragement may depend on their perceptions of the discouragement's significance, support from mentors, and experiences that suggest new possibilities (Pizzolato, 2007). Continued engagement along a science career path may require women to skillfully balance their hopes and fears for a scientist possible self. Asking the women participating in the study to reflect on their career-related possible selves and share the influence of those possible selves on their occupational choices provided some insight into the ways social context and gender identity guide some women toward nontraditional careers in academic science.

Other Considerations

Before selecting possible selves theory, I considered other analytical frameworks for use in my proposed study, including retrospective sensemaking (Weick, 1979), discursive positioning (Davies & Harre, 1990); career circumscription and compromise (Gottfredson, 1981); and social cognitive career theory (Lent, 2005; Lent, Brown, & Hackett, 1994, 2000). While these frameworks contain elements that would contribute to my understanding of women scientists' career-related experiences, they do not provide a method to analyze women's career-related views of self *and* career negotiation processes from inside each woman's internal meaning-making structures.

For example, retrospective sensemaking addresses individuals' cognitive and affective internal processing. In particular, retrospective sensemaking is concerned with understanding and interpreting past events (Weick, 1991). However, while interpretation of past events provides potential insight into women's career-related behavior, retrospective sensemaking does not directly address conceptions of self and their interaction with career development processes. Alternatively, discursive positioning provides insight on the social contexts framing an individual's identity (Davies & Harre, 1990), but does not describe the internal meaning making processes individuals' use to shape their self views and guide their career-related behavior.

On the other hand, social cognitive career theory (SCCT) offers a rich framework for understanding career choice, performance, and persistence (Betz & Hackett, 2006). However, SCCT is primarily used to frame observations of observed behavior related to individual's

perceptions regarding task achievement (i.e. self-efficacy). One of the purposes of my study is to understand the views of self that lead to self-efficacy in women scientists. For this reason, SCCT is a complementary framework, but still not the best fit. Similarly, Gottfredson's (1981) theory of circumscription and compromise offers an effective framework for understanding career development across the lifespan and a focus on gendered career dynamics. And like SCCT, Gottfredson's theory offers an explanation for women scientists' career experiences by placing attention on the social contexts of career from an outside perspective looking inward.

Ultimately, I selected the possible selves construct (Markus & Nurius, 1986) as an effective framework for analyzing the narrative stories I collected because I believe it offers a well-developed explanation for women's career-related behavior. The possible selves construct combines both sociological and psychological ways of understanding career development processes. Additionally, of the frameworks I reviewed, possible selves provided the most effective method of understanding women's career-related views of self from inside each woman's internal ways of making meaning.

Study Design and Rationale

Most research on women in science and technology professions has been focused on identifying causal factors to explain women's underrepresentation (Blickenstaff, 2005; Cronin & Roger, 1999). The intent of my study was to address a gap in the current literature by using qualitative methodology to explore the views of self and career experiences of women working in academic science. Qualitative studies are needed to illuminate the lived

experiences of women working within academic science professions. Further, qualitative research provides the kind of rich detail necessary to understand the complex experiences of people within their own contexts (Creswell (2007). Specifically, qualitative methodologies enable researchers to conceptualize a social process such as the construction of an identity group (Riessman, 2008). Given the stated goals of my study, a qualitative research design was aligned with my theoretical perspective, analytical framework, and appropriate for exploring the possible selves and career experiences of women scientists.

I employed a life story narrative approach to explore the interaction of women's views of self and their academic science career experiences. According to Atkinson (1998), a life story narrative approach is an effective method of exploring women's stories regarding their own career experiences. Additionally, Blustein, Schultheiss, and Flum (2004) suggested that narrative inquiry within studies of career development brings the researcher closer to the site of study. The exploration of personal narratives offers a way of seeing how individuals address the constraints of their life circumstances (Riessman, 2002). In the case of women scientists working in higher education, life story narrative has the potential to highlight the significant experiences and personal meanings that have guided their professional careers. By conducting semi-structured, life story interviews, I sought to elicit stories describing how women construct scientist possible selves compatible with careers within academia.

As described by Markus and Nurius (1986), an individual's current behavior is motivated by his or her possible selves. Possible selves are unique to individuals and guide them toward desired future selves and away from feared selves. An exploration of possible

selves reveals deeply held beliefs about the self concept (Frazier and Hooker, 2006). For the purposes of my study, possible selves theory provided a way to explore the participants' meaning making processes related to their careers. Additionally, possible selves theory specifically addresses the circumscription and compromise processes women experience when gender and sociocultural expectations guide their identity formation or establishment of career goals (Pizzolato, 2007).

Researcher Subjectivity

A central tenet of my ontology is that reality is socially constructed. Specifically, our perception of what is real and how we make meaning of the information we take in through our senses is influenced by our social, cultural and historical interactions with others. Further, underlying my research questions is an ontology that rejects the existence of a single reality. Rather, I believe there are multiple realities held within the minds of individuals and communities as they strive to make sense of their experiences (Guba & Lincoln, 1989). Ultimately, I believe one of the purposes of life is to identify which aspects of our reality and experiences will define our life choices. The focus of my research is an extension of my belief in the potential of individuals to recognize how they shape their life experiences by accepting or rejecting social constructions.

Particularly in work settings, I tend to emphasize education as a tool for awareness and discovery of the ways we continuously redefine our personal realities through the choices we make. A significant theme of my professional career has been the refinement of skills useful in assisting others with strategic career planning. Specifically, I assist staff

members in identifying and applying their own work-related skills. Over the course of my professional career as an employee recruiter and trainer, I have noticed some interesting patterns in the way that men and women approach work and career. Men and women often expend a great deal of energy in adapting their behaviors and perspectives to work environments without examining their usefulness or how their choices shape their everyday existence. I imagine individuals who are consistently required to use talents and skills that are not inherent to their natures, but considered appropriate for their gender, expend even greater amounts of energy and are less effective at completing work tasks or achieving professional goals.

Experience has taught me to be critical of the ways in which gender roles are defined in Western society and I believe that we are often disconnected and unaware of the socially-constructed constraints on our self-perceptions and perspectives of reality. I find it discouraging that many occupations have been implicitly or explicitly labeled as appropriate for one gender over another. The reality of gendered occupations is in direct opposition to my belief that an individual's talent and interest should direct him or her toward an occupation. As a woman and a feminist, I am concerned that the occupations deemed appropriate for women tend to be lower paying or lower status than those for men. Even more disturbing to me is the knowledge that many women self-select away from math and science occupations because they believe them to be more appropriate for men. My particular interest in this study evolved from a desire to explore how some women seem to define themselves in ways that challenge the widely-accepted cultural and historical cues for their gender. I wanted to

understand how women come to see themselves as scientists capable of pursuing careers in academia.

My approach to this study was framed by a feminist standpoint perspective that asserts women's experiences must be studied separately from men's experiences. Additionally, I view science as culturally-biased in favor of men, creating both visible and invisible barriers to the success of women scientists. In choosing to study women working in academic science, one of my guiding assumptions is that women share gendered experiences that can be explored through qualitative interviewing methods. My goal as a researcher was to explore the possible connections and disconnections between women's views of self, their life experiences, and their pursuit of academic science careers.

Limitations of the Study

By selecting narrative inquiry as the methodological approach for my study, I relied on the personal recollections of women scientists to explore their possible selves and career experiences. Further, the use of life story interviewing techniques focused on career-related experiences highlighted smaller, context-bound components of the women scientists' lives rather than providing a more global perspective. Additionally, my positionality as a researcher and my choice of feminist standpoint theory as the framework for the study privileged gender dynamics as central to women scientists' views of self and their career negotiation. While culture, race, age, ethnicity and many other aspects of identity are embedded within our social structures and shape women's science career experiences, addressing all of these aspects was beyond the scope of this research project.

Chapter Summary

To address a gap in existing literature, this research project focused on adult women currently negotiating science careers within the academy. I employed a life story narrative approach to explore how women scientists' develop possible selves that enable them to pursue their careers. This chapter outlined the background and context for the issue under study, clarified the specific research problem being addressed, and presented the guiding research questions. Additionally, this chapter explained my choice of feminist standpoint theory to frame the study and my selection of possible selves theory as an appropriate lens for data analysis. The next chapter will review extant research regarding academia as a work environment for women scientists, gender as a constraint on women's career choice, and possible selves as a lens for exploring women's career-related views of self.

Chapter Two: Literature Review

This chapter outlines the scholarly research informing my exploration of the possible selves and career experiences of adult women working within academic science, technology, engineering and mathematics disciplines. My study focused on how women scientists currently working in academia construct views of themselves as scientists and how they use their views of self to negotiate their careers. The following questions guided the inquiry: 1) how do women scientists develop views of self, and 2) how do women scientists negotiate their careers?

Beginning with the broadest perspectives framing the study, this chapter will situate issues concerning women working in academic science and demonstrate the need for research that illuminates their individual experiences. First, I will offer context regarding the work environment for women scientists in academia. Second, I will describe the influence of gender on women's pursuit of their math and science interests as well as their science career-related views of self. Finally, I will present relevant literature regarding women's construction of possible selves compatible with an academic scientist identity. By connecting the aforementioned literature, my goal is to outline the conceptual framework which served as my working model for how women are able to negotiate academic science careers.

Women and Science Careers

Often, traditional approaches to career guidance are not effective in supporting women's science career goals (Plimmer & Schmidt, 2007). Rather than recognizing that people represent ever-evolving interests, experiences, and knowledge, traditional career

development approaches assume career decisions are made once and never change (Plimmer & Schmidt, 2007). However, women's career experiences are unique and may progress differently than expected as a result of their complex life contexts (O'Neil and Bilimoria, 2005). Additionally, a relational emphasis has been noted as pervasive within women's career development processes (Fletcher, 1996). Further, women's underrepresentation in science and technology, as well as their absence from top leadership positions creates particular challenges for their career progression. Similarly noting the unique characteristics of women's career development, Quesenberry and Trauth (2007) found that women's career decisions are driven by a complex set of factors such as home and childcare responsibilities.

Barriers to Women's Participation in Academic Science

Despite historical claims of culture-free objectivity, the existence of science as a predominately male domain creates both visible and invisible barriers for women working in academia (Gupta et al., 2005). Feminist critiques of science epistemology reveal the dualistic, male-dominant perspectives that define science as being rational and objective (Keller, 1985; Harding; 1991; Sonnert; 1996). The modern conception of science, having developed within the culture and traditions of men during the Enlightenment period of the eighteenth century, cannot truly produce culture-free, gender-neutral knowledge (Brickhouse, 2001). In fact, the terms used to define science (i.e. reason, objectivity) are cultural definitions most associated with masculinity (Brickhouse, 2001). Expertise in mathematics and science, established on male normative standards, has become culturally-equated with intelligence, rationality and productivity (Fox, 1999). Given that modern academia is largely influenced by the historical

preeminence of traditional science (Fox, 1999), feminist scholars argue that higher education work environments are designed to support men (Brickhouse, 2001).

The gendered perspectives of male scientists have created professional expectations and practices which constrain and often exclude women from the science community (Sonnert & Holton, 1995). Keller (1985) asserted that the nature of science not only excludes women from its professional ranks, but also privileges men's preferred ways of conducting research as superior. In science, men have historically defined the problems deemed worthy of study and their perspectives have shaped the direction of research (Davis, 2001). Traditionally, men's cultural assumptions, values and beliefs have influenced the choice of inquiry topic, theoretical approach, experiment design, and analysis of collected data (Fox, 1999; Davis, 2001). Further, Keller (1985) described a divide between traditional, male-oriented scientific approaches that emphasize one-directional causal relationships and female-oriented approaches that emphasize multiple intersections and pathways. Essentially, the tension between approaches is an artifact of the dualism embedded within traditional, positivistic science (Keller, 1985; Fox, 1999).

Identifying the underlying values of science and connecting those values to the historical dominance of men is critical to understanding how the traditional study and practice of science has helped to create barriers for women scientists and women who aspire to be scientists. In recent years, researchers have argued that a significant and lasting increase in women's science participation will only occur as a result of changes to the study and practice of science (Mayberry, 1998). Scientists themselves have suggested that increasing

the number of women scientists as part of the diversification of science practice is necessary to improve the quality of science as a field of study (Sonnert, 1999).

Rates of Women's Participation in Academic Science

Unfortunately, the belief that increasing women's access to education would result in gender equity in scientific careers has yet to be substantiated (Fox, 2001). In the United States, Title IX legislation has fostered equal participation of women and men in higher education. However, despite the expanded educational opportunities for women as a result of Title IX, increases in the number of women scientists over the past twenty years have been uneven across disciplines (Sonnert, 1999). The National Science Foundation (2004) reports that women represent fewer than 13% of the science and engineering doctoral-level employees at universities and 4-year colleges and approximately 5% of the full professors in information science. Women are significantly present in the fields of psychology and the biological sciences, but are rarely found in technology, engineering, and natural sciences such as physics (Sonnert, 1999). While women comprise 48% of the U.S. college-educated workforce (Buck et al., 2007), a disproportionate number of women are likely to move away from the pursuit of science education and careers in science (Sonnert, 1999). Further, the National Science Foundation (2004) noted that women are less likely than men to achieve the highest faculty ranks.

Challenges for Women Scientists Working in Academia

In higher education, the assumption underlying academic careers is that women can pursue their aspirations via a work environment structured around men (Bailyn, 2003).

Further, the operating assumption is that if women are able to successfully follow the men's model, they will receive the same rewards and opportunities (Bailyn, 2003). Unfortunately, as women enter science careers, they continue to face barriers that discourage persistence along their chosen path (Sonnert, 1999). In academia, they are disadvantaged in comparison to men with regard to the type of entry-level position they can expect to achieve (Ginther & Kahn, 2006). For example, women scientists working in higher education are less likely than men to begin in a tenure track position.

There are widely held beliefs in academic science that the early years of a scientist's career require considerable focus on establishing expertise and positioning for the future possibility of tenure (Bailyn, 2003; Graziano, 2007). According to O'Neil and Bilimoria (2005), women in the early stages of their career are confident and believe they have control over their career progression. This is not quite the case for women in academic science. Women experience the ongoing challenge of resisting beliefs about women's weaker abilities to achieve in science and perceptions that they are attempting to be successful in men's domain (Graziano, 2007). Despite the lifelong challenge of resisting expectations for low performance and demonstrating a high degree of knowledge and skill, women entering science careers still express lower confidence in their abilities (Ginther & Kahn, 2006). In their study of postdoctoral interns, Martinez et al. (2007) found that women expressed lower confidence than men in their ability to successfully negotiate the job search process. Further, Sonnert and Holton (1995) noted that women scientists were more cautious in their research methods and more meticulous about details than their male colleagues. Fox (1999) suggested

that women scientists tend to be more cautious in practice because women are given less room for error.

For women, early career often coincides with the peak reproductive years. Issues surrounding whether or not to have a family factor greatly in women's career decision making often in ways that men never need consider (Graziano, 2007; Martinez et al., 2007). In fact, married women with or without children may be more concerned with job demands and more willing to make job concessions than men (Martinez et al., 2007). Research has indicated that a significant reason adult women leave the science career pipeline is conflict with childcare and family responsibilities (Ginther & Kahn, 2006; Graziano, 2007). Graziano (2007) reported that approximately 45% of tenured faculty in higher education are childless. She argued that the high number of childless faculty indicates an underlying belief that women in academe cannot have both tenure and children.

Arguably, women are taxed with contributing to their work environment at the same level as men, but doing so by meeting different standards for performance and earning less for their efforts. For example, women scientists face progressive salary gaps and can expect to earn less than men as they navigate their careers (Graziano, 2007). Even controlling for factors such as productivity, the gap between men and women increases along the science career pipeline with the greatest gap found as scientists reach full professor rank (Ginther & Kahn, 2006). Further, the gap in salary at the full professor level cannot be explained by observable characteristics of the scientists (Ginther, 2004). The implication is that gender,

rather than job performance, determines the salary for scientists who reach full professor rank.

Accordingly, women who choose to leave the academic science environment have some strong incentives to do so. Graziano (2007) suggested that a primary reason for women scientists to leave academe is that higher paying, more interesting, and family-friendly positions exist elsewhere. She offered industrial biotechnology as a field that employs women and men in almost equal amounts, has a respectable level of pay, and provides reasonable work hours. Similarly, Settles et al. (2007) suggested women scientists may also leave academic science frustrated by their slow progress toward promotion, reduced opportunity to demonstrate leadership, and lack of support for their independent research projects.

Gender and Science

Science, being no different than others forms of knowledge, is shaped by its cultural context including embedded beliefs about gender and gender roles (Brickhouse, 2001). Gender is a hierarchical construction that has historically established men's behavior as normative (Risman, 2004). An underlying assumption of my study is that the concept of gender and its perpetuating forces are central to women's continued underrepresentation within academic science and mathematics. "The academy is anchored in assumptions about competence and success that have led to practices and norms constructed around the life experiences of men, and around a vision of masculinity as the normal, universal requirement of university life" (Bailyn, 2003, 143). The resulting work environment requires women to

work harder and contribute more as a way to prove their qualifications and meet normative standards. Fox (2001) found some support for this supposition in her 1998 study of eleven graduate programs. All of the programs characterized the underrepresentation of women in science as resulting from the social construction of gender.

Gendered Views of Self

Being born biologically female (i.e. sex-typed as female) is not synonymous with being gender identified as a woman. Gender is a construction of meaning within human cultures that is reproduced over time through experiences shaped by formalized social structures and engagement in social interactions (Risman, 2004). For men and women, the construction of gender is perpetuated by socially-produced rules and standards which define acceptable manhood and womanhood (Burr, 1995). Faulkner (2007) described gender as existing within the social institutions that structure our choices and shape how we see and act in the world. "I have come to see gender *norms* as a major force for stability, one consequence of gender norms being that particular activities and behaviours are perceived and felt to be more 'gender authentic' for particular groups at any given time and place" (Faulkner, 2007, p. 333). The construction of gender and its associated norms for womanly behavior is so powerful that it persists despite the existence of conflicting discourses.

Gender beliefs carry within them stereotypes regarding appropriate gender behavior (Correll, 2001). Men and women display different levels of commitment to pursuing science careers because men are perceived to be more competent at the associated science career tasks. Lips (2004) referenced a very consistent gap between men and women in their

perceptions of their own academic achievement. She suggested that students absorb messages that certain academic domains are more appropriate for one gender rather than the other. For example, young women develop the belief that science is appropriate for males rather than females and step aside as young men actively participate in science activities (Weisgram & Bigler, 2006).

An implication of gendered activities is that men and women's differences in behavior maintain the social structure. Men and women are motivated to align with gender roles and willingly evaluate themselves against gender role standards (Evans & Diekman, 2009). Correll (2001) suggested that gender beliefs are powerful because they are not only what individuals expect, but they also represent what others expect and accept to be true. Ultimately, women and men draw comfort from conforming to gender role standards because they are deeply embedded within the self-concepts people hold for themselves.

Referencing the work of Valian (1998), Bailyn (2003) described the effect gender schemas have on the climate within academic science. Gender schemas, as presented by Valian, are the implicit beliefs we hold about gender and gender roles. Gender schemas guide our definitions of appropriate behavior associated with masculinity and femininity. In academia, gender schemas, not only shape our expectations of behavior, they provide the standards by which we evaluate performance (Bailyn, 2003). The traditional, male-dominated structure of the science community means that women's ways of performing tasks according to gender role may be different than the standard for men.

Bourne and Ozbilgin (2008) suggested that gendered views of self create artificial boundaries "which limit the career imagination of women and men" (p. 323). Further, Cronin and Roger (1999) advocated a different approach to understanding the problem of women's underrepresentation by arguing that science culture will not be changed by the inclusion of more women. Rather, effective solutions for increasing women's participation in math and science will need to address the ongoing conflict between feminine and masculine gender identities.

Gender Constraints on Science Interest

In Western cultures, young girls and women receive both tacit and explicit messages which discourage, undermine or divert any interest they may have in exploring math and science interests (Fox, 2001). Accordingly, women may hold stereotypical images of scientists which clash with their desired images for themselves (Buck, Clark, Leslie-Pelecky, Yu, & Cedra-Lizarraga, 2007). In examining why some young women do not maintain their espoused occupational aspirations in male-dominated fields from late adolescence through young adulthood, Frome, Alfeld, Eccles, and Barber (2006) found that the best predictors of women dropping their occupational aspirations in science and math were concerns about balancing career and family along with a lower value for science-related domains. Women find themselves situated in an environment which filters their beliefs and subsequent values about math and science occupations through the socially-mediated norms of acceptable womanhood.

Gender and Math Ability. Men and women's divergent career choices appear to be connected to gender differences in self-concept regarding personal competence and the ability to perform the tasks associated with mathematics and science. For a woman to progress along the path toward a science career she must demonstrate academic proficiency in mathematics and science (Fox, 1999). Unfortunately, empirical evidence suggests that women face noteworthy barriers which undermine demonstrations of their math and science abilities (Betz & Hackett, 2006). Often self-assessments regarding competence in mathematics are made at a very young age. Adya and Kaiser (2005) observed that women working in information technology were making career-oriented decisions in early adolescence which is well before they have completed high school and before they fully understand the long-term impact of early career decisions.

Stereotypically, men are expected to perform better than women in science and math (Benbow & Stanley, 1980; Correll, 2001; Betz & Hackett, 2006). The stereotype of men's superiority in the sciences has significant influence on others' perceptions of women's abilities, but also guides women's perceptions of their own abilities (Correll, 2001; Jacobs, 2005; Betz & Hackett, 2006). Women not only believe that they are not meant to perform well in science disciplines, but their beliefs are reinforced by the opinions of their family members and peers who have the same preconceptions about science being men's domain.

Maintaining a sense of competence regarding their science and mathematics abilities can be challenging for women. In 1980, Benbow and Stanley published a study seeming to assert significant gender differences in mathematics ability. The Benbow and Stanley study

became controversial when the popular press reported the findings as irrefutable evidence that men are naturally better at science than women (Jacobs, 2005). While Benbow and Stanley (1980) did not definitively assert men's mathematical abilities as superior to women's abilities, they did provide empirical evidence that men are more likely to achieve academically in math than women. In fact, there is considerable research that reports women as less likely to enroll in math and science courses and pursue science careers even when their academic achievements are equal to or better than men's achievements (Jacobs, 2005).

In the wake of the Benbow and Stanley controversy, scholarly literature reports that while gender differences in course selection and career pursuits persist, the differences have not been proven to be a result of differences in math ability (Correll, 2001; Jacobs, 2005). However, interest in, and pursuit of, math and science opportunities is linked to individuals' perceptions of their mathematics ability (Correll, 2001; Jacobs, 2005; Betz and Hackett, 2006). When individuals have high self-perceptions of competence in mathematics they are more likely to engage in the kind of mathematics or science activities which lead to science careers.

Understanding the persistence of math-related stereotypes is important to unraveling the critical connection between math performance and future science career pursuits. For both men and women, higher rates of mathematical competence increase the likelihood they will continue on the educational track toward math and science careers. Given the persistence of beliefs regarding men's superiority in mathematical abilities, men are significantly more likely to pursue activities leading toward careers in science, math, and engineering (Correll,

2001). Clearly, self-perceptions have a powerful influence on the behavior preferences guiding career choice. A significant stream of research has evolved around efforts to illuminate the connection between women's views of self and their preferences against math and science.

Science Value and Relevancy. Narrow beliefs regarding the value of science have discouraged young women from seriously pursuing their math and science interests. Evans and Diekman (2009) found that women perceived their values and goals could not be supported through a science career. Young women tended to espouse gender-stereotypic goals which they did not equate with science and technology occupations. In their study, Packard and Nguyen (2003) found that young women tend to be interested in careers focused on helping others.

Similarly, Miller, Blessing and Schwartz (2006) found that young women did not see science as connected to their personal lives. Further, young women reported that science courses did not cover topics of interest to them. They were also more likely to report their interest in a particular major as a way to help other people or animals. For those women planning to study science, they preferred life sciences because of their relationship to the health professions. Although women reported that science was not interesting to them, they viewed life sciences as a necessary hurdle to overcome in order to become a doctor, veterinarian, physical therapist, etc.

Weisgram and Bigler (2006) conducted two studies designed to explore the ways in which altruistic values, egalitarianism, self-efficacy, and perceptions of utility informed

adolescent women's interest in science. Their findings demonstrated that adolescent women who could recognize altruistic value within a science career scored higher than their peers on science-related self-efficacy and utility measures. They also found that a young woman's belief in the altruistic value of science predicted her interest in science activities. Weisgram and Bigler's results underscore the value adolescent women place on altruism and the importance for women of being able to match personal value with career choice.

Gendered Career Choice

Men and women continue to show divergent preferences for careers. Gender segregation within the labor market persists despite structural changes in society (Correll, 2004). In fact, the large increase in the number of women who work and the increase in professional opportunities for women have not significantly lessened the tendency for men and women to choose disparate careers (Correll, 2004; Evans & Diekman, 2009). Bourne and Ozbilgin (2008) suggested that gendered career choice is one of the fundamental causes of gender inequities still occurring in our work and home lives. Particularly troubling is the persistent and progressive absence of women from career pathways in mathematics, science and technology (Cronin & Roger, 1999). However, despite increases in women's engagement and achievement in science courses, women continue to avoid careers in the sciences (Hanson, Schaub & Baker, 1996).

An underlying assumption guiding the study of career preference is that individuals choose careers for which they hold a self-conception of competence regarding the primary tasks associated with the career (Correll, 2001). Accordingly, men and women prefer certain

occupations because the roles involved in those professions allow them to carry out their gender expectations (Evans & Diekman, 2009). Traditional male and female-designated occupations are perceived to support different goals influencing men and women to express different interests in career pursuits. Empirical evidence suggests that the gendered division of labor leads to disparate gender-role expectations and encourages sex differences in attitudes and behavior (Evans & Diekman, 2009). While a self-conception of competence is not the only consideration in selecting a career, confidence in one's own competence is essential for sustaining commitment to a particular career path (Correll, 2001).

Gottfredson (1981) argued gender is the aspect of self-concept that is most sensitive to the perceived traditional or nontraditional nature of a potential occupation. The process of matching gendered self to potential careers leads to a narrowing of acceptable aspirations. Gender influences our decisions to accept, ignore, or reject the possibilities of a particular career (Lips, 2004). Using gender as a filter, individuals may not see themselves in certain roles and may disregard entire segments of career options without deeper exploration or further academic study (Gottfredson, 1981; Lips, 2004; Turner & Lapan, 2005). As noted by Bourne and Ozbilgin (2008), the gendered filtering process is problematic because it fosters stereotypical perceptions of gender roles and leads to the segregation of jobs and professions.

Similar to Gottfredson (1981), I suggest that blinders resulting from women's gendered experiences unnecessarily restrict their views of self and the careers they consider as possible. Further, the construction of gender can be viewed as fostering perceived

incompatibilities between women's aspirations for science careers and their aspirations for a family life. Meara, Chalk, Day, and Phelps (1995) suggested that women may not choose a science career because they believe traditionally female professions allow women to combine work and family roles more effectively than traditionally male professions. Referencing findings from her 2000 study of women engineers, Faulkner (2007) suggested that their retention and progression are weakened by deeply entrenched structural barriers and subtle, less visible gender dynamics. By pursuing a gender-typical career, women avoid the internal conflict of denying what they may believe are their womanly responsibilities in order to engage in the masculine activities associated with science careers. Similarly, Packard and Nguyen (2003) suggested that science careers may be viewed as undesirable to women who uphold the primacy of family and relationships.

Women who prioritize career flexibility for the purpose of supporting a rich family life are more likely to abandon their aspirations for a science or technology career for fear that those occupations will not support their personal goals (Frome et al., 2006). "If there is an increasing divergence, it may be partly because, as they approach academic and career decision points, young women envision future difficulties, even if they view themselves as currently competent in science, engineering, and technology" (Lips, 2004, p. 358). Women's beliefs that they will be primarily responsible for childcare in conjunction with society's expectations regarding gender roles may create pressure on women to make concessions in their career goals to support family life (Frome et al., 2006). For example, the graduate student participants in Buck, Leslie-Pelecky, Clark, Yu, and Creswell's (2006) study

expressed an explicit understanding that their choices to pursue careers as scientists was in direct conflict with their expected roles as family caregivers. Judging from this evidence, concerns about future family responsibilities are a powerful factor in women's choice to maintain their science career aspirations into adulthood and beyond.

Women and Possible Selves

In an attempt to address the loss of women from the science career pipeline, a significant stream of research has examined women's academic and career choices in relation to their views of self (Lips, 2007). Theorized explanations emerging from empirical studies include self-efficacy related to math competence (Betz & Hackett, 2006), gender schemas (Valian, 2004; Weisgram & Bigler, 2006), gender role congruity (Evans & Diekman, 2009), and possible selves (Markus & Nurius, 1986). The diverse explanations offered in the research literature represent both psychological and sociological approaches. With regard to science, mathematics and technology careers, women's views of self regarding their academic competencies appear to be gendered through interaction with social and cultural expectations and interpreted by their individualized, internal mental processing. Additionally, self views about issues not directly related to academic performance may also be involved in young women's choice not to pursue a science career (Lips, 2007). For these reasons, understanding young women's choices through a framework that combines both psychological and sociological concepts is particularly useful.

Possible Selves

Research literature regarding career has traditionally utilized psychological or sociological frameworks. Psychological frameworks typically consider career choice, career orientation, or self efficacy while sociological frameworks are concerned with career patterns and career pathways (O'Neil & Bilimoria, 2005). Possible selves theory with its combination of psychological and sociological elements provides a critical framework for understanding women's underrepresentation in science (Lips, 2007). Specifically, possible selves theory offers a way to explore women's meaning making processes with regard to external and internal messages about gender roles and career aspirations. For example, a woman may envision a possible self as a scientist, but fear that the scientist self will be socially isolated. If the fear of social isolation is greater than the desire to achieve the scientist self, the woman may avoid behaviors she believes will move her closer to the reality of a scientist self.

As mentioned previously, women's perceptions of reality, including their interpretation of language and experience, are co-constructed through interactions with their sociocultural environment. "Possible selves" is a social psychological theory that offers a way to understand how women's future images guide their current career behavior (Packard & Nguyen, 2003). Markus and Nurius (1986), who introduced the construct, describe the domain of possible selves as a form of self-knowledge pertaining to the beliefs individuals hold in regard to their potential endeavors. While an individual is able to create many possible selves, each self emerges from the individual's most salient sociocultural and

historical contexts as well as the everyday models and images present within the individual's current environment. A guiding assumption of possible selves theory posits that the assortment of potential selves an individual can access in a specific context influences her beliefs about what is possible for her future (Lee & Oyserman, 2007). Rossiter (2004) emphasized that an individual's possible selves are only comprised of roles or identities "psychologically accessible and personally meaningful" and consequently, represent "both culturally determined and self-constructed aspects of the self" (p. 139). Views of possible selves are grounded in social roles and categorizations while also including past experiences and self-evaluations (Meara, Day, Chalk, & Phelps, 1995). Thus, a woman's possible selves can be defined as an interpretation of her internal reality and a reflection of the social discourses she upholds as the standard for womanhood.

Research literature indicates that the self-concept in interaction with the social context, guides individual's science-related academic and occupational choices (Lips, 2004). In two studies conducted by Chalk, Meara, and Day (1994), women tended to hope for the traditionally masculine jobs, such as science occupations, more than they expected to pursue and achieve them. Their results indicate that views of self congruent with math and science interests may produce different career-related self perceptions for women than men. Similarly, Lips (2004) found that some women rejected the construction of possible selves within engineering and physical science disciplines despite reporting current self perceptions

with positive inclinations toward math and science. She hypothesized that the women's possible selves were in conflict with their beliefs about femininity, or they had no female role models in these areas to help inspire a science career possible self.

Possible Selves and Gender

In her work, Hilary Lips has explored women's construction of possible selves. She asserts that possible selves are influenced by cultural messages, such as gender stereotypes, within an adult's environment (Lips, 2000). In the case of women, gender stereotypes may obscure or derail their life goals or career aspirations because the gender messages prevent a particular possible self from being constructed. In other words, adults' beliefs about their role in society and their personal abilities guide the variety and structure of the possible selves they are able to imagine. Additionally, Lips (2004) found gendered characteristics with respect to the number of future possible selves in comparison to the number of current selves women construct. She found that university women expressed fewer possibilities for themselves than high school women. Her findings suggest that, as women transition into college and adulthood, they are actively narrowing the possibilities they envision for their future.

Frequently, gender is one of the filters used to accept, reject or ignore possible selves (Lips, 2004). Guided by gender stereotypes, individuals may be encouraged or discouraged from certain career aspirations and may learn to view themselves as not being acceptable for certain roles (Lips, 2004). Gender becomes a considerable force in constraining women's

career development processes. Women actively construct their futures while they are constructing their views of self. Further, they are shaping their views of self to fit gender-appropriate futures. As gender typically defines roles more narrowly for women, Lips (2004) posited that women and men may be diverging more and more in their ability to envision a variety of possibilities for themselves.

Possible Selves and Aspirations

The ways adults see themselves is critical to understanding their subsequent behavior (Lips, 2004). For example, the tendency for women and men to pursue careers that represent their traditional gender roles may be revealed and better understood through their possible selves. Possible selves act as self-regulatory processes that influence men and women's motivation and behavior (Hoyle & Sherrill, 2006). Men and women's projected images of what is possible for them to achieve serve as individualized motivation that guides and directs behavior toward a particular goal (Markus & Nurius, 1986).

Some possible selves are more likely than others to influence current behavior (Hoyle & Sherrill, 2006). Norman and Aron (2003) found that individuals are highly motivated by possible selves they believe to be available, accessible, and under their perceived control. In their study, they found that higher degrees of accessibility increased the likelihood that an individual would pay attention to a specific possible self. The possible self was even more motivation for individuals if they could conceive of being able to make decisions and access to resources that would make the possible self a reality. Possible selves associated with

behaviors that adults feel confident they will be able to perform and maintain over time are the most likely possibilities to motivate behavior (Hoyle & Sherrill, 2006). Reporting similar findings, Oyserman et al. (2004) asserted that possible selves effectively motivate behavior when they are detailed and provide strategies for goal achievement and ways to integrate the self into an individual's existing social context.

Constructed, in part, through social interaction, possible selves are vulnerable to biases and distortions present in an individual's sociocultural context. Achievement of a particular possible self can be inhibited when a woman does not understand how to achieve the goals associated with that self (Norman & Aron, 2003). Additionally, a possible self may be inhibited when a woman cannot balance her fears with her desires connected to a particular self (Pizzolato, 2007). For example, feared possible selves of "nerdy scientist" or "spinster scientist" are highly motivating conceptions to avoid a science career. In this way, lack of knowledge or strong fears can inhibit career-related possible selves.

Pizzolato (2007) identified possible self inhibitors as fears that lead to the constraint or compromise of career goals. With regard to feared outcomes, Lips (2007) provided an example of women envisioning themselves as future leaders. While women recognized that as leaders they would be able to assist or advocate for others, they also feared the social isolation and misperceptions that often accompany women's experiences as leaders. Similarly, women may see the potential of pursuing a science or technology career, but fear the associated perceptions of being overly intelligent and lacking appropriate social skills.

The ability of women to persist on their career paths despite external threats may depend on their perceptions of the threat's significance, support from mentors, and experiences that suggest new possibilities (Pizzolato, 2007). Continued engagement along a science career path may require women to skillfully balance their hopes and fears for a scientist possible self.

Women's Possible Selves and Their Science Careers

The possible selves framework offers the potential for insight regarding the complexity of women's career development. Meara et al. (1995) suggested five ways that possible selves support individuals' career development pathways. First, possible selves are deeply personal and place the individual at the center of career considerations. Possible selves incorporate interests and values, but they also reflect perceptions of ability and efficacy. Second, possible selves frequently serve as avoidance goals by providing individuals with alternative views of the future. Possible selves can be particularly salient when they counterbalance an individual's feared outcome. The third way possible selves support career development is by capturing powerful emotions that direct the individual toward or away from specific career aspirations. Next, possible selves are embedded with motivating images of achievement. For example, a woman who has a vivid image of herself making a scientific discovery may use that image to direct her behavior toward science-related activities. Finally, possible selves often provide hints regarding action steps or potential strategies for career goal achievement.

Possible Selves and Scientist Identity

As a woman is exposed to new ideas and concepts, she develops the capacity to see possible career options for herself (Gottfredson, 1981). As she considers potential career options, she rejects options that she believes are unobtainable and eventually chooses an occupational path that seems to be a match of her interests, skills and role in life. At the core of the process of career goal construction is an individual's evolving view of self. Pizzolato (2007) suggested that possible selves theory specifically addresses the circumscription and compromise processes young women experience when they consider gender and sociocultural expectations in articulating their identity or establishing career goals. The degree of a woman's possible selves development affects her identity construction and her career development processes.

As mentioned previously, research suggests that individuals' desired possible selves may create and sustain the motivation to achieve future goals (Norman & Aron, 2003). This is a significant implication for understanding women scientists' career development efforts through a possible selves framework. Given women scientists' challenges in resisting low performance expectations and obstacles in the academy, their ability to maintain desired possible selves may explain their ability to sustain their science career aspirations over time. Further, women scientists' self-concepts must contain not only goals, but also strategies about how to reach the desired outcomes (Oyserman et al., 2004). Women's ability to create and re-create desired selves as scientists may be the key to their perseverance along career paths within academia.

Chapter Summary

In this chapter, I discussed the research literatures informing my understanding of issues surrounding women's attraction to, or avoidance of, science careers. Research suggests the tradition of science as a male domain creates barriers for women working in academia. The perpetuating forces of gender fuel the persistent underrepresentation of women in the study and practice of science. Women who are able to pursue their interests in science and negotiate careers within the academy may do so because of their ability to create and sustain desired possible selves compatible with a scientist identity. The next chapter will outline the methodological approach I used to explore women scientists' possible selves and career experiences.

Chapter Three: Methodology

This study utilized a qualitative research design to explore women scientists' views of self and their career experiences. I hoped the collection and analysis of the participants' stories would provide insight regarding the ways women create scientist possible selves that help them negotiate careers within the academy. The research questions guiding this exploration of women scientists' narratives include: 1) how do women scientists develop views of self, and 2) how do women scientists negotiate their careers?

By seeking answers to these questions, my goal was to move away from existing research focused on how to increase women's participation in academic science toward an exploration of the experiences and views of self that enable women to persist in their academic science careers. Women currently working in academia were the focus of this study because their presence demonstrates some level of success in negotiating science careers. I argue that women's success in science is predicated not only on social and structural supports within their work environments, but also the quality and tenor of the internal meaning and self-views that emerge from their sociocultural interactions. As an explanation for my approach, this chapter provides a description of the research methodology. The following elements are discussed specifically: a) the rationale for qualitative methodology, b) the rationale for narrative approach, c) data collection, d) data analysis, f) limitations of the study, g) researcher subjectivity, and h) veracity and trustworthiness.

Rationale for Qualitative Methodology

Existing research studies have largely relied upon quantitative methods to explain why women are not studying science or pursuing science careers in greater numbers (Blickenstaff, 2005; Cronin & Roger, 1999). However, research studies focusing on the lived experiences of women who select and persist in academic science careers is an often overlooked approach to increasing women's representation in math and science disciplines (Kinzie, 2007). This study was intended to address a gap in the current literature by using qualitative methodology to explore the career experiences and possible selves of women scientists working in academia.

According to Riessman (2008), qualitative methodologies enable researchers to conceptualize a social process such as the construction of an identity group. As discussed in chapter two, there are some clear connections between the construction of a woman's gender identity and her choice of career (Faulkner, 2007; Frome, Alfeld, Eccles, & Barber, 2006; Lips, 2004). Qualitative studies offer opportunities to discover how women make meaning of their life experiences and translate those experiences into decisions about whether or not to pursue their intellectual and professional interests within academic science. Further, qualitative studies offer researchers the opportunity to investigate how individuals interpret experiences within their own social, cultural and historical environments. Creswell (2007) asserted that qualitative research provides the kind of rich detail necessary to understand the complex experiences of people within their own contexts.

Rationale for Narrative Approach

A useful way to explain the decision process used in designing the study is to highlight some of my epistemological and methodological considerations. My selection of narrative inquiry is in line with feminist standpoint scholar, Sandra Harding (1991), who suggested that epistemological assumptions direct the research methods we choose, how we define ourselves as researchers, and how we determine the form of our research products. A preference for narrative inquiry is an extension of my appreciation of story as a way of knowing and making sense of experience. Additionally, I have a strong desire to collect the individual career stories of women working in the academy to better understand their career-related decisions.

Arguably, qualitative studies may be more effective at revealing how and why women's career experiences are unique. Blustein, Schultheiss, and Flum (2004) asserted that narrative inquiry within studies of career development brings the researcher closer to the site of study. A narrative approach provides the opportunity to hear descriptions of events in a person's life through her own voice (Chase, 2005). Additionally, narratives offer a way of seeing how an individual addresses the constraints of her life circumstances. Further, a narrative view of the issues under study allows for consideration of its interconnected and evolving nature (Clandinin, Pushor & Orr, 2007). In other words, narrative inquiry provides an opportunity to see how women connect their past, present and future experiences.

Given the stated purpose of the study, collecting life story narratives encompassing career development experiences was an appropriate approach for exploring women's views

of self including gender and professional identity. A life story narrative is particularly useful in helping researchers define participants' place in the social order and understanding how they arrived in a particular place (Atkinson, 1998). Insight into the details of a person's life is possible because narratives present the details in encapsulated stories (Moen, 2006). By collecting and analyzing the life story narratives of women scientists, I elicited the stories they used to make sense of their career experiences in relation to their views of self.

Data Collection

Participant Selection

Participants were purposefully recruited using "snowball" or "chain" techniques (Creswell, 2007) beginning with professional contacts of faculty working at my employing institution and three other higher education institutions in the state of North Carolina. Snowball sampling techniques rely on effective use of personal and professional networks to identify participants who meet the researcher's predetermined criteria (Miles & Huberman, 1994). Beginning with my own contacts, I sent out an informational e-mail requesting referrals to potential participants. I sent out over 30 initial informational e-mails. Every potential participant referred to me received a detailed invitation to participate, including an introduction to the purpose of the study, the time commitment required, and the scope of their involvement (Appendix D). Over the course of three months, 12 women responded favorably to my invitation, but for scheduling reasons and other reasons not shared with me, four of the women chose not to participate.

Ultimately, a total of eight adult women working full-time within academic science, technology, engineering, or mathematics were recruited to participate in the study. The critical criteria for selection were that the women identify themselves as scientists during the recruitment process, currently hold full or part-time employment in academia within a science, technology, engineering, or mathematics profession, agree to participate in two interviews, and agree to disclose self-reported biographical information. The eight women recruited to participate in the study represent the professional disciplines of food science, horticultural science, chemical engineering, physics, industrial engineering, mathematics, and information technology. Table 3.1 lists the participants, their terminal degrees, and current position titles.

Table 3.1 – List of Participants

Participant	**Degree/ Discipline**	**Position**
Susie	Ph.D/ Food Science	Program Coordinator
Lane	Ph.D/ Horticultural Science	Professor
Lisa	Ph.D/Chemical Engineering	Associate Professor
Teresa	Ph.D/Physics	Assistant Professor
Marie	Ph.D/Industrial Engineering	Professor
Christine	Ph.D/ Mathematics	Professor
Jeri	Ph.D/ Mathematics	Lecturer
Katie	Ph.D/ Information Technology	Associate Professor

To increase the opportunity for varied perspectives on careers in academic science, I sought participants who varied in age, race, ethnicity, and cultural background. While I was able to recruit participants who ranged in age from 34 to 66, I was not successful in recruiting women with ethnically or culturally diverse backgrounds. Seven of the eight participants identify themselves as being white Americans. The participants are employed at institutions with varying structures and missions, including one participant who works at a community college. By varying the sites where I recruited participants, I hoped the study results would reflect the individual experiences of the participants rather than the culture of a particular type of institution (Patton, 2002). Additionally, I recruited women who indicated an interest in sharing their career experiences and demonstrated a willingness to participate in the study (Moustakas, 1994). The participants were not only interested in the topic of the study, but were also willing to engage in reflection and self-disclosure.

Participant Interviews

After confirmation of their participation, the women selected for the study were asked to complete a biographical timeline worksheet (Appendix F) as a way to encourage reflection on their experiences in relation to their career development processes (Atkinson, 1998). Additionally, each woman was asked to participate in two 60-minute, semi-structured life story interviews regarding their career development experiences across the lifespan. I requested that each woman submit her reflection worksheet before the second interview so that I would have time to review their responses and adjust my follow up questions accordingly.

To make the interview process as convenient as possible for the participants who lived in various locations across the southeast United States, I developed a plan to conduct and digitally-record either in-person interviews or telephone interviews using *skype* voice over internet protocol (VOIP) technology and its partner software tool, *Pamela Call Recording*. With an inexpensive three-month subscription to skype and the call recording software, I would be able to place telephone calls to the participants from my computer and digital record the conversations from start to finish. Additionally, the skype subscription would allow me to contact the participants who might be using a traditional home or office telephone.

The interviews were conducted in the style preferred by each participant. Surprisingly, all of the participants chose to participate in telephone interviews indicating that their schedules were too busy to allow for two in-person meetings. I had some initial concerns that conducting interviews using internet technology might create distance between me and the participants in ways that would stifle my ability to collect their stories. However, I found that I was able to put the participants at ease fairly quickly and build rapport with them despite not meeting face-to-face. Although never articulated, the fact that half of the participants used skype suggests that they were comfortable with similar teleconferencing processes.

Each of the two interviews were scheduled to last no more than 60 minutes and typically lasted 45 to 50 minutes per session. The purpose of the first interview was to elicit each participant's life story narrative and the purpose of the second interview was to follow

up on the gender identity or gendered career experiences disclosed in the initial interview (Riessman, 2002). To elicit personal narratives that indicate the positioning of self within social discourse as well as women's privileged identities, I asked interview questions that focused on family dynamics, educational experiences, personal values and influences (Atkinson, 1998). My goal was to understand science career experiences from the viewpoint of each participant in the study. An interview guide (Appendix E) was used to structure the interviews and allowed for additional questions when participant responses needed follow up or clarification. Further, the interview questions were arranged to begin with general questions that became more specific as the participant revealed more details about her experiences.

Using a relaxed, conversational approach, I encouraged the participants to share those experiences that were most meaningful to them (Clandinin & Connelly, 2000). By listening to the women and asking follow up questions specific to their stories, I wanted to demonstrate my interest in them as unique individuals. I opened each interview by briefly sharing my background and the reasons I am interested in their experiences as women scientists. I hoped that the development of rapport and trust over the course of two interview sessions would result in participants feeling more comfortable with disclosing information about their personal experiences. I took notes during the interviews to capture my initial thoughts and feelings from each experience. At the end of the first interview, I scheduled an appointment with each participant for a follow up interview.

Following each first interview, I reviewed my notes as well as each participant's biographical timeline or "reflection" worksheet. I also reviewed the interview recording. These steps helped me identify areas for follow up or clarification. The second interview, like the first, was intended to be conversational and comfortable for the participants. I asked open-ended questions intended to explore more fully possible selves and career experiences introduced in the first interview. Follow up questions in the second interview were selected to provide participants with an opportunity to reflect on their previous disclosures and share new insights (Atkinson, 1998). I closed each interview by asking the women if there was anything else they would like to add and providing them with an overview of the next steps in my data collection process.

Data Analysis

For the purposes of this narrative inquiry, the data collected for analysis was in the form of transcribed text from digitally-recorded participant interviews and text from participant biographical reflection worksheets. Conscientious about my process as a new researcher and concerned that I would draw conclusions about the study findings prematurely, although I listened to the interview recordings to prepare for follow up interviews, I waited until all interviews had been completed before transcribing the recordings. I was particularly concerned about drawing early conclusions and then purposefully selecting or only following up on participant responses that fit my initial judgments of the data being collected. Since some of the interviews occurred six weeks before I began the transcription process, review of my interview notes and initial reflections

(as recorded in my research log) were helpful in refreshing my memory regarding the individual interview sessions.

My underlying assumption in analyzing the collected texts was that they represent the lived experience of the study participants (Reissman, 1993; Denzin, 1989; Cole & Knowles, 2001). To manage the large amount of data I collected, I continuously reviewed the purpose of the study and guiding research questions and worked to avoid exceeding the scope of the overall project.

Coding the Data

The interviews and biographical timelines were reviewed using narrative analysis techniques. The process of analysis involved several rounds including "re-storying," coding and categorization of data for emergent patterns, reviewing appropriate literatures to contextualize and situate the data patterns, and identifying my positionality as the researcher (Denzin, 1989).

Re-storying the Narratives. Guided by Riessman's (1993) recommendations, I began analyzing the narratives by "hearing" the story from the perspective of the participants. Riessman suggests that by focusing on the narratives' internal structures first, researchers avoid the tendency to simply focus on the words used in the content of the transcripts. For example, as I listened repeatedly to the interview recordings and re-read each woman's interview transcripts, I looked for the stories she was conveying with her words before paying attention to what she values as important, what she dislikes, what she accepts to be true, etc. My intent in this process was to start my analysis from inside the stories as a way of

privileging the participants' voices in describing their educational and career-related experiences.

Once I had a sense of each woman's experiences, I created a biographical narrative describing how her math and science interests developed form early childhood through her current career as a scientist working in higher education. By using the participants own words as much as possible, I worked to represent each woman's unique career journey.

Looking for Patterns. As outlined by Miles and Huberman (1994), I also created start codes prior to conducting the interviews and distributing the biographical timeline worksheets as a preliminary structure for categorizing the data. My initial codes were derived from the literature on women in science and possible selves. For example, I began with desired, feared, and expected selves from Markus and Nurius (1986); math and science self-efficacy from Betz and Hackett (1983); altruism and science relevancy from Weisgram and Bigler (2006); and career conscription and compromise from Gottfredson (1981).

After completing the initial biographical narratives, I used the start codes to conduct several rounds of thematic coding looking for common elements across all of the participants (Miles & Huberman, 1994). Throughout the coding process, I worked to keep the underlying messages within the participants' narratives intact (Stake, 1995). Keeping stories intact is a central aspect of narrative analysis and provides the basis for the researcher's subsequent interpretation of findings (Riessman, 2008). Marshall and Rossman (1995) suggest that this may be the most challenging aspect of the process for researchers as they try to remain true the participants' experiences while constructing coherent codes. For instance, I found that the

gathered data did not always confirm women scientists' experiences as described in the literature and made corresponding notes in my research log.

After several rounds through the data, the start codes were refined. For example, altruism and science relevancy did not emerge as a theme, but the concept of intellectual curiosity did. Similarly, career conscription and compromise emerged in connection with the participants' obligation to family responsibilities and their preference for the higher education work environment. Some codes were not found in all of the transcripts. I paid close attention to the codes and related concepts that appeared in five or more of the participants' transcripts and used them as the basis for identifying common themes. When I was no longer able to identify unique codes from the data (Miles & Huberman, 1994), I ended the coding process. By grouping related codes, I ultimately identified seven common themes across the participants' individual experiences: a) education is a core value, b) intellectual curiosity is encouraged, c) teachers are mentors, d) gender is not a barrier, e) family needs direct career path, f) higher education is the preferred work environment, and g) I'm an educator who teaches science.

Situating the Data. The literature reviewed in chapter two informed my data collection process. Accordingly, I consulted existing research findings to define and re-define my codes and categories for data analysis. The process of consulting the literature helped me identify areas of the participants' experiences that aligned with what is already known about women scientists. For example, the participants in this study are generally confident in their math ability which has been identified as a key component of persistence in math and science

careers. Consulting the literature also helped me identify potentially new or neglected aspects of women scientists' experiences. Additionally, existing literature assisted me in making sense of the women's stories by filling in gaps between my experiences and their experiences. To support my efforts in situating the data, I used my research log to keep track of the coding process. Notes in my research log helped me track key terms, coding categories, and how my process changed over time. Research notes also helped me identify elements of my own bias as a researcher.

Identifying my Positionality. Although I worked to privilege the voices of the women who participated in the study, I recognize that as the primary instrument of data collection and interpretation (Merriam, 1998), my biases and assumptions shaped the research findings. Throughout data analysis, I paid attention to how various elements of the women's narratives challenged or supported my way of thinking and being in the world. I remained critical of personal judgments that urged me to draw conclusions early in the process. As mentioned above, writing research notes to track the choices I made during data analysis helped me identify my positionality. I also used my research log to track feelings and ideas as I listened to interview recordings, reviewed transcripts, and categorized the data.

Reporting the Findings

After completing the coding process, I organized the codes into a pattern that tells a story about the views of self and career experiences of the study participants. Using the themes and patterns that emerged as an outline, I constructed an aggregate narrative that captured my interpretation of the women's common experiences as women scientists

working in academia. To give the narrative depth and life, I used direct quotes from the study participants (van Manen, 1990). Since the purpose of the study is to understand the views of self and career experiences of women scientists from their own perspectives, I used their words to help the reader understand their story from the inside out. In chapter four, I present the finalized aggregate narrative along with a table of summarized participant demographics and the previously mentioned biographical narratives that were created to highlight the unique experiences of each woman.

Veracity and Trustworthiness

As a researcher, I am responsible for following ethical guidelines for conducting research involving human subjects. I reviewed the Informed Consent (Appendix C) process with each participant and received her signed acknowledgement before collecting data. I maintained the confidentiality of the participants throughout the process by assigning pseudonyms and storing data in ways that were not identifiable to specific participants. I have been as transparent as possible regarding my subjectivities and engaged in member checking as a way to provide participants with a voice in guiding my interpretation of their experiences. Additionally, I consulted with my faculty advisor as a way to challenge my assumptions and reflect on my thought processes throughout the research project.

Pilot Interview

Before beginning the full study, I completed a pilot interview with a woman who did not meet the requirements to participate in the study. The purpose of the interview was to practice my interviewing techniques, test my interview recording protocols, and gather

feedback on the structure and content of the interview questions. Based on her feedback, I was able to make appropriate adjustments to the order and timing of my interview questions.

Member Checking

The study participants' approval and confirmation of the results is an important measure of the study's credibility (Lincoln & Guba, 1985; Patton, 2002). I verified my understanding of each participant's interview responses by providing them with opportunities to give me feedback regarding my interpretation of their experiences. The individual biographical narratives and the aggregate participant narrative describing common themes were shared with participants on two separate occasions. While most of the participants did not have specific recommendations, two of the eight women pointed out a few inaccuracies and made suggestions regarding the common themes. The finalized version of findings presented in chapter four reflects the participants' suggested changes and recommendations.

Limitations of the Study

My study is limited by its use of a narrative approach. Narrative inquiry provides snapshots from the ongoing, ever-evolving lives of the participants. For this reason, the strength of narrative inquiry is its ability to reveal small parts of a much larger story. Additionally, my study used interviewing techniques which rely on participants' recollections and their capacity to provide rich detail of their internal world (Denzin, 1989). I found that the participants varied in their level of comfort with sharing their stories as well as in their use of language to describe their experiences. Further, in order to remain sensitive to issues of nuances in speech, structures of response, local contexts of production, and social

discourse that shapes what is said and what is not, narrative inquiry is limited in scope (Reissman, 2008) and typically will not allow for large numbers of participants.

Accordingly, my study was specifically designed and tightly defined to illuminate the possible selves and career experiences of women scientists working in academia. Focused on the gendered aspects of women scientists' career narratives, my study did not attempt to address issues related to culture, race, ethnicity, age, sexual orientation, or socioeconomic status. While I acknowledge that many of these elements may inform the themes that emerged in my findings, focusing on the many other aspects of identity was beyond the scope of this research project.

Finally, this study is limited by the subjectivity and positionality of a single researcher. As the primary research instrument, my perspectives and beliefs shaped the interpretation of data collected in this study (Merriam, 1998). My interests and experiences determined the research questions and choice of content for study. For example, my choice of a feminist standpoint framework assumes that gender dynamics are part of women scientists' development of self views and career negotiation. As I collected participant narratives, analyzed the data, and interpreted the findings, my positionality as a researcher gravitated toward the gendered aspects of women scientists' views of self and career negotiation.

Chapter Summary

This study employed a life story narrative approach to explore the interaction between women scientists' views of self and their career experiences in higher education. A total of 8

women were recruited to participate in the study and were selected based on their current full-time employment status within academic science, technology, engineering, or mathematics disciplines. Over the course of two semi-structured, life story interviews, I elicited the significant experiences shaping the women's views of self and their careers. Using thematic narrative analysis, interview transcripts were reviewed and coded to reveal the individual career journeys of the participants and the common elements identified across all of the participants' stories. In the next chapter, my interpretation of the participants' experiences is presented in individual, biographical narratives as well as an aggregate narrative.

Chapter Four: Findings

To explore how women create scientist possible selves which enable them to negotiate careers within the academy, I designed a narrative inquiry guided by two research questions: 1) how do women scientists develop views of self, and 2) how do women scientists negotiate their careers? The findings reported in this chapter were developed through analysis of the data collected using possible selves theory and feminist standpoint theory as frameworks. In answer to Question 1, the findings indicate that the women scientists in this study developed their views of self or "possible selves" through interactions with supportive family members and teachers. Additionally, the findings indicate that women scientists' possible selves are gendered by virtue of their existing social-historical context and their experiences in male-dominated academic science environments. In answer to Question 2, the findings indicate that the women scientists in this study developed a view of themselves that is compatible with their interests in math and science, but also aligned with their gender beliefs regarding the roles and responsibilities of women. Specifically, rather than view themselves as scientists, the participants in this study developed a view of themselves as "educators who work in science."

The data supporting these findings were collected from eight women who were recruited to share their views of self and career-related experiences across the lifespan. Semi-structured interviews were the primary data collection method for this study. Additionally, each woman was asked to complete a reflection worksheet that prompted her to

list or describe significant events and relationships that supported her interests in math and science. The interviews were designed to collect biographical information, but also intentionally designed to gather the women's beliefs and perceptions about themselves in relation to their science careers. Interview recordings were transcribed and analyzed using the narrative and thematic coding methods outlined in Chapter Three.

The participants range in age from 34 to 66 and represent the diverse disciplines of food science, horticultural science, chemical engineering, physics, industrial engineering, mathematics, and information technology (see Table 4.1). All of the women hold doctorates in their respective fields and are currently employed as faculty members at institutions of

Table 4.1 – Participant Demographics

Participant	**Age**	**Race/ Ethnicity**	**Family Status**	**Degree/ Discipline**
Susie	56	White	Widow, 1 child	Ph.D/ Food Science
Lane	51	White/ Native American	Married, 2 children	Ph.D/ Horticultural Science
Lisa	46	White	Married, 1 child	Ph.D/Chemical Engineering
Teresa	34	Hispanic	Single	Ph.D/Physics
Marie	47	White	Married, 1 child	Ph.D/Industrial Engineering
Christine	58	White	Married	Ph.D/ Mathematics
Jeri	46	White	Married, 2 children	Ph.D/ Mathematics
Katie	66	White	Divorced, 2 children	Ph.D/ Information Technology

Table 4.1 – Participant Demographics Continued

Participant	**Position**	**Tenure Status**	**Institution Type**
Susie	Program Coordinator	N/A	Community College
Lane	Professor	Yes	Large, public university
Lisa	Associate Professor	Yes	Large, public university
Teresa	Assistant Professor	No	Large, public university
Marie	Professor	Yes	Large, public university
Christine	Professor	Yes	Large, public university
Jeri	Lecturer	No	Large, public university
Katie	Associate Professor	No	Small, public university

higher education. For purposes of the study, the eight women are referred to by the pseudonyms Susie, Lane, Lisa, Teresa, Marie, Christine, Jeri, and Katie.

The distinctive elements shaping the participants' individual experiences and their possible selves are presented in biographical profiles that were developed by analyzing and reflecting on each woman's narrative in a case-centered approach as outlined by Riessman (2008). For effective analysis of narrative, Riessman suggests first listening for, and identifying, the stories that each woman is relating through her words. While the participants' stories are unique and reflect their individual lives and views of self, their nontraditional experiences as women working in math and science disciplines share some commonalities. I developed an aggregate narrative of the women's experiences that is reflective of the

elements common to their possible selves and career paths. The full text is presented following the participant profiles.

In general, the participant profiles and aggregate narrative follow a life-story progression beginning with childhood and family experiences, proceeding to educational experiences, and ending with career experiences. Additionally, the participant profiles and the aggregate narrative are structured to highlight the women's possible selves and the meaningful experiences that shaped those views. Direct quotes and excerpts from the interview transcripts and reflection worksheets are interspersed throughout the subsequent sections of this chapter as support for the findings presented.

Susie

Susie has vivid childhood memories of being surrounded by "animals and the outdoors" in southern New Mexico. Inspired by her parents' respect for nature, she embraced opportunities to explore her home state.

> We would go out and look at the chollo cactus blooming each spring. We would camp and fish in the mountains of New Mexico. As a family we would sit outside and watch the sunsets and talk about how beautiful it all was. I still have the rock and fossil collections from my family that we collected over the years.

Touring the Goddard museum in Roswell, New Mexico; working with her family in the orchard and garden; and raising livestock with 4-H remain meaningful early experiences.

More than likely, involvement in 4-H set her on a course for a career in animal and food science. "I took Veterinary Science in 4-H and anything to do with animals or

gardening." Favorite activities included riding horses, raising sheep, rating meat products, and judging the quality of wool. From as early as fourth grade, she looked forward to opportunities to discover and explore in science class and was disappointed to be excluded as she grew older. "I wanted to be in Vo Ag, but they wouldn't let me because I was a girl, so I was active in 4-H." Involvement in 4-H became her primary mechanism for developing skills in scientific observation and investigation.

Unlike younger students, ninth-graders could choose between a home economics class and a science class. Choosing science over home economics wasn't difficult.

> I was still such a big tomboy. And I remember, we had an open house and my parents came and we were going through talking to all the teachers. And the Home Ec teacher was like, "Oh, she'll be coming in the ninth grade and we learn about dating and we learn how to dress nice." You know, all that kind of stuff. No way! (Laughs). I'm not going to do that! So, that helped me say I wanted to take science that year.

Thriving as one of the few girls taking science class, she thought about becoming a veterinarian so she could work with cattle. Before high school graduation, she changed her mind deciding not "to deal with the veterinarian situation." Observing the struggles of other girls who graduated ahead of her, she wanted to avoid the same challenges. "I had friends who were the first girls to go to Texas A & M to vet school. It was hell on wheels for them." She doubted her ability to handle the academic pressure. "And, of course at that time, you had to have a 4.0 average and it was harder to get into vet school because there were fewer of

them than there are now." Studying animal nutrition or meat production seemed more feasible.

A part-time job with the United States Department of Agriculture (USDA) meat inspection service as a college senior led directly to professional employment as a meat inspector. Dissecting meat products in search of disease tested her knowledge of anatomy and pathology. While perfecting her skills as an inspector, she sought new opportunities and volunteered for the USDA's commodity market meat grading service. While the work was rewarding enough to continue, there were some work-related frustrations and incidents of overt sexism to manage.

> . . . I was stationed in a field station. So, I would be home for two weeks and away two weeks. I really got tired of that. I was single, so I got the really bad jobs of having to work on holidays so that everyone who was married could stay home with their families.

The migrant workers she interacted with in the field were often derogatory and disdainful of her qualifications to be an inspector.

> But uh ... a lot of the people I worked with had a hard time with women in that role... in that position. And, it was an authoritative role being an inspector. And, there was just... you know, a lot of times they tried to push your buttons or try to see how far they can push you where you wouldn't try to make them do something, basically. . . you know, that was a requirement. So, you know, they thought because you were

> woman, you would be easier on them. Then, if you were super hard on them they would say you was a bitch. You know, so we were going through that kind of stuff all the time.

By age 25, it was time for a change. She considered moving away from agricultural sciences to study business management. A stint as a juror brought her into contact with a man who was working on his MBA. His description of the type of work she would be doing was enough to convince her to continue her science pursuits.

After completing a master's degree in agriculture, rather than return to the USDA, she chose to teach at a small state university in Oklahoma. In addition to supervising a lab, the next 11 years were filled with teaching a variety of courses including meat judging, reproduction of farm animals, and artificial insemination of farm animals. On a professional level, working in higher education was satisfying, particularly coaching students in meat judging and other activities. While on the personal front, her life expanded significantly following marriage and the birth of her son.

Plans to begin doctoral study unexpectedly changed when her husband died as the result of a brain tumor. Suddenly a widow with a young son to raise, her priorities shifted. Originally, the plan was to study at a university in Kansas. After her husband's death, she needed full-time work. Managing the commute to Kansas while raising a toddler was simply not possible. Completing her doctoral studies as a distance education student, while working full-time, became the best option to achieve her professional goals.

After earning a doctorate in food science, pursuing a tenure-track faculty position wasn't a serious consideration. Instead, starting up a consulting service as a food safety expert enabled her to maintain flexibility in her work schedule. Her expertise and professional training through the USDA prepared her to work with a variety of clients including hotels, restaurants and hospitals. While she enjoyed the autonomy of being a consultant, she wasn't an effective business woman. More often than not, she gave away advice on food safety and nutrition.

On the promise of additional opportunity and a possible business partnership with a friend, she moved her small family to North Carolina. The business partnership didn't materialize, but other opportunities opened up in her new home state. She accepted a couple of positions working as an adjunct faculty member at small colleges teaching "anatomy and physiology, microbiology, etc." Eventually, through perseverance, she earned a full-time position at the community college where she now serves as the Program Coordinator for Biotechnology. Designing the program curriculum, as well as teaching, allows her to be a "developer" taking projects from the idea-generation phase through the implementation phase. As Program Coordinator, she expresses her passion for finding new ways of using technology to deliver educational content to students.

At this point in her career as a food scientist, having written a handbook on safety in livestock production (used by the U.S. Army to train farmers in Afghanistan) is a significant source of pride. Additionally, utilizing her expertise to support a faith-based veterinary mission has created opportunities to consult on projects outside of the United States. Still, the

most meaningful accomplishment is having a son follow in her footsteps by earning a degree in animal science.

Lane

Born and raised in rural Maine, the hard work and pleasures of gardening are embedded in Lane's earliest memories. Inspired by her grandfather, "an avid gardener," she learned to plant flowers and share in the maintenance of the large vegetable garden that helped feed the family during the long winters. Having enough money for necessities was a constant struggle. After her parents divorced when she was 13, the family's "poverty level became acute (less food, loss of plumbing). . . ." After the divorce, her mother's fortitude enabled them to stay in the same house and avoid changing schools.

The culture clashes that ended her parents' marriage also shaped her values regarding formal education. Her father "was a multigenerational Mainiac with the associated inbreeding effects from 300 years in the same state." By contrast, her mother "was from out of state . . . and had been raised with a strong sense of not dropping standards to the local level –such as, using correct grammar and accent." When her mother took on the responsibility of leading a 4-H chapter, she benefited from opportunities to learn and broaden her perspectives. While her father saw no value in higher education, her mother insisted that education was the way out of poverty. "Mother not only encouraged college as the next step after high school, but started a degree program herself."

Teachers at the high school shared many of her mother's beliefs regarding the value of education.

> Teachers in high school came from "away." At this time, college loans could be forgiven if teachers worked in districts deemed as poverty level. So, we gained teachers from other states (New York, New Jersey, Pennsylvania, Massachusetts), from more affluent and more sophisticated backgrounds who understood the need for higher education and had outside views. Teachers actively encouraged questioning rather than acceptance (this was also during the late 60's, early 70's).

Despite her love of plants, she never considered pursuing horticultural science as a career until her mother announced to her teachers that she would study plants in college.

Surprised, but agreeable, she began researching colleges with the idea of studying plant science.

> Mother decided pretty much what I should study, pointing out [my] strong interest in plants. Although surrounded by fine schools and several Ivy League schools in the area, I chose to go to a land grant university because it was closest to what I thought was most relevant (i.e. plant sciences was closer to working with plants than biology would have been) . . . .

Given the financial deprivation of her childhood, the cost of a college education and choosing an appropriate career path were significant concerns. "[I was] also afraid of the financial burden of attending a private school. At this time, still no idea what I would do after college, vague ideas of being a greenhouse or gardens attendant."

Attending a university was a revelation. “Found for the first time that [I] felt in the right place with others like myself (interested in academic pursuits rather than just sports).” While the plant science courses were enjoyable, soil science courses were more readily available. Working as a lab assistant through the federal work-study program proved to be more pleasant and rewarding than being out in the field, weeding. She started to believe a career as a lab scientist might be possible.

During her senior year in college, life changed significantly as her personal and professional future took shape. First, she married a “local guy who was ambitious and also wanted me to accomplish higher things.” Then, the chair of her academic department introduced the idea of pursuing graduate study which, admittedly, “had never occurred to me.” With the encouragement of her husband and undergraduate faculty, she applied to three graduate programs.

> [I was] accepted at two, and decided to move far away (to Florida) to escape family pressures on both sides, as well as the rust belt years of Maine (few job opportunities, grinding poverty). This turned out to be one of the most significant stepping stones – leaving familiar surroundings and knowns for the great unknown.

Successfully navigating the personal and professional environment surrounding her graduate program boosted her confidence.

> Again, felt as if [I] belonged in [my] new status a graduate student with people of similar interests around. Making the move from Maine gave me a stronger sense of confidence in being able to handle what hurdles came my way (and there were many).

> At the time I entered the department . . . there were two female graduate students, no female professors/instructors, and the first female had just completed her PhD. Had some professors tell me that I belonged in the kitchen which simply fired my desire to finish.

Despite enjoying her course of study, the political environment of her academic department took its toll.

> After seven years in [Florida], with the infighting in the department and traffic with rich students, I wanted to go back to a more rural setting and people who could at least get along. Many of my friends were finding that as females, it was still difficult to get equal pay and status in university settings. So, I took a position with the government (who were actively recruiting women at equal pay) at a small isolated station in rural Oklahoma.

While working outside of the academy provided a certain amount of relief, she soon missed the intellectual stimulation of interacting with faculty and students. “I quickly found that brain death was inevitable unless I kept myself actively engaged out of state, first in travel, then in professional matters.” Changing professional circumstances, and the fear that her field station would be shut down, prompted thoughts of returning to higher education as a faculty member.

After finding an opportunity to teach in North Carolina, with the support of her husband, she moved her family back to the east coast. In her current role as a professor, she enjoys “being engaged with students and their enthusiasm.” The administrative

responsibilities of being a faculty member, such as writing grant proposals and annual reports, are the cost of having autonomy as a researcher and resources to support the scientific discovery process.

Lisa

As a child, Lisa was exposed to the idea that a woman could have a career and a family.

> My mother worked full-time. So, certainly I saw her example of someone who had a full-time career and was a mom. So, she was a great, great example and model for me . . . I think seeing my mom as a working mother just made me think, well, of course I can do this.

Despite having two parents working in the banking industry, there was never pressure to follow a similar career path. Her parents taught the value of education and allowed her to direct her own interests and set her own goals. Being naturally “achievement oriented,” her standards for excellence were high.

> When I was in high school, I was very academically focused. I was the valedictorian, but I was also the senior class president and I was editor of the yearbook and very involved in my church . . . and I certainly didn't get pressure from my parents to do that it was just something that I wanted to do.

She wasn’t especially interested in math and science at first. She didn’t connect science coursework to a potential occupation. In fact, until high school, the idea of being “a photographer for National Geographic” remained intriguing. As she was preparing to enter

tenth grade, the ninth grade science teacher suggested that students “don’t need to sign up for Honors Biology” unless they planned to be scientists.

> (Laughs). I didn't sign up for honors biology. And over the summer, my...uh, the biology teacher from the high school called me at home and said, ‘this is [the science teacher] and I'm teaching honors biology at [the] High School and I was wondering why you didn't sign up for honors biology. You look like a very good student and someone who should.’

The intervention and support of her high school science teachers set her on the path toward a science-related career. As she progressed through chemistry, physics and calculus courses, she was encouraged to consider a career in chemical engineering.

> When I took chemistry in the 11th grade, I really enjoyed it and my high school chemistry teacher who was trained as a chemical engineer encouraged me to consider engineering as a profession. I think if he had not had that background, he might not have been familiar with that discipline and encouraged me in that direction.

Confident in her choice to pursue a degree in chemical engineering, the next step was enrollment in a competitive land-grant university.

She flourished as an undergraduate student. Her life-long record of academic achievement continued without any apparent gender constraints.

> You know, chemical has traditionally been one of the more female-friendly disciplines along with biomedical. So, there were several other women in the class. And actually one of the more important things I did that contributed to my success is I

> found a study group about my sophomore year. We were actually put into teams to work on homework and I was put on a random team and I was with all men. And we just kind of clicked and we just stuck together the whole way. Even when teams weren't assigned, we were a team. And we always worked together.

Interactions with faculty were generally positive and evolved over time into the supportive, collegial relationships she continues to enjoy in her professional career.

The ability to create supportive networks led to diverse internship and research opportunities as a student, including working for DuPont, Argonne National Lab, and Washington Internships for Students in Engineering. Through these experiences, she refined her career interests.

> And by the time I got to my senior year, I knew I didn't want to work in manufacturing because I worked at DuPont. I knew I didn't want to work, say, for the government because I had an engineering public policy internship. I knew I didn't necessarily want to work in a national lab setting because I had done that. They were all great experiences, but they sort of helped me define okay, I don't want to do that, I don't want to do that, I don't want to do that –okay, I guess I want to do this.

"This" turned out to be pursuing a doctorate in chemical engineering with a focus on "process design and optimization." The study of process design would allow for the development of expertise in a variety of contexts and prevent the professional challenges of being too narrowly focused.

A position in industry working for a large chemical company followed completion of her doctorate. Over the course of nine years, she applied her process-modeling and problem-solving skills to numerous projects. Despite having colleagues who "were great to work with" in an environment that was "very family-friendly," she began to long for a change.

> When I was at Eastman for about 10 years, I had moved from a technical position to more of a management position and I was doing a lot of traveling and at that time I had a 2 or 3 year old. I was thinking, "You know, I'm not enjoying this travel. I'm not enjoying the business aspect as much as I had the technical." So, after being there for 10 years it was sort of the point of I'm either going to stay here and take whatever path I'm going to take or I'm going to make a change.

Hoping to return to her home state and be closer to family, she applied for an administrative position at her undergraduate institution. "So, I actually applied and did not get it, but in the course of going through the process I reconnected with the Chem E department." She was invited to come back and teach a senior design course. Although she had not seriously considered teaching in the past, she now had experiences and expertise that might be beneficial to students. "So, after I had worked for 10 years, I thought I would really enjoy teaching because I could convey things I had learned about process design and industry and professional development, etc." Serving as a visiting professor for a few years led to classification as a lecturer, then to an appointment as a teaching associate professor responsible for the direction of the undergraduate program.

She finds freedom and fulfillment serving in a non-tenure track faculty role. “I never had the intention of pursuing a tenure track position. I did fine with the research when I was in graduate school, but that really wasn’t what I enjoyed and wanted to focus on.” Instead of developing research projects, her time is spent addressing the needs of the undergraduate students in the chemical engineering department. “It’s really important to have someone in the department who can focus on undergraduates, who can do a good job of teaching, who can do a good job of advising, and all the curriculum, and all of the scholarships, and co-ops and undergraduate stuff that needs to be focused on.” She helps students broaden their perspectives on what chemical engineers can do with their knowledge and experiences.

Teresa

Teresa was a solitary child set apart from her peers, in part, because of her unique family background. Her parents, well-educated political refugees from Argentina and Chile’, met while hiding in Peru. When she was a baby, her family immigrated to Canada with limited financial resources. Judged on first appearance as poor and ignorant by classmates and teachers, school was a place that fostered intolerance rather than a source of positive growth.

> No, teachers were never inspirational to me. I mean... I grew up... my parents were immigrants and I grew up pretty poor. And I had teachers that were... if anything, they were the opposite. Throughout my childhood, I had teachers that were mean and racist and I just didn't... um, absolutely not.

Given their poor treatment of her, teachers’ opinions had no value or influence.

By age 12, she recognized the extent of her isolation and disconnection. “I didn't... um... no, I wasn't... when I was growing up, I wasn't part of any... I didn't have any extracurricular activities. I wasn't involved in anything. I never played sports. I was always terrible at it. I never got involved in any clubs at school. So, it's not like there's anything around me that.... Mostly, I just pursued my interests on my own.” She was lost and conscious of having perspectives that were out of step with those around her.

Development of a diverse intellectual life was encouraged at home. “I just kind of absorbed everything around me. And that was what was fed to me. My dad was always interested in watching those PBS documentaries, so it was something I did with him.” An early interest in art emerged, but wasn’t an appropriate career consideration. Despite her natural leanings toward artistic expression, pursuit of a more pragmatic professional occupation was expected. “It's something I always wanted to study, but was never encouraged 'cause, you know you can't really do much with a degree in art.” So, art was enjoyed quietly while the focus on learning and developing her talents in math and science increased.

Her interest in physics emerged during high school. The subject matter was interesting and challenging while reading books about physics-related topics was equally compelling. For the first time, she was intrigued by the intelligence and unique approach presented by a teacher.

> I did have a really awesome physics teacher in 11th and 12th grade. And that was fairly inspirational, but I don't think that was directly inspirational in that I didn't

> interact with him on a one-to-one basis very much. He was just a very interesting person and in that sense he inspired me. And I liked the way he taught.

He set a high standard for performance and was only interested in working with students who could meet that standard. His teaching style was refreshing, challenging her in a way that her other classes had not.

Being a talented student of physics didn't initially lead to a physics major in college. "Actually, philosophy and English were my primary interests, but I was heavily guided towards science . . . ." Friends encouraged her to consider physics because of her skill in that area. "I was always really good at it, so people . . . when it was time to go to university, I was strongly encouraged by absolutely everyone around me, even my friends, that I should get into science rather than the humanities." Ultimately, physics was an appropriately challenging subject of study and something that she couldn't master on her own.

> And when I chose to study physics, it was out of... I. thought out of everything I'm interested in this is the one thing I'll never be able to teach myself. So, I'm thinking if I'm going to invest in this education, I should make it for something out of all my interests this is the one thing I'm never really going to sit down and read a book and learn about.

Enrollment in graduate school followed as a natural extension of her plan to pursue a career in physics. Unfortunately, graduate school proved to be a tenuous experience. In addition to being a woman, her diverse interests made her feel even more different from her male peers. "My male peers could bond over sports and beer, for example, which I never

shared, but I could never bond with anyone over my interest in art." Working as a post-doc in a national lab was similarly discouraging: ". . . not so much obstacles, but I guess difficulties in just that feeling of not fitting in." As she had been in childhood, she was disconnected from her colleagues because of her perspectives and artistic personal style. "I never felt comfortable wearing a skirt (and I *love* to wear skirts and dresses). I really enjoyed my post-doc experience in the work itself, but the environment was quite stifling and didn't fit my expressive personality."

Accepting her current faculty position at a large state university in North Carolina introduced her to a work environment where she can be herself. Unlike the post-doctorate experience of working in a national research lab, serving as a faculty member in a physics department feels better both personally and professionally. "Well... right now, my work life is pretty good. I love my department. Everyone's really open and friendly. So, I think I have a very positive working environment and I think that's probably what allowed me to feel free in pursuing other interests." Contentment in her personal and professional life means she can both enjoy her work and continue to explore her diverse interests.

Marie

Marie has always been comfortable in the company of men. Born "the fifth child of six," early years were spent tagging along behind three older brothers to attend, and participate in, sporting events. "My oldest brother (nine years older) took me to fun track meets so I could compete –he acted as my coach. I was comfortable around the guys –his

friends." An early interest in mechanics came from assisting her father with projects around the house.

> I often observed (helped) my dad work on the home air conditioning unit which failed often. I also "helped" when dad worked on the engine of our boat (Mercury 500). My "help" was always welcomed and encouraged.

By the end of elementary school, her talent for mathematics was apparent. "In 5th grade, I was separated from the other students (except one male) and worked ahead in math as an individual since I quickly moved through what they were working on as a class." Interest in math and science never set her apart or made her feel different from other girls.

> My academic success was always encouraged. I was surrounded by classmates who excelled in academics. We had honors classes that included both males and females. I never felt as if I was the only female in class.

Inspired by her older brothers and wanting to follow their lead, she selected electrical engineering as her major in college. "One brother was a computer science and math student in college; another was an electrical engineering major. I always thought if they could do the work necessary to be successful in these majors, so could I." Supportive parents allowed her the flexibility and freedom to choose her own path. She chose to attend a small university in Ohio "where students were strongly supported by the professors."

The lack of women faculty members in college had no affect on her academic performance.

> Our class was over 20% female, so we did not feel that we were not represented. Students were treated equally. I was the strongest female student in their history (at that time). I graduated second in the class. I was always strongly supported by my advisor (a male).

However, by the end of senior year, she wanted a change. “Upon graduation, I new I wanted to go to graduate school, but was tired, so I went into the workforce.” As she had in college, she continued to perform well. For an employee engaged in a variety of opportunities, advancement came quickly. In her experience, female employees were treated no differently than male employees.

> I did have female colleagues who thought they were being discriminated against. I supported them, but never had a similar experience. My upper level management (all male) always strongly supported me.

The company supported completion of a master’s degree while she worked full-time. “I was one of the first engineers to do this at the company. Others followed.” Eight years later, a leave of absence was granted to support her doctoral studies.

A brief return to industry followed completion of her doctorate. Unfortunately, although she was working on different projects, she was doing the same thing over and over. “I became bored with my work and did look for another position.” Growing interest in the “big picture” prompted a search for positions in higher education where she would have the opportunity to use her skills differently.

As a faculty member, her expertise in industrial engineering combined with a willingness to take a systems approach to solving problems allows for a different approach to work. The ability to use professional connections to bring multiple perspectives to the table means her skills are often in demand. “I get pulled, then, to support a lot of different . . . in my 11 years here, I would say most of the things I have taught have been the things that people have said, ‘would you teach this?’” Being valued for her knowledge and unique contributions as a professor is both satisfying and fulfilling.

Christine

Christine has always loved playing with numbers and enjoys the patterns and arrangements they can form. Attraction to color, form and structure is the root of her quirky, life-long interest in office supplies. “The beginning of a new school year was always exciting and I loved when my Dad took me to buy school supplies on the first day. To this day, I find school/office supplies exciting and I have to hold back (probably the same way some women feel about shoes).” Love of pattern and form also inspire her passion for music. “[My] parents started me on piano lessons in 4th grade. I kept it up through college. It opened up my world.”

Competitive by nature, her desire to win has always been motivation to achieve high levels of academic performance. “Became best friends with the smartest girl in the class. I was always trying hard to beat her scores on tests, but she was casually smart, easygoing, and did not mind losing out to me sometimes.” A competitive spirit also inspired her to follow the example of her aunt and uncle.

> My uncle started going to night school and was taking courses like "algebra" which sounded very mysterious and exciting to me, so I knew I would try to learn it the first chance I got. My aunt went to nursing school and I got to visit her in the dorms. My aunt and uncle were just 5 to 10 years older than me. I looked up to them –wanted to impress them –maybe felt a bit competitive or saw from them that you could keeping going to school past high school.

Active engagement in intellectual pursuits was nurtured surprisingly well in school. "[I attended] unbelievably (from my perspective today) good public schools in working class neighborhoods where dads worked in factories or at the steel mill and most moms worked at home." She had "great math, science, music and French teachers in middle and high school." A clear preference for the "absolutes in math where there is always one right answer" over the subjectivity of courses "like English" began to emerge. Support from teachers and family, along with an early understanding of her skills and abilities, led to admission in a private college well-known for its science and engineering programs.

College was full of opportunities for growth and development outside of the classroom. "Going to an engineering school, living in co-ed dorms with engineering students (mostly male, which was kind of cool), surrounded by other students all immersed in math/science/engineering culture" was exhilarating. Inside the classroom, professors failed to meet her expectations. "Interestingly, except for French, music, theater, all of my math and science teachers at my undergraduate institution were terrible." Real support and challenge

came from her peers. “But it didn’t matter, we didn’t even know they were supposed to try to help us learn. We thought it was our job to figure out how to learn from them.” Life-long inspiration arrived in the form of her future husband.

> I think he was the smartest of all the students, especially at math and physics, but I found him beautiful and fascinating. We are still together, 40 years later. I think part of his attraction to me had to do with my interest and ability in mathematics, so that has been a subtle motivator for me to keep at it.

As it had in the past, her competitive spirit and need to achieve continued to result in high academic performance during college.

Confidence in her abilities didn’t mask the growing awareness of gender and socioeconomic barriers that could prevent her from accomplishing her goals. Coming from a working class background heightened sensitivity to the challenges created by limited financial resources. “Money was always a source of stress in my family. When I was little, my father was out of work occasionally and even after he joined a union, he had to go on strike sometimes.” Working during the summers helped support her through college, but she quickly learned that young women had few options.

> In my city, boys could get summer jobs in a factory, or in construction and make a lot of money. But girls could only work as a clerk or waitress or office assistant making minimum wage. No matter how smart or clever you were, you were stuck doing things like scrubbing the trays in the back of the bakery.

Desire for a life free of financial worries spurred her on. “And I also knew that if I did not succeed in college that was the kind of job I would have to go back to. So, there was no way I was going to drop out or flunk out of college.”

Somehow, math and science pursuits would lead to a more financially stable life. “Sometime in college, at the engineering school, I think I first realized that math and science would lead (in some mysterious and unknown, but certain way) to a high-paying job. And the more I learned, the more I would earn.” Learning about the significant financial support typically awarded to graduate students in math and science was a revelation. “I don’t think most people realize it, but going to graduate school in math (or most areas of science and engineering) is free! If you are accepted to a PhD program in math, engineering, physical sciences, you are offered a half-time teaching or research assistantship, which for working 20 hours per week, pays you a stipend you can live on *and* covers your tuition.”

Acceptance into a mathematics PhD program along with a graduate assistantship meant the responsibility of teaching undergraduate courses in algebra, calculus and trigonometry. “It was the first time I was paid to do something that used my brain and I was living my childhood fantasy of being a teacher. There was really no doubt that I wanted to continue doing it” Thirty-three years later, her role as a professor is still a source of excitement and satisfaction.

> All these years, I have much enjoyed doing research in mathematics. It’s like playing games. And I get to do a lot of collaborative research with cool and smart people,

> both students and colleagues. I would never be able to do this except in the university environment.

Another, perhaps the best, reward is the opportunity to pursue the interests she has in common with her husband who "is also a professor in a math/science/engineering discipline" and someone with whom she can "share the problems and excitements" of work.

Jeri

Jeri grew up surrounded by the love and support of a close-knit family. Frequent moves during childhood meant relying on her immediate family as the primary source of encouragement and advice. "And, I know that other people's parents didn't talk to them the way my mom and dad did. They're not as "okay, well you go on and do that." They're more like, "oh, you can't do that." Yes, she was expected to work hard and be a good student, but she never felt burdened or restricted by her parents' expectations.

As an intelligent and engaged child earning good grades came naturally. Math and science were not, however, her strongest subjects early on. "I was never in the advanced classes until I was in high school. But I had a really good math teacher and I was in a really small school." Rather than limit her opportunities, attending a high school that had an approximate enrollment of 400 students produced the opposite effect. "So, I ended up taking . . . it was a big deal to be able to take algebra II and geometry in the same year, my sophomore year. I mean, only the really smart people got to do that." The experience of being in small, specialized classes was particularly fun and interesting.

> But back then, the fact that I got to take those two [algebra II and geometry] in the same year and I wasn't going to pass out from the hardness of it (laughs) . . . it was great. Me, and about four other kids, did that. So, we had our own special little crew. Then, we took advanced math I as a junior and advanced math II as a senior. There was only a few of us in there. And, it was just fun. We got to do a little programming on the computer. The whole school had one computer. It was a little Tandy and you programmed in Basic. (Laughs). And, we got it to add two little things together, sort of random numbers, and spit out the answer. And, we were like just thrilled out of our minds that we got to do that.

The combination of inspiring teachers and the experience of being in an elite group of learners gradually directed her academic interests toward math and science. By the time she was a senior in high school, she had decided to study nuclear engineering so that she could be involved in collider projects and "smash atoms."

The plan was to earn an engineering degree in nuclear physics by attending a large land-grant university in her home state. Unfortunately, freshman year was a struggle. "I didn't like the engineering part of it. I had a hard time sort of settling in to college. So, I ended up leaving after the first year and ended up going home." While at home, unexpected developments further altered plans to earn a science degree.

> Oh, my gosh. It's just a weird . . . weird little ride. So, anyway, that was the thought – I was going to be an atom smasher, a nuclear engineer. And then, I came home and

> stayed at home for awhile. And then, I had my daughter. And, I was by myself. Her father didn't want to be in the picture.

With a daughter to raise and earning slightly more than minimum wage, finding a way to improve her career options was imperative. "I thought, 'I have got to go back to school.' (Laughs). So, I decided to be a math teacher because that's a good life path and I always liked to be a teacher."

The responsibility of being a mother was enough incentive to return to the same state university as a math education major. Some of her professors suggested the addition of a second major in mathematics. "And I liked it, it wasn't hard, and it took an extra semester. And I thought it opened up avenues or whatever, you know, maybe if I decided to do something else." "Something else" arrived less than four years after she began teaching high school math. "I was living down east and it was just so small, you know. And, I thought, 'I have got to get out of here.' I went back to grad school just thinking I would get my masters degree in math education just to move away from there and try something different." Again, Jeri enrolled in her alma mater, but soon realized that the only math classes she had not taken were on the doctoral level.

> There were some pretty bright math people in there. I mean, second-year doctoral students. So, anyway, I started looking into perhaps getting a PhD in math. So, that's how that started and I ended up doing that. (Laughs). I sound like I just fell into it, don't I. I pretty much did. There was never a point in my whole world to ever get a PhD in math.

Working part-time over the course of nine years, Jeri pursued her doctorate in mathematics.

Having earned all of her degrees from the same institution where she is currently employed, her career path is unique. Most of her choices have been made in deference to family commitments. “I stayed here for my family. I was older when I came back to school. I had a daughter . . . I chose based on my family and career kind of came second. It’s difficult to have . . . well, it’s practically impossible to have a research position and do that. It’s very, very difficult.” After ten years as a lecturer, she is uncomfortable with the limitations of her current role. “I would like to have a better career path. It’s very, very difficult to be where I am right now because I have always been there and some of the senior faculty still see me as a grad student.” Pursuing research opportunities to fulfill her teenage dream of “smashing atoms” are still possible. She is only a “year or two away from working on a project like that.”

Katie

Despite living in an industrial city, Katie developed an early appreciation for nature with the help of her parents who nurtured her curiosity about birds and plants.

> Many evenings were spent watching chimney swifts dive down the chimney of the factory behind our house. My father always pointed out various birds. I still remember when he pointed out a catbird when I was older. These events stimulated my interest in the natural sciences.

Favorite memories include camping and playing in her own garden. “I loved to dig in the ground and was not the least bit afraid of bugs, earthworms, etc. I have a picture of me

holding a very long earthworm." Natural curiosity about the world translated into strong academic performance, particularly in math and science. "I was the first 6th grader in [my hometown] to get a perfect score on the math portion of our achievement test." While proud of her academic achievements, she was reluctant to be set apart from her friends and classmates and rejected an invitation to attend the "opportunity school" for talented students.

Excellence in math and science resulted in unconditional support from her teachers. "I was never discouraged and was often praised for my good grades." Her talent in math also created opportunities to help others.

> I was frequently called upon to help my friends with their math homework and always enjoyed doing that. Two boys I count as my earliest success stories in teaching. In tenth grade, I helped a male classmate with plane geometry and the next year I helped my boyfriend with algebra. Both went on to major in math in college.

She committed early to becoming a teacher. "I think I always wanted to be a teacher, probably because I had really nice teachers in school and because my mother was a teacher although she never worked full-time." High school math teachers and a particular biology teacher were inspirational role models for her future teaching practices.

Enrolled in college as a pre-med major, the plan was to teach biology or become a researcher in genetics. It didn't take long to figure out that math was her true preference.

> I found it was a lot easier for me to do very well on math tests and I did not have to memorize tons of material. All of the memorization in biology was not fun. Solving math problems was fun.

She changed her major to mathematics after she began dating the man she would eventually marry because “a career in math or working with computers would blend better with marriage and family.”

Although she planned to be a teacher, her professional career didn’t begin immediately after college. “I was a stay at home mom for 14 years. Meanwhile, I took painting lessons and read lots of books, fiction and nonfiction.” When financial circumstances seemed uncertain because of diminishing opportunities for her husband in the textiles industry, she began working as a substitute high school math teacher. After moving from North Carolina to Ohio to California and back to North Carolina, financial need provided an even more compelling incentive for employment outside of the home.

> I needed to get a job to supplement our income and by chance found out about a MA program in mathematics at [a nearby state university]. Within a month, I had a teaching assistantship. Two and a half years later, I had an MA in math.

The plan of becoming a college math instructor stalled when she learned that a doctorate was required to teach math at the university level.

> However, it was 1982 and colleges needed lots of computer science profs (Apple II was all the rage) to teach students who wanted to learn about computers. I was flexible and needed a full-time job. There is a close connection between math and computer science and I landed a teaching position at a [a small, private university] as a computer information systems instructor.

Aware that her teaching options would be limited, she permanently rejected the idea of becoming a college math instructor.

Earning a master's degree in computer science was immediately followed by earning a doctorate in information technology. "I pursued the PhD because I wanted to have the choice to change jobs. I knew that without the PhD, I would need to remain at [the small, private university] until I retired." Completing her doctorate as an older student created some unique challenges. She had fewer opportunities than other classmates to collaborate with faculty on research projects.

> In graduate school, I noticed that professors did not approach me about doing research with them. Now, it may have been because I was a woman. I'm not sure about that. The other thing is that it may have been because I wasn't a traditional graduate student. I wasn't early twenties. By that point, I was in my mid-thirties.

Refusal to be discouraged resulted in completion of the degree and her current appointment as a faculty member at a small state university where she enjoys both the teaching and research aspects of her role.

Emerging Common Themes

The narratives of the eight women scientists highlighted in the previous sections provide snapshots of the diverse experiences that shaped their views of self as well as their math and science interests. While each woman has her own story about how she negotiates her career as a scientist or mathematician, collectively their journeys have some common elements. Through close and repeated listening of interview recordings and reviews of the

corresponding transcripts, I have identified seven themes running across the participants' individual stories: a) education is a core value, b) intellectual curiosity is encouraged, c) teachers are mentors, d) gender is not a barrier, e) family needs direct career path, f) higher education is the preferred work environment, and g) I'm an educator who teaches science. To expand on each theme and illustrate what it represents for the development of the women's career-related possible selves, I have created the aggregate narrative presented below. The aggregate narrative is written in first person to reflect the core story that emerged through analysis in a manner that can be symbolically heard in a cohesive, powerful way. Additionally, the participants own words provide tangible examples of how their views of self have shaped their career paths. The quotations and excerpts presented in the aggregate narrative were selected because they seem to crystallize the experiences of several participants revealing a clear, if brief, view of the women's common experiences.

An Educator Who Works in Science

In reflection, I'm not sure why I was able to persist in my field when other women haven't. "I don't really think I'm any different. Yeah, I don't think there's anything different about me except blind perseverance" (Teresa). I simply followed a path that was aligned with my natural skills and interest in teaching others. "I never thought about building a career as a mathematician [or scientist]. I never went to it that way" (Jeri). While there have been some challenges, I have found that most people, including male classmates, professors and professional colleagues, have responded well to my work ethic and openness to learning. I

also credit my family for giving me full support and never giving me a reason to doubt my ability to be successful in my chosen career.

Education is a core value. I was raised to value education. “My family is really supportive. My dad . . . he was very supportive. He was always about me being the boss, not the worker bee” (Jeri). My family may not have had much in the way of financial resources, but my parents always encouraged me to study and perform well academically. “My father didn’t finish high school. He had to quit school to get a job to help support his family. And, my mom did finish high school and worked as a secretary. And, um . . . so, they liked me to do good in school. And, they weren’t very particular about what [I] pursued” (Christine). For me, education was a way for me to improve my circumstances and exposed me to opportunities that my parents couldn’t. Fortunately, I was a good student and able to take advantage of the lessons being taught by my teachers. Given the environment I grew up in, with its focus on hard work and education, I always assumed I would attend college.

Intellectual curiosity is encouraged. Perhaps, because of my parent’s value for education, I never felt restricted or limited in what I could learn about. “They all were just great. I didn’t realize how unusual it was to have that kind of support. I mean, they all just kind of let me do my own little thing and if I read weird little science fiction books, they were like, ‘oh, there goes [Jeri] again’” (Jeri). In fact, my intellectual curiosity was encouraged and nurtured in a variety of ways. I was exposed to the sciences by working with animals, exploring the outdoors, reading a variety of books, and assisting with home

improvement projects. “I just kind of absorbed everything around me. And that was what was fed to me. My dad was always interested in watching those PBS documentaries, so it was something I did with him” (Teresa).

I discovered fairly early that I had a talent for mathematics because I could see patterns where others couldn’t and I had the stubbornness to stick with a problem until I found a solution. “I just think the hook that got me –the problem solving, the challenge of being able to look at something I’ve never seen before and be able to figure it out was a real high. Much better high than an artificial high” (Katie). While I didn’t always know the specific direction my career would take, I knew that my career would somehow involve math or science.

Teachers are mentors. In general, I found my school teachers and faculty members to be important mentors. “If I think back to my undergraduate and graduate mentors . . . they made themselves available . . . they took a genuine interest in me not only as a student, but as a person” (Lisa). By sharing their experiences with me and introducing me to new ideas, they helped me refine my academic interests as I grew and developed. “I had a really good math teacher and I was in a really small school. Um . . . so, I had the opportunity to do some things that maybe other people didn’t --in a small school. Because my math teacher was just so good and inclusive of everybody. You know, everybody just loved him” (Jeri). Typically a good student, either through perseverance or natural talent, I found that most teachers were willing to support my efforts. “I got my undergrad degree in math education, but because I had . . . because I really like math and I was really good at it, they encouraged me to double

major in math and math ed. ‘They’ being the professors: ‘oh, if you just take a couple of these classes,’ and ‘you’re really good at it’” (Jeri). Honestly, my selection of one of the science and mathematics disciplines as my undergraduate major was first sparked by the exciting ideas introduced by my teachers.

Now that I’m a faculty member, I can trace much of my own practice to what I learned from my teachers and professors. “I really feel fortunate that I had a teaching mentor who is really well-grounded in educational scholarship and appropriate pedagogy . . . .” (Lisa). They introduced me to effective teaching methods for engaging students as well as ways to design courses. “Yeah, it’s changed how I teach. It strongly affects how I teach. I design curriculum. So, I take a very . . . um, I try to take a systems look at the curriculum in a holistic sense.” (Marie).

Gender is not a barrier. I rarely, if ever, felt isolated or disconnected from my teachers or my classmates simply because I’m a woman. “I never felt like I was being discriminated against or asked not to do something because of my . . . because I was a girl. Never” (Jeri). In fact, it was very important to me that I demonstrate the ability to achieve in the same way my male classmates did without any special treatment. I knew about various organizations designed to support women in my field, but I never felt that I needed anything from these organizations.

> I was not a member of the Society of Women Engineers. I did not want to be a member of the Society of Women Engineers when I was an undergraduate because I didn’t believe in the kind of organization . . . well, I didn’t need the organization is a

> better way of putting it. And I wanted to be in the organizations with everybody else. I wanted to be in the organizations that the guys were in (Marie).

Occasionally, I would have an insensitive male professor or professional colleague who would make sexist remarks. Those remarks only made me more committed to achieving my goals. I was confident that I could handle any challenges. "I was a good student. I'm strong academically, secure in myself" (Marie).

As a faculty member, I haven't experienced anything I would call discrimination based on my gender. "I think it could have been a problem depending on where I went. I just happened to end up at a place where everybody was trying to do their best. It doesn't seem like it has ever been a problem" (Christine). I think the challenges faced by women faculty members are more directly connected to their personal choices rather than questions about their competence or skill as scientists.

> I don't think there are any impediments for women in the workplace. It may be there is not quite the same encouragement in the beginning, but people seem to be more aware. The biggest problem as far as impediments would be at home, if they do choose to marry and have a family. They have to figure out how they can handle that (Katie).

Family needs direct career path. As a wife and mother, my family has been a significant influence on the direction of my career pursuits.

> I really wanted a family. Ever since I was a little girl, I played with dolls . . . so, I was the typical little girl looking forward to getting married and having a family, but for

> some reason I also thought I could do the other. I thought I could go to work and have a career and do something interesting (Katie).

I have always understood that my choice to have a family and a career would require compromises. “In the workplace, I felt like I could achieve a balance –maybe not be promoted at the same level or achieve the high profile assignments . . . but, that was okay, you know, that was a very worthwhile trade off.” (Lisa). I accept that women have to make some choices and plan ahead to balance career and family. “There are some things that women just have to do. I mean, men can’t get pregnant. So, if you want children, you better figure out are you going to have children before the PhD or after the PhD –probably not a good idea to do both at the same time.” (Katie).

My decision to pursue graduate studies as well as teach is very much connected to my goal of having a rich and rewarding family life. “I stayed here for my family. I was older when I came back to school. I had a daughter . . . I chose based on my family and career kind of came second” (Jeri). To balance personal and professional needs, including the need to have flexible work hours as a working mother and the desire to get closer to aging parents, I chose a teaching position in academia over the potential financial rewards of working in industry.

Higher education is the preferred work environment. Admittedly, I have not followed the most direct career path in becoming a faculty member. For a variety of reasons, I chose to work in industry for several years. During those years in industry, I was able to develop my competence and expertise. I was able to work in a variety of roles and further refine my

professional interests. Ultimately, while I enjoyed my work outside of higher education, I missed the intellectual stimulation and engagement that can only be found in institutions of higher learning.

> To be honest, I wasn't entirely happy there. Again, it's this conflict, right. In the one sense, professionally, it was this great opportunity, but on the other hand, it was this weird . . . I didn't think it was a good fit for my personality. I wouldn't have wanted to stay there forever. I wanted to be on a college campus. . . . (Teresa).

I'm motivated by innovation and the opportunity to continuously improve my knowledge and skill, but found that I was not always able to work at this level given my everyday job responsibilities. "I got bored in industry and needed a challenge. In academia, the challenges change every day." (Marie).

To continue my personal and professional growth, I went back to school and completed my doctorate while I was working full-time. After earning my doctorate, rather than continue working in industry, I actively pursued teaching positions at colleges and universities. Ultimately, working in higher education provides me with opportunities for personal and professional fulfillment.

> I'm still around people doing math and this environment feeds a part of me that I can't get anywhere else. I mean, a university is kind of its own little world. You meet people from different places and there are people there who are like-minded in a way that they like math. (Jeri).

At this point in my life, I can't imagine working anywhere else.

I'm an educator who teaches science. In the back of my mind, I was probably aware that I would one day be a teacher. "I liked school, so I always thought I'd be a teacher. Uh . . . I didn't think of myself as a college professor at first, but I did want to be a teacher" (Katie). Although I have earned a doctorate and have the credentials of an expert in my field, I still view myself primarily as an educator.

> Maybe until recently, and maybe still, I don't feel like a real mathematician. The more I've learned, the more I know there is to learn . . . so, I always feel kind of very humble. I don't maybe even think of myself as a mathematician, but as somebody who's allowed to do mathematics (Christine).

Through a combination of hard work and serendipity, I now find myself in a faculty position that allows me the autonomy to design courses and set my own research agenda.

I didn't seek a tenure-track position because I wasn't particularly interested in conducting research or engaging in the politics typically associated with the tenure process. I was much more interested in teaching undergraduate students and passing on what I have learned over the course of my professional career. "I want students (and it goes both ways) and faculty to enjoy learning . . . to enjoy learning, to want to learn more, to just keep on being open to experiences, and to take it in and to just build from it." (Marie). Encouraging others and facilitating their development is immensely rewarding. "I like talking about math. I like analogies and being able to help people understand things. It's really nice to watch somebody get it, to have that light bulb moment. I mean, that's very satisfying to me." (Jeri).

As a faculty member, I exchange ideas with some of the best minds in my field and play a role in shaping our understanding of the world. "Because that's one thing I'm very passionate about –expressing science . . . or, I guess communicating science to the general public. I think that's something that really worries me a lot in society --how limited people's understanding about science is." (Teresa). I hope through my work that I will continue to help educate others and have the opportunity to mentor the next generation of scientists and mathematicians.

Additional Considerations and Indications

Although the participants have some experiences in common, it is important to note that each woman has unique life experiences and her own career journey. While most of the women enjoyed school and exhibited talents in math and science early in life, this was not the case for all of them. As an immigrant, Teresa was marginalized in school by unwelcoming, unsupportive teachers and classmates. Meanwhile, Jeri did not recognize her strong math and science interests until high school. Similarly, regarding gender issues, each woman has her own story to tell. Susie was denied the opportunity to participate in the vocational agriculture program as a young girl and learned an early lesson about sex discrimination. On the other hand, Marie grew up tagging along behind older brothers never feeling different or excluded from her preferred activities.

Additionally, the women's career paths varied – starting at different points and taking slightly different trajectories. After completing her bachelor's degree, Katie delayed the start of her career for 14 years to be a full-time homemaker. Upon earning their first degrees,

Susie, Lisa, and Marie went immediately to work outside of higher education while Lane, Christine, and Teresa chose to move directly into graduate school. However, what is interesting about the women's experiences, and serves as the basis for this study, is how they followed their individual interests in math and science to arrive at similar destinations serving as faculty members in institutions of higher education.

Despite their comments to the contrary, the participants' experiences with overt sexism and employment decisions guided by family commitments indicate that gender dynamics are very much involved in shaping their career opportunities and guiding their career-related possible selves. Further, the discrepancy between their experiences and what they say about those experiences suggests the women may not be fully aware of how much gender has affected their views of self and science careers.

Chapter Summary

For the purpose of this study, I recruited eight women to share their views of self and career development experiences within academic science. The findings from their interviews are presented in biographical narratives that highlight their individual journeys. Analysis of their stories revealed seven themes common across their separate narratives. The common themes were explicated in an aggregate narrative to highlight the central story that emerged. It is important to note that every theme does not represent each woman equally. Additionally, there are some indications that gender dynamics have affected the women's possible selves and careers in more ways than they realize. The next chapter provides a feminist analysis and

discussion of these findings to highlight how the participants' views of self and the ways they have navigated personal context have led to the current state of their careers in academic science.

Chapter Five: Analysis and Discussion

By linking concepts regarding gender and women's career development and framing them within possible selves and feminist standpoint perspectives, the primary goal of this study was to trace how women create views of self while navigating gender and personal context to pursue and sustain careers in academic science. Specifically, the study sought to answer two questions: 1) how do women scientists develop views of self, and 2) how do women scientists negotiate their careers? In response to Question 1, the findings indicate that the participants in this study developed possible selves compatible with careers in academic science through their interactions with supportive family members and teachers. Further, the findings indicate that the participants' possible selves are gendered by virtue of their existence as women and their experiences in male-dominated academic science environments. In response to Question 2, the findings indicate that the participants have negotiated their careers in academic science by developing possible selves as educators who work in science rather than as scientists.

To explicate the study findings and provide context for the tensions revealed by my feminist analysis, this chapter is presented in three main parts. The first part of the chapter explicates the seven themes that emerged from the participants' narratives: a) education is a core value, b) intellectual curiosity is encouraged, c) teachers are mentors, d) gender is not a barrier, e) family needs direct career path, f) higher education is the preferred work environment, and g) I'm an educator who teaches science. The themes will be discussed in

terms of the participants' perspectives regarding their possible selves and their career-related choices. The second part of the chapter will reframe the findings from a feminist perspective, highlighting my interpretation of how the participants have negotiated their current careers in male-dominated academic math and science professions; taking particular note of the ways gender constraints have shaped their experiences and views of self. Finally, this chapter will conclude with a discussion of implications for theory and practice.

Overview of Findings

When considered from the participants' perspectives, the study findings generally describe predominantly male educational and work environments as sites that supported and fostered their development as women scientists. Rather than a discouragement, the women found their minority status to be, at varying times, an inherent part of pursuing their interests, an opportunity to prove themselves, and an impetus for excellent performance. In some ways, the findings support the participants' view of themselves as unhindered by many of the barriers that have confounded other women. For example, with the support of their parents and teachers, the participants were able to develop possible selves as competent in math and science contributing to their ability to pursue science careers. This is in line with Markus and Nurius' (1986) assertion that men and women's projected images of what is possible for them to achieve serve as individualized motivation that guides and directs behavior toward a particular goal.

However, the connection between the participants' possible selves and the career opportunities they have negotiated within academic science are shaped by gender in ways

they may not fully realize. Lips (2000) suggested that possible selves are influenced by cultural messages, such as gender stereotypes, within an adult's environment. In the case of the study participants, gender stereotypes may have obscured or prevented particular views of self from being constructed limiting the variety and structure of the possible selves they are able to imagine. From a feminist perspective, there are noteworthy differences between the experiences the women describe and their perceptions of those experiences. The findings further suggest there may be limits, self-imposed or otherwise, to what some women can achieve within the current context of academia.

The Participants' Perspectives

The common themes identified from the participants' narratives reveal a shared ability to create possible selves compatible with a math or science-related professional identity. This ability may have developed from early positive experiences at home and in school that supported their intellectual curiosity. The unconditional support of their families and consistent encouragement from teachers instilled the participants with the sense that they had the capability to excel in math and science pursuits. As adult women, the participants have continued to develop their skills and have persisted in their science careers. From their perspective, gender was not a significant concern during their formative years. Most of the participants were not aware of gender or their status as women until they pursued their undergraduate and graduate studies. Despite experiencing instances of overt sexism and career-related decision-making guided by their roles as wives and mothers, the participants are reluctant to acknowledge gender as a barrier to their career success. They view their

ability to persist in math and science careers as proof that women can achieve their goals despite historical gender constraints.

The following subsections will describe the experiences that shaped the participants' career development and possible selves related to their professional identities. The descriptions are based on the aggregate narrative presented in chapter four. While the findings represent common themes across all of the participants' experiences, it is important to note that each woman has a unique story and the findings do not represent all of the participants to the same degree. For this reason, I have included a discussion of noteworthy distinctions revealed in one participant's narrative. This first section of the chapter will conclude with a review of key findings.

Education is a Core Value

Most of the women in this study described humble beginnings in which their families worked tirelessly to ensure the basic necessities were attained. With the exception of Lane, Lisa and Teresa, their parents were not educated beyond high school, but saw the value of higher education for their children. In their narratives, the participants describe how their parents explicitly encouraged higher education as a pathway to a more financially secure future. Jeri explains that her father wanted her to be "the boss" rather than a "worker bee." Lane tells of her mother's determination to see all of her children earn degrees to avoid the hardships of a working class life.

The participants grew up in an environment that reinforced the idea that a college education was essential and therefore expected of them. Rather than feel pressured to

achieve, the women seem to have embraced the idea of pursuing higher education as integral to achieving their personal and professional goals. To some degree, all of the women found pleasure in the learning opportunities provided by formal schooling. Only Teresa described hostile, uninspiring school environments which she attributes to her immigrant status. Seven of the eight participants view themselves as academically talented; able to excel in most of their classes throughout their primary, secondary, undergraduate and graduate experiences. Susie, who denies any inherent intellectual prowess, developed a possible self predicated on perseverance. Regardless of the nature of their academic accomplishments, all of the women have demonstrated, through their choice to work as faculty members at colleges and universities, an appreciation for and commitment to higher education.

Intellectual Curiosity is Encouraged

A particular trait shared by all of the women which has served them well throughout their professional careers is an appreciation for learning and discovery or "intellectual curiosity." Their narratives are filled with examples of childhood experiences that sparked their intellectual growth and encouraged them in their math and science pursuits. Susie describes exploring the outdoors of New Mexico with her family, and Katie describes the pleasure of tending her very own garden. Additionally, Teresa describes watching science documentaries on public television with her father, and Marie describes helping her father with home repair projects, including working on an air conditioning unit and tinkering with the family boat. All of these examples highlight how the participants' parents facilitated and nurtured their daughters' intellectual curiosity by 1) exposing them to learning opportunities,

2) assisting them to develop competence and self-confidence, and 3) refraining from gendering the learning experiences.

The parents of the women in this study provided a variety of opportunities for their daughters to actively engage with the world around them. Some of Susie's favorite memories are of family trips spent camping in the wilds of New Mexico and touring museums. Katie recalls watching birds with her father from the roof of their home in an industrial area of Pennsylvania. Rather than discourage the questions from their curious children, the parents helped them seek out answers through exploration and discovery. Whether or not their actions were intentional, they were effective as teachers creating home environments that were filled with early science lessons.

Their efforts are in line with research suggesting that women indicate more interest in science when they can see firsthand its relevancy to their lives (Weisgram & Bigler, 2006). Rosser (1990) suggested connecting science to real world experience is a key element to engaging young women in the study of science. These early science lessons taught in a supportive family environment may have been the foundational experiences the women needed to develop the interest and self-confidence to take on the challenges of math and science.

In their interviews, the women struggled to pinpoint how they developed their self-confidence. In varying ways, they articulated that they had always been the way they are. At the same time, their stories illustrate that childhood experiences taught them to be interested in the world around them and to not be afraid to be "hands on" in their exploration.

Additionally, the women benefited from having parents who never questioned or doubted their daughters' capacities to pursue their academic interests (Adya & Kaiser, 2005). Surrounded by unequivocal support, the women have not found it necessary to be critically reflective regarding their interests in math and science or their ability to achieve academically.

Although recent studies reference a longstanding gap between men and women in their perceptions of their own academic ability in math and science (Lips, 2004; Weisgram & Bigler, 2006), the participants' individual histories gave them no reason to doubt their capacity for success or reconsider the gender-appropriateness of pursuing their interests. While their confidence may the result of several intersecting influences, including being white and academically talented, the participants' ability to progress may also be an offshoot of having parents who did not introduce or reinforce gender biases related to math and science ability. For example, Marie was never made to feel uncomfortable about being a girl who enjoyed learning about air conditioning units and working on the family boat. Similarly, Susie's family supported her interests in working with cattle and encouraged her to continue her involvement in 4-H. Being able to develop their math and science talents without the burden of gender-bias helped provide space for the women to create possible selves as competent in math and science. Given that pursuit of math and science opportunities is linked to self-perceptions of ability (Correll, 2001; Jacobs, 2005; Betz and Hackett, 2006), the women's positive self-perceptions of their competence may partially explain their ability to

create possible selves that supported successful progression through academic studies to professional careers in math and science.

Teachers are Mentors

Outside of their immediate families, the most significant sources of support described by the study participants were their teachers and professors. While a few of the women related stories about sexist, insensitive, or ineffective teachers, these stories were overshadowed by the narratives regarding the quality of the mentoring they received from instructors throughout their formal education. Lane spoke with great respect about the teachers from the city who came to her rural school in Maine and introduced her to new and exciting ideas. Lisa described the fondness she feels for the chemical engineer who taught her eleventh grade chemistry class as well as former undergraduate professors she now engages with as colleagues. Jeri laughed about how much fun math and science classes were when taught by the teachers in her small high school. Katie credited her math and science teachers for the inspiration to pursue her mathematics and computer science degrees.

Support from mentors and experiences that suggest new possibilities, such as the classroom activities described by the participants, are noteworthy influences on women's ability to persist in their math and science careers (Pizzolato, 2007). The study participants' narratives highlight examples of teachers introducing math and science concepts in ways that were intriguing, inspiring them to continue learning. In return, the women received recognition from teachers for their achievements. Katie recalls being invited to attend "opportunity school" after earning a perfect score on her sixth grade math achievement test.

Christine was selected to represent her high school at a three-day science symposium. Similarly, during the summer between 11th and 12th grade, Lisa was selected to attend "Governor's School" in the area of science.

The rewards associated with their ability to excel in math and science contributed to their positive self-views (Markus & Nurius, 1986). From a possible selves perspective, the women's educational experiences and academic mentors assisted the women in constructing achievable objectives and provided them with opportunities to see themselves as successful resulting in increased self-confidence (Oyserman et al., 2004). By the time the women had graduated from high school, their academic accomplishments had supported their view of themselves as capable of excelling in math and science courses. As noted in the previous section, this positive self-view or "self-efficacy" in relation to math and science abilities has been identified as a key element in women's math and science career persistence.

For the women in this study, the gender of their teachers and professors was not the defining element in determining the potential for a mentoring relationship. In describing the mentoring relationships they developed with various instructors, the participants indicated that they were significantly influenced by individuals who had the math and science skills they most admired, and demonstrated interest in their learning. Interestingly, the participants reported being positively influenced by both male and female instructors. Admittedly, the participants did not have many opportunities to engage with women faculty during their undergraduate and graduate studies given the low numbers of women scientists teaching in academia (Xu, 2008). However, they did describe the positive influence of interactions with

female teachers in primary and secondary school. Yet, the women's most significant and long-standing mentoring relationships were developed with the men who taught and advised them during their post-secondary and graduate education.

This seems to contradict, at least in part, suggestions in extant literature regarding the detrimental effect that a lack of women scientist mentors has had on the progression of women in science (Miller, Blessing, & Schwartz, 2006). Lisa provides a richly detailed description of how her master's thesis advisor counseled her regarding strategies for balancing her multiple roles as a student, wife, mother and worker. Being a new father himself, her advisor was particularly empathic regarding the challenges she was facing at that time in her life. Jeri explains the powerful inspiration she drew from the unlikely feedback she received from a "brilliant" graduate professor. He was so impressed by her performance as a master's student in his doctoral-level course that he encouraged her to take a qualifying exam because he was "not convinced that she would fail." These examples demonstrate that supportive and encouraging men can have a powerful effect on the persistence of women scientists.

Gender is Not a Barrier

The participants in this study differentiate their experiences as women in math and science from the experiences of other women. Their ability to complete doctorates and enjoy careers in academia illustrates, to them, that gender is not an insurmountable obstacle in math and science professions. While the women's narratives describe environments in which they were the minority, their experiences were generally positive and they felt supported to persist

in their math and science pursuits. In fact, despite occasionally encountering overt sexism in the classroom and in the workplace, the study participants were unwilling or unable to identify gender as a significant barrier inhibiting their careers. In general, they viewed gender dynamics as separate from their experience while acknowledging that gender discrimination did affect other women. This finding mirrors Jorgenson's (2002) study of women engineers. Despite the women's challenges working with male clients and service vendors, Jorgenson found them unwilling to claim gender discrimination.

Most of the participants never found it necessary to be critical about their interests in math and science in relation to their gender identity. When asked if they had ever felt different or set apart from their peers in math and science courses, seven of the eight participants said that during primary and secondary schooling gender was never an issue for them. Susie reports being initially denied access to the vocational agriculture program because of her gender, but was allowed to choose science over home economics in high school. Still, none of the women noted anything different about the experience of being a girl in a math or science class until they entered their undergraduate and graduate studies and found themselves to be part of a minority group. However, the awareness of being female in male-dominated classrooms did not seem to overwhelm or concern them. Lisa and Marie specifically mention choosing not to join women's engineering organizations during their undergraduate years because they did not believe they needed gender-specific support. Christine enjoyed the challenge of the male-dominated classroom environment and Jeri enjoyed the attention of being one of a few women among all of the men.

Given gendered perceptions regarding the traditional or nontraditional nature of potential occupations, researchers have suggested that individuals may not see themselves in certain roles and may disregard career options without deeper exploration or further academic study (Gottfredson, 1981; Lips, 2004; Turner & Lapan, 2005). This was not entirely the case for the women participating in this study. Rather than create discomfort or inner conflict, the women seemed to take note of their minority status and then shrug off any question of changing their course of study or career plans. During their years as students, the combination of their intellectual curiosity, self-confidence, and social support from family and mentors may have helped them develop possible selves that sufficiently buffered them against any doubts or concerns about pursuing careers in professions dominated by men.

Family Needs Direct Career Path

For most of the participants, career decisions have always taken into account the needs of their immediate families. Their personal commitments required the women to consider employment options that would meet their professional needs, but also the needs of their families. Lane, Christine and Katie were married and Jeri was already a mother by the time they completed their undergraduate degrees. Research demonstrates that married women tend to be more concerned with job demands and are typically more willing to make job concessions than men (Martinez et al., 2007). Accordingly, these study participants have shaped their professional careers around their family concerns.

Some studies suggest that issues surrounding family responsibilities influence women's career decision-making in ways that men may never consider (Graziano, 2007;

Martinez et al., 2007). For example, women's beliefs that they will be primarily responsible for childcare in conjunction with society's expectations regarding gender roles create pressure on them to make concessions in their career goals in support of motherhood (Frome et al., 2006). Based on their accounts, the participants' individual decisions to pursue careers within academia were likely influenced by their acceptance of traditional gender roles and the associated behavioral expectations. At the time the participants sought employment as faculty members, seven of them were married and most had at least one child. A significant concern for them at the time was the growing need to balance family and professional life. They understood as women they would be expected to choose family responsibilities over professional goals more often than their husbands.

In their narratives, Susie, Lisa, Jeri, and Katie acknowledge that working in higher education was a way to balance their responsibilities as wives and mothers with their professional interests. To some degree, they recognized the necessity of sacrifice for their families and understood the potential affect on their careers. Katie is plainspoken in her acknowledgement that women have the responsibility to compromise some of their professional goals if they want to be mothers because "men can't get pregnant." Jeri, a single mother at the start of her career, needed the support of her family to assist in raising her daughter which placed geographic limitations on her employment opportunities. Similarly, Lisa understood that her choice to be a wife and mother meant that she might not achieve the same status or advance as quickly as the men in her department.

Higher Education is the Preferred Work Environment

Some scholars suggest that women scientists leave positions in academia because higher paying, family-friendly positions exist elsewhere or, they become frustrated by their slow progress toward promotion and the lack of support for their independent research projects (Ginther & Kahn, 2006; Graziano, 2007; Settles et al., 2007). Different from the experiences of other women scientists, the higher education environment seems to be an excellent fit for the participants in this study. Their narratives indicate that they have chosen to work in higher education because their employing academic departments provide the support other women scientists reportedly have not received.

As noted in the previous subsection, the study participants chose teaching positions in higher education because they believed the work schedule would be flexible enough to support their family obligations. Additionally, Susie, Lane, Lisa, and Marie each worked in industry and found that the intellectual challenge and potential scheduling flexibility of working in academia was more valuable to them than the possibility of a higher income. With regard to support for research, Susie and Lane report a significant amount of autonomy and resource support for their independent research projects. Likewise, Christine, Lisa and Teresa indicate that they are involved in interesting research projects that they might not otherwise have engaged in outside of higher education.

I’m an Educator Who Teaches Science

In their narratives, the women participating in this study indicate that they don’t necessarily view themselves as scientists. They seem most comfortable with viewing

themselves as educators. This is the case for all of the participants to varying degrees. The differences in their professional identity alignment may partially be a result of their personal interests and educational experiences within their respective disciplines. Christine, Jeri and Katie have self-views most aligned with their educator roles because teaching was always a part of their career plans. However, both Lisa and Marie described undergraduate coursework and professional work experiences that reinforced their view of themselves as engineers while Susie and Lane's coursework and professional training encouraged them to view themselves as agriculturalists –a field of study typically associated with vocational training rather than science. All of the participants enjoy the scientific process of discovery, but express equal enjoyment in opportunities to share knowledge and enhance the quality of practice within their respective disciplines.

The participants are likely more comfortable viewing themselves as educators because their possible selves are grounded in social roles and categorizations including past experiences and self-evaluations (Meara, Day, Chalk, & Phelps, 1995). Viewing themselves as educators is compatible with the traditional standards for womanhood and, unlike the scientist identity which has a male connotation (Harding, 1991), is available, accessible, and under their perceived control (Norman & Aron, 2003). As educators, the participants have been able to make decisions and access the resources that would make this particular view of self a reality. For example, as educators they are immediately associated with a profession that has a demonstrated history of developing women leaders. Given their years of teaching

experience, they are confident they can maintain their role as faculty members over time, and being a faculty member is a self-view they can integrate into their existing social context (Hoyle & Sherrill, 2006; Oyserman et al., 2004). Additionally, viewing themselves as educators means that the participants can use their skills in math and science to productively contribute to their chosen professions.

Teresa's Story: A Counter Perspective

As stated in the introduction of this first section of the chapter, there is one study participant whose experiences were significantly different than the other women. Throughout the data collection and analysis process, I could hear Teresa's distinctive voice politely and assertively requesting that her story be told. In several key respects, her story is so different that her narrative presents a direct challenge to the seven themes guiding the participants' aggregate narrative. Because the experiences of the other seven women are reflected to some degree in each element of the shared narrative, they set Teresa's experiences apart in a way that could be treated as an anomaly that silences her voice and keeps us from considering the insight that her particular journey can provide. To honor the traditions of qualitative inquiry, Teresa's unique experience, and foreshadow some of the implications revealed by my feminist analysis of the study findings, this subsection will highlight Teresa's perspectives.

Demographically, Teresa is different from the other participants. At age 34, she is the youngest woman who participated in the study. She identifies as a Hispanic woman and is the daughter of immigrants. All of the other women identify as white, and were born and raised in the United States. The other women have been married and most have at least one child.

Teresa is a single woman with no children. Like the other participants, her parents supported her intellectual development and taught the value of education. Unlike the other women, she chose to study science because she had demonstrated skill in that area, and because she understood that her family expected her to enter a profession that was perceived to be more financially stable than the arts or the humanities. Teresa acknowledges that she felt isolated throughout her formal education experiences. She attributes the isolation she felt as a child to her status as an immigrant. She connects her isolation as graduate student, and later as a researcher, to her status as a woman in physics.

Teresa's willingness to identify her feelings of isolation and connect them to her experience as a woman in man's science is noteworthy in comparison to the other participants. Additionally, her descriptions of her work experiences are unique because she identifies instances where she felt she was discouraged from expressing diverse interests outside of science and wearing feminine clothing, such as dresses and skirts. In fact, Teresa's experience as a woman in science more closely matches the findings in studies aimed at identifying why women remain underrepresented in science. Her narrative presents examples of the "chilly" classroom climate, boy's club exclusivity, and hindered career progression widely reported in scholarly literature (Blickenstaff, 2005; Cronin & Roger, 1999). Accordingly, the discrepancies between Teresa's narrative and the common narratives of the other participants demand deeper consideration. The analysis and discussion presented in the next section of this chapter is my attempt to make sense of the participants' common experiences and why they may diverge from Teresa's experience.

Review of Key Findings

Based on the common themes that emerged from the participant narratives, I suggest women who hope to persist in math and science professions are aided in their endeavors by unconditional support from their families. This support may help to promote the development of science-related possible selves in women by serving as a source of strength when they are faced with the challenges of excelling in male-dominated classrooms and workplaces. Similarly, the findings highlight positive experiences with teachers and faculty as an important support for women's persistence in math and science. While acknowledging their own occasional experiences with gender bias, the participants are reluctant or unable to identify their gender as a barrier to their success in academic science. They point to academia as a site where they have been able to balance their family commitments with their professional interests. Further, in choosing to work as faculty members they have possible selves more compatible with an educator identity than a scientist identity. Teresa, one of the eight participants, presents a distinctive narrative that aligns with research regarding women's underrepresentation in science, but diverges from the aggregate narrative in some key ways. Those differences hint at underlying issues concerning women's science career experiences and will be discussed in the next section.

A Feminist Perspective

As a researcher, I began this project hoping to gain insight to support the development of strategies aimed at helping women persist in their math and science pursuits.

While I suspected there would be a high degree of complexity involved in approaching this topic, I did not anticipate how responsible I would feel for articulating the underlying gender dynamics that continue to suppress women's achievements in science. Aligned with the tenets of feminist standpoint theory, I wanted to represent the participants' perspectives in a way that privileged their experience (Hartsock, 1981). However, I was also concerned that the participants' experience of being situated within male-dominated work environments might have suppressed or obscured aspects of their stories. To balance my commitment to the participants, but also my commitment as a feminist researcher to expose gender inequities, I utilized specific strategies to support my analysis of their narratives (Devault, 1990). These strategies included being mindful of the participants' expressed emotions as well as their language choice; taking care to present the participants' voices as individual and distinct; and being reflexive about my subjectivity (Gergen & Gergen, 2000). Conscientious application of these steps underscores the trustworthiness of the research project and adds credence to my findings.

Guided by the feminist standpoint critique of science as a male domain that has historically ignored or devalued women's contributions (Harding, 1986), I recognize that the participants' common narrative tells a story of women's success in academic science that falls short of presenting some of the more concerning aspects of the women's experiences. Reframed through a feminist lens, the aggregate narrative reveals discrepancies between the actuality of the participants' career development experiences and their perceptions of those experiences. For example, although they had stories to share about being singled out or

treated differently because of their gender, the participants are reluctant or unable to view these occurrences as evidence of systemic gender bias and discrimination affecting their career progression. What is most disturbing about these women and their experiences as scientists is not that they seem unburdened by the gender biases and constraints that surround them. In many ways, the perceptions of the women in this study are no different than other women who have successfully negotiated careers within academic science (Jorgenson, 2002). What is most discouraging is that their stories, when viewed critically, confirm the persistence of gender inequities despite years of scholarship highlighting its detrimental effects.

For the purpose of exploring the detrimental effects constraining the study participants' careers in academic science and limiting their views of self, the next series of subsections will highlight the following gender-related tensions revealed through a feminist analysis of their common experiences:

1. Women scientists' career choices are guided by gender.
2. Women scientists face challenges in career progression and advancement because of gender dynamics.
3. Women scientists may strive for gender neutrality that contributes to the perpetuation of gender inequities.
4. Women scientists' views of possible selves are potentially limited by their gender beliefs.
5. Women scientists make contributions to science in ways that are not valued.

Additionally, Table 5.1 is presented below as a guide to illustrate the gender issues discussed in this section along with its corresponding conceptual or theoretical framework. At the end of this section, I will present a summary of the implications identified through this feminist analysis.

Table 5.1 – Concepts Guiding Feminist Analysis

Researcher(s)	**Concept Guiding Analysis**	**Study Implications Based on Findings**
Correll (2001,2004); Gottfredson (1981)	Gendered career choice; circumscription and compromise	Women scientists' career choices are guided by gender.
Bierema (2001); Fox (1999); Brickhouse, (2001)	Gender barriers in the workplace	Women scientists face challenges in career progression and advancement because of gender dynamics.
Dryburgh (1999); Eisenhart & Finkel (1998)	Gender neutrality	Women scientists may strive for gender neutrality that contributes to the perpetuation of gender inequities.
Markus & Nurius (1986); Norman & Aron (2003)	Possible selves; aspirational selves	Women scientists' views of possible selves are potentially limited by their gender beliefs.
Harding (1991); Keller (1986); Fletcher (1999)	Feminist standpoint theory; male science; devaluing of women's contributions	Women scientists make contributions to science in ways that are not valued.

Women scientists' career choices are guided by gender. Like Gottfredson (1981) and Lips (2007), I believe women construct gendered views of behavior that constrain their

understanding of available career options and potentially limit their career choices. Women working in science are burdened by the same social contexts which inform gender beliefs, values and roles in the larger society. Although these social contexts take various forms, they often create hidden or unchallenged barriers which become work environment stressors for women that male scientists do not experience (Gupta et al., 2005). While I observe significant gender dynamics surrounding the experiences of the participants and their career-related choices, the participants did not specifically identify gender roles and associated constraints as key elements guiding their career paths. In their interviews, the participants did not express any criticism of their traditional roles as women, or the expectation that their professional goals would need to be compromised in favor of their responsibilities as wives and mothers. However, based on their accounts of their career decision-making processes, it is clear that traditional gender role expectations have influenced their career paths.

Each of the eight participants in this study currently holds a faculty position at a college or university. Interestingly, only three of the women actually planned to teach as their primary occupation. However, the women described selecting careers in higher education because they were portable and would allow them to find work whenever their husbands' careers required a change of location. From the participants' perspective, seeking out employment that will accommodate a husband's career is a natural, expected process of being a working wife and mother. For example, Katie described placing her career on hold for 14 years to be a full-time wife and mother. Lisa acknowledged that her position as a teaching faculty member was "an acceptable trade off" because it allowed her to spend time

raising her daughter. The participants seemingly made these career concessions without any concern for the potential imposition on their career goals.

Additionally, the participants' seeming acceptance of their roles as women may mean they do not see a need or do not feel empowered to challenge the status quo of the existing work environment within academia (Bierema, 2001). According to their narratives, the participants entered academia with the goal of balancing personal and professional interests, not necessarily to become full professors. This aspect of their common experience may in some ways explain why they report that academia is their preferred work environment when much of the literature describes the opposite experience for women (Blickenstaff, 2005). If they entered their careers in academic science with no expectation of earning tenure or reaching full professor, I find it plausible that they would find their work environments satisfactory. However, their narratives also indicate that they, guided in part by their gender roles to choose careers in academic science, may not have fully considered the opportunities or obstacles related to long term career progression and advancement.

Women scientists face challenges in career progression and advancement because of gender dynamics. The participants in this study believe any failure to realize their full potential as scientists is the result of their personal choices, including the decisions to become mothers and family caretakers. However, there is significant evidence to support the argument that the responsibility for improving the career progression of women scientists is more than a matter of individual career choices (Xu, 2008). Women scientists are less likely than men to have tenure track positions, less likely to receive tenure or be promoted to a full

professorship, and if they do have tenure, less likely to have children (Fox, 1999; Ginther & Kahn, 2006; Graziano, 2007). The fact that women are able to earn the same math and science degrees as men, but not achieve the same results regarding career progression, suggests gender dynamics are working against women's best interests in the academy. Of the eight women participating in this study, only half have earned tenure.

As noted in the previous section, the women in this study made career concessions in support of their family commitments illustrating the assertion that issues surrounding women's career progression are embedded with issues related to partners and children (Bierema, 2001). Existing conceptions of work established on the traditional model of men working outside of the home while women serve as primary homemakers requires individuals to compartmentalize their lives as if there are distinct divisions between home-life and work-life (Brickhouse, 2001). I assert that the attempt to separate personal life from work life is arbitrary and women, who are often tasked with the role of primary caregiver while also working full-time outside of the home, bear much of the responsibility for negotiating conflicts between the needs of the family and the needs of the workplace. Further, women accept this responsibility as inherent to their roles as wives and mothers along with the expectation to act as if the balancing of these worlds (home-life and work-life) uses little or no energy (Jorgenson, 2002). In reality, resources in the form of time, focus, and creativity are continuously being diverted between home-life and work-life with the result being that many women develop views of themselves as not able to perform their roles well at home or at work.

My study findings suggest that the participants managed potential role conflicts by adjusting their professional goals to suit their beliefs about what was required of them to pursue both their math and science interests, and also maintain a family life. For example, Lisa intentionally chose not to pursue a tenure-track position in the academy for fear that she would not be able to balance her commitments. In fact, seven of the eight participants sought faculty positions within the academy because they viewed it as a flexible career option that would allow them to fulfill their family obligations while actively engaging their intellectual interests. None of the participants articulated the achievement of tenure or full professorship as primary career goals. The implication is that the study participants may have persisted in their academic science careers because their primary goal was to balance personal and professional interests rather than advance to the highest levels of their professions.

What is difficult to determine, and was not specifically articulated as part of the participant interviews, is the degree to which the women are satisfied with their career achievements. All of the participants have earned doctorates, teach courses, advise students, and are actively involved in research projects. Yet, their comments made me wonder if they were benchmarking themselves against some external ideal of where they should be in their careers. Jeri describes her disappointment that she is still a lecturer despite working for the same institution for 10 years and still thinks about the possibility of “smashing atoms.” Susie noted, in particular, that her work has recently opened up opportunities to collaborate with scientists outside of the United States. Lisa subtly defends her choice to remain a teaching faculty member because “someone has to advise the students and take care of scholarships.”

There is a sense that they need to defend their career choices or apologize for somehow failing to meet the unwritten standards of "true" science (Eisenhart & Finkel, 1998). The need to match their personal and professional credentials to an external ideal of science practice may encourage some women to minimize their femininity as a way of establishing their suitability for science.

Women scientists may strive for gender neutrality that contributes to the perpetuation of gender inequities. During the data collection process, I was surprised to note that a few participants referenced their ability to get along with men as a skill distinguishing them from other women. Lisa described the rapport she was able to establish with her all-male study groups in college. Marie attributed her comfort in men's company to her past as an athlete and having grown up with older brothers. Additionally, Lisa and Marie recall choosing not to join women's professional organizations because they did not want to be viewed as needing special support. Other participants echoed the sentiment of wanting to be considered the same as their male peers. From my perspective, the participants' comments indicate an attempt to separate themselves from the challenges of being a woman in a male-dominated profession, including isolation from colleagues and questions regarding their competency.

Dryburgh (1999) suggested women scientists strive for gender neutrality as a way to assert that they are no different than their male counterparts with regard to professional skill. Additionally, she asserts that by denying the existence of sexism in their classroom or work environments, women are attempting to present themselves to men as nonthreatening, team

players. While this strategy may be effective in promoting individual women's career advancement, Eisenhart and Finkel (1998) argue that reliance on gender neutrality undermines the power of collective action to address women scientists' historical disadvantages in the work place. In other words, by pretending that gender differences do not exist, women scientists fail to gather sufficient focus and momentum to catalyze real, lasting change in their work environments. Additionally, women scientist's silence or disregard of gender issues may perpetuate the myth that aspects of womanhood are not fit for the practice of science and inadvertently encourage gender beliefs that undermine women's views of themselves as scientists.

Women scientists' views of possible selves are limited by their gender beliefs. Research regarding career-related possible selves indicates that particular views of self can be inhibited when a woman does not recognize, or understand how to achieve, the goals associated with that self (Markus & Nurius, 1986; Norman & Aron, 2003). Although women may feel capable of carrying out many of the tasks associated with science and technology occupations, they tend to view these career options as too masculine to pursue (Chalk et al., 2005). This is partially true for the participants in this study. As discussed in the first section of this chapter, the "ideal" or "true" scientist identity is not something the study participants believe they can achieve, so they replace the scientist possible self with the educator self they believe can be achieved. Additionally, rather than change professions, the women in this study have negotiated careers in academic science that allow them to use their knowledge and skills in ways that are compatible with their achievable possible selves.

The study participants have developed an educator identity grounded in their love of math and science. I suggest that an important aspect of their ability to persist within their math and science careers has been the development of a view of themselves as different from, but still compatible with, the stereotypical persona of a scientist. When asked to describe the typical scientist, the participants used words like “researcher in a lab,” “narrowly focused,” and “lacking social skills.” Often, women hold stereotypical images of scientists which clash with their desired images for themselves (Buck, Clark, Leslie-Pelecky, Yu, & Cedra-Lizarraga, 2007). While the participants did not specifically mention gender, their word choices are aligned with the general descriptions of the “older, white male obsessed with his research” most often associated with scientists. From the perspective of the participants, a scientist is someone who works primarily as a researcher and is focused on testing hypotheses and making new discoveries. While the scientist identity continues to evolve, our current conception of what it means to be a scientist carries masculine traits that seems to fit a historical ideal of the profession (Benckert & Staberg, 2000).

Although the participants did not articulate this directly, their reluctance to claim a scientist identity for themselves suggests that they recognize that the ideal masculine scientist does not necessarily fit their views of self. Chalk, Meara, and Day (1994) found that women tended to hope for traditionally masculine jobs, such as science occupations, more than they expected to pursue and achieve them. Their results indicated that possible selves congruent with math and science interests may produce different career-related self perceptions for women than men. Similarly, Lips (2004) found that some women rejected the construction of

possible selves within engineering and physical science disciplines despite reporting current self perceptions with positive inclinations toward math and science. She hypothesized that the women's possible selves were in conflict with their beliefs about femininity, or they had no female role models in these areas to help inspire a scientist possible self.

While viewing themselves as educators rather than scientists allowed the participants to create space for a professional identity that is compatible with their traditional gender roles as women, this study suggests their view of themselves as something other than "true" scientists has potentially limited their thinking regarding what it is possible to achieve within their careers. For example, Teresa enjoyed the intellectual challenge of working at a national lab, but was uncomfortable on a personal level because she could not dress and act as herself in the work environment. Additionally, Jeri dreamed of "smashing atoms" but believed that a single mother could not successfully manage a career as a researcher. Further, some participants view themselves as "works in progress" or not yet fully-realized scientists despite having earned doctorates and twenty or more years of experience. Lane suggests there are limits to her effectiveness as a scientist because of her unwillingness to risk the study of big ideas. Meanwhile, Christine questions whether or not she has the "powerful tools" or intellectual agility to consider herself a mathematician.

The experience of the women in this study begs the question: how many women working in academic science view themselves as educators rather than scientists? The answers to that question could have a significant influence on research regarding women's underrepresentation in the sciences. In the case of the women participating in this study, their

view of themselves as educators seems to be aligned with their professional goals. However, what is not known is how many of the participants hoped for a different type of career, but "settled" for a teaching career because their perceptions of the academic science environment made that option seem more feasible. Similarly, what could be concluded by the women's views of themselves as educators is that they see themselves as somehow less worthy than true scientists and therefore their contributions to science are not as important.

Women scientists make contributions to science in ways that are not valued. Aligned with Harding's (1986) assertions regarding the relationship between women and science, I suggest that women add something unique and valuable to the study and practice of science by nature of their womanhood. However, rather than being encouraged to contribute their skills from a place of strength, women's approaches to science are often devalued because they do not match the masculine definitions of scientific practice. Specifically, feminist scholars such as Keller (1985), suggest that female-oriented approaches emphasizing relationships and multi-level connections have historically been disregarded. The study findings support this view. For example, Lisa recalls being discouraged by male colleagues from pursing a doctorate in chemical engineering and process optimization because it was considered too general and not technical enough. However, she moved forward with her plan because she understood that she has a talent for making connections across seemingly disparate ideas and developing effective processes.

According to Bierema (2001), disregard for women's ways of working is the result of women's assimilation into male-dominated work culture and the associated devaluing of

women's gender roles and identity. Given that only half of the eight participants in this study are tenured faculty members despite an average of 20 years working in their respective disciplines, their experiences seem to add credence to the assertion that women scientists' contributions to science have not resulted in the same career rewards as men's contributions (Xu, 2008). The work that the study participants contribute as educators may allow them to apply some of their most effective talents, such as mentoring and advising (Bierema, 2001; MacRae, 1995), but are typically not seem as valuable within their professions or as worthy of tenure as direct scientific achievement.

Guided by Fletcher's (1999) work in identifying the myriad ways in which women's contributions are reduced and rendered invisible, I assert that as long as academic science remains a site where women scientists perceive they cannot make full use of the perspectives, knowledge and skills derived from their experiences as women, we will not be able to achieve gender equity in the study and practice of science. As mentioned previously, the study participants perceive themselves as having different skills and interests than "true" scientists, but as faculty members have created a space to pursue their interests in math and science. Similarly, by choosing to pursue a more process-oriented specialization in her discipline, Lisa was creating space to practice science in a way that best suits her individual skills and talents.

As a researcher, I have mixed feelings about these findings. On the one hand, I am inspired by the women's ability to persist in their math and science pursuits. On the other hand, I am concerned about our collective ability to improve women's perceptions of their

place in science when women who have earned doctorates in math and science do not feel a direct connection to the scientist identity.

Review of a Feminist Perspective

When viewed through a feminist lens, the aggregate narrative reveals discrepancies between the participants' reports of their career development experiences and their perceptions of those experiences. While the participants have successfully negotiated careers in academic science, their stories confirm the persistence of a series of gender inequities and suggest limitations to women's career achievements may exist within academic science. Specifically, women scientists working in academia continue to experience career choice and advancement constrained by family obligations as well as work environments that do not recognize or devalue their skills and contributions to the profession. Additionally, women scientists may struggle to balance their possible selves as women and as scientists in academic science environments that encourage gender neutrality and adhere to traditional, male-dominant views of "true" science. In response to potential or perceived conflicts between their views of possible selves, the women in this study developed an educator identity more compatible with their personal and professional goals than a scientist identity. Further, the study findings indicate that the women's views of self, shaped by constraining gender beliefs, may have limited their scope regarding what it is possible to achieve within their science careers. The final section of this chapter will present implications for theory and outline recommendations for research and educational practice as essential action steps in addressing the gender dynamics influencing women scientists' careers and views of self.

Conclusions and Implications for Theory and Practice

One of the goals of this study is to contribute to our increased understanding of how unexamined gender beliefs and biases perpetuate the underrepresentation of women in math and science and promote educational practice that actively disrupts these beliefs. Further, my hope is to add support to the argument that our continued reliance on historical conceptions of gender-appropriate roles, responsibilities, occupations, etc. undermines efforts to eliminate gender inequities. For example, as long as we adhere to rules identifying particular behaviors as more appropriate for one gender over another, such as taking out the trash or bathing the baby, we are complicit in the process of attaching worth or value to some behaviors over others.

I do not expect to see gender inequities eliminated in my lifetime. The gender dynamics that have evolved over centuries will not dissolve through wishful thinking or impassioned pleas. Rather, change will come as it always has – when society is receptive to a new way of envisioning itself. As an educator and a researcher, I want to present new and different ways of looking at ourselves. I aspire to present ideas in ways that will spark the imagination of others and encourage them to believe in the possibility of more equitable and collaborative ways of living in the world. Through my experiences as a doctoral student, I have come to understand that one of my motivating beliefs is that we cannot hope to achieve a goal that we have not first imagined as possible. Further, I believe our socio-historical context – our situation in life- has the power to constrain our imaginations and limit our perceptions of what we are able to achieve.

Accordingly, I also believe the findings from this study will support the efforts of other educators by contributing to existing theory, raising critical questions for further study, and offering suggestions for educational practice.

Theoretical Contributions

This study contributes to existing theory in two specific ways. First, the use of the possible selves construct in conjunction with a critical feminist perspective extends possible selves into the feminist literatures and provides a deeper, more nuanced understanding of the role of patriarchy in the development of views of self. Second, the study findings confirm the assertions of Markus and Nurius (1986), Lips (2000; 2004; 2007), and others that gender is a central force in the construction of possible selves. In this study, the participants developed views of themselves, not as scientists, but as "educators who work in science." This critical distinction enabled these participants, perhaps unknowingly, to accommodate conflicting gender/role demands and legitimize their 'less than' status in the academic scientific community. Guided by these contributions, the recommendations for future research presented below are rooted in my belief that education is a powerful tool for change and the hope that somehow my suggestions for further study will promote continued efforts to understand women's views of self in relation to the ways they negotiate their careers.

Recommendations for Future Research

Recommendation 1. Educators, and others, who strive to increase women's participation in the sciences should be concerned about the relationship between women's views of self and their ability to persist in math and science pursuits. My findings suggest

that the participants in this study are hindered by masculine definitions of the scientist role. They did not see their roles as faculty members matching their definition of a “true” scientist. If women faculty in the sciences do not view themselves as scientists, what does that say about the conditions of working in academic science? This idea also raises questions regarding women’s views of self and whether or not they need external validation to claim a particular identity. Additionally, I wonder what messages students are being inadvertently taught regarding who has the “right” to call herself a scientist. If I am a student of color or otherwise different from the “ideal” scientist, will I struggle with the feeling that I need permission to be a scientist? Future research projects should explore these ideas in more depth as a way of contributing to discourse that challenges existing beliefs, but also to provide support to educational interventions directly affecting students.

Recommendation 2. My findings suggest that the women participating in this study may not be fully aware of the narrowed array of options from which their career decisions were made. For the women in this study, teaching provided an opportunity to pursue intellectual interests, help support their families, and live within the traditional structures of their roles as women. Although most of the participants had opportunities to work in industry or research, they all viewed the higher education environment to be the best fit for their personal and intellectual pursuits. What is not clear is whether or not the women believed they had any other realistic options for balancing career and family needs. Further, the findings also do not indicate the degree to which the women are satisfied with their career achievements. There are indications in some of the women’s narratives that they may have

compromised and “settled” for a teaching role as the best available career option. Their experiences raise the question of whether or not existing structures reinforce beliefs in women that direct them toward teaching and away from practicing science and math as pure researchers. Further investigation of this issue should examine how existing social structures involving power, gender, and work potentially create a funnel that pushes women scientists toward teaching and away from other career options. Again, following this line of inquiry contributes to our ability to challenge gender beliefs that limit women’s choices and also supports educational practices that prepare women for professional work in science.

Recommendations for Educational Practice

The recommendations for future research outlined above are presented in support of educational practices in higher education intentionally designed to disrupt gendered perceptions of science and science career options. I believe that scholarly research can inform educational practice in ways that will, over time, reshape or eliminate the gender beliefs that limit women’s views of themselves. Further, I believe educators can create environments where women are empowered to explore a full range of science career possibilities unconstrained by outdated gender beliefs.

Based on the experiences of the study participants and guided by Bourne and Ozbilgin’s (2008) strategies for addressing the gendered perceptions of professions, I am presenting three recommendations for educational practice related to working with students: 1) encourage involvement in a variety of experiences and contexts; 2) expose students to a

variety of career alternatives; and 3) recognize and acknowledge students' diverse backgrounds in the design and implementation of interventions.

To actively disrupt gendered perceptions of science and science career options, educators should look for ways to add diverse experiences to their course designs. Specifically, requiring students at all levels to explore other perspectives and engage in hands on experiences that will challenge them to consider their gender role assumptions is essential to helping them imagine new and different possibilities for themselves. Next, my experience working with undergraduates students has taught me that most students have very limited information on the types of careers that are available to them. Intentionally exposing students to a variety of career alternatives within their chosen field of study may help them find a place that is compatible with their skills, talents and views of self. Finally, educators should be aware that their students may need the same information delivered and experienced in a variety of ways to accommodate different learning styles, differences in knowledge base as well as a host of socioeconomic considerations. For example, students may not have been directly exposed to professionals working in the fields they hope to pursue and may need facilitated access to individuals who can share the details of their educational pathways and work experiences.

These recommendations for practice are not limited to classroom instruction, but also apply to any number of educational interventions, including those developed for student organizations, peer mentoring programs, residential living-learning communities, career development workshops, and adult education programs. Ultimately, the goal of these

recommendations is to encourage the creation of educational opportunities that will prompt students to imagine career possibilities unconstrained by outdated gender beliefs.

Chapter Summary

The goal of this study was to trace how women develop views of self that enable them to navigate gender and personal context for the purpose of pursuing and sustaining careers in academic science. In this chapter, I analyzed the findings that emerged from the participants' narratives in two parts. The first part presented the study findings as seen through the eyes of the women scientists who participated in the study. In the second part of the analysis, I reframed the findings and presented them from a feminist standpoint perspective. The feminist analysis revealed five distinct gender-related tensions shaping the participants' possible selves and career experiences within academic science: 1) women scientists' career choices are guided by gender; 2) women scientists face challenges in career progression and advancement because of gender dynamics; 3) women scientists may strive for a gender neutrality that contributes to the perpetuation of gender inequities; 4) women scientists' views of possible selves are limited by their gender beliefs; and 5) women scientists make contributions to science in ways that are not valued.

Based on the participants' accounts of their experiences and the gender issues surrounding their careers in academic science, the findings suggest that they have successfully negotiated their careers by developing views of themselves as "educators who work in science" rather than scientists. While their ability to persist in their math and science careers is a noteworthy achievement, the gender biased limitations of their situations within

academic science raise concerns regarding women scientists' views of self and the likelihood that other women will face similar limitations should they choose to follow their path into academic science. This study contributes to existing possible selves theory by extending it into the feminist literatures and confirming the importance of gender to the construction of views of self. Informed by the study's contributions to theory, my recommendations for future research and educational practice are aimed at supporting educational interventions designed to better understand women's career negotiation processes and actively disrupt women's existing gendered perceptions of math and science careers. As these study findings indicate, interrupting women's constraining gender beliefs may be an integral piece of helping women expand their vision regarding what it is possible for them to achieve in their academic science careers.

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APPENDICES

North Carolina State University

Institutional Review Board for the Use of Human Subjects in Research
SUBMISSION FOR NEW STUDIES

GENERAL INFORMATION

1.	**Date Submitted:** February 2010 1a. **Revised Date:** _____
2.	**Title of Project:** Seeing the Possible and Achieving the Improbable: The Narratives of Women Negotiating Careers in Academic Science
3.	**Principal Investigator:** Kimberly C. Tullos
4.	**Department:** Adult and Higher Education
5.	**Campus Box Number:** N/A
6.	**Email:** kctullos@uncc.edu
7.	**Phone Number:** 704.425.1696
8.	**Fax Number:** N/A
9.	**Faculty Sponsor Name and Email Address if Student Submission:** Julia Storberg-Walker, julia_swalker@ncsu.edu
10.	**Source of Funding? (required information):** N/A
11.	**Is this research receiving federal funding?:** No
12.	**If Externally funded, include sponsor name and university account number:** N/A
13.	**RANK:** ☐ Faculty ☐ Student: ☐Undergraduate; ☐ Masters; or ☐PhD x Other (specify): Ed.D.student

As the principal investigator, my signature testifies that I have read and understood the University Policy and Procedures for the Use of Human Subjects in Research. I assure the Committee that all procedures performed under this project will be conducted exactly as outlined in the Proposal Narrative and that any modification to this protocol will be submitted to the Committee in the form of an amendment for its approval prior to implementation.

Principal Investigator:

Kimberly C. Tullos _____ _____
*

(typed/printed name) (signature) (date)

*As the faculty sponsor, my signature testifies that I have reviewed this application thoroughly and will oversee the research in its entirety. I hereby acknowledge my role as the **principal investigator of record**.*

Faculty Sponsor:

Julia Storberg-Walker _____ _____
*

(typed/printed name) (signature) (date)

***Electronic submissions to the IRB are considered signed via an electronic signature. For student submissions this means that the faculty sponsor has reviewed the proposal prior to it being submitted and is copied on the submission.**

Please complete this application and email as an attachment to: debra_paxton@ncsu.edu or send by mail to: Institutional Review Board, Box 7514, NCSU Campus (Administrative Services III). **Please include consent forms and other study documents with your application and submit as one document.**

****

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Reviewer Decision (Expedited or Exempt Review)

☐ Exempt ☐ Approved ☐ Approved pending modifications ☐ Table

Expedited Review Category: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8a ☐ 8b ☐ 8c ☐ 9

_____

Reviewer Name Signature Date

North Carolina State University
Institutional Review Board for the Use of Human Subjects in Research
GUIDELINES FOR A PROPOSAL NARRATIVE

In your narrative, address each of the topics outlined below. Every application for IRB review must contain a proposal narrative, and failure to follow these directions will result in delays in reviewing/processing the protocol.

A. INTRODUCTION

1. Briefly describe in lay language the purpose of the proposed research and why it is important.

The purpose of the proposed research is to explore the career development experiences of women scientists working within higher education. Using narrative inquiry methods, the proposed study is designed to explore the experiences and self beliefs that have helped women create their scientist identities and pursue careers within the academy. Insight gained from this study is hoped to provide adult educators with additional context for understanding the challenges faced by adult women in creating and maintaining a career identity congruent with employment with a science or technology field. In addition, the study may reveal areas for future study related to the intersection of gender identity and science careers.

To date, most of the research regarding women's participation in science study or science careers has relied upon quantitative methodologies and focused on adolescents or college students. By focusing on the experiences of adult women currently working as scientists, I hope to contribute to the existing body of knowledge aimed at understanding women's persist underrepresentation in science, technology, engineering and mathematics disciplines.

2. If student research, indicate whether for a course, thesis, dissertation, or independent research.

This study is proposed for the purpose of dissertation research.

B. SUBJECT POPULATION

1. How many subjects will be involved in the research?

Approximately 8 to 12 participants will be involved in this study

2. Describe how subjects will be recruited. Please provide the IRB with any recruitment materials that will be used.

Using "snowball" or "chain" sampling techniques, I will recruit potential participants through my personal and professional contacts employed at institutions of higher education. Potential participants will be contacted via email. Please review the attached proposed email invitation.

3. List specific eligibility requirements for subjects (or describe screening procedures), including those criteria that would exclude otherwise acceptable subjects.

Eligible participants will be women working full or part-time in higher education within the fields of science, technology, engineering or mathematics.

4. Explain any sampling procedure that might exclude specific populations.

The use of snowball sampling relies upon personal and professional contacts for participant recruitment. As a result, participants for the proposed study will be comprised primarily of women scientists who are connected in some way to my personal and professional contacts. However, no specific population of women scientists is being intentionally excluded from the study.

5. Disclose any relationship between researcher and subjects - such as, teacher/student; employer/employee.

The researcher does not have a pre-existing relationship with any of the study participants.

6. Check any vulnerable populations included in study:

- ☐ minors (under age 18) - if so, have you included a line on the consent form for the parent/guardian signature
- ☐ fetuses

- ☐ pregnant women
- ☐ persons with mental, psychiatric or emotional disabilities
- ☐ persons with physical disabilities
- ☐ economically or educationally disadvantaged
- ☐ prisoners
- ☐ elderly
- ☐ students from a class taught by principal investigator
- ☐ other vulnerable population.

7. If any of the above are used, state the necessity for doing so. Please indicate the approximate age range of the minors to be involved.

The proposed study focuses on the experiences of women and may include individuals who are pregnant. Pregnancy is not central to the study, but it is not being considered as a reason to exclude participants.

C. PROCEDURES TO BE FOLLOWED

1. In lay language, describe completely all procedures to be followed during the course of the experimentation. Provide sufficient detail so that the Committee is able to assess potential risks to human subjects. In order for the IRB to completely understand the experience of the subjects in your project, please provide a detailed outline of everything subjects will experience as a result of participating in your project. Please be specific and include information on all aspects of the research, through subject recruitment and ending when the subject's role in the project is complete. All descriptions should include the informed consent process, interactions between the subjects and the researcher, and any tasks, tests, etc. that involve subjects. If the project involves more than one group of subjects (e.g. teachers and students, employees and supervisors), please make sure to provide descriptions for each subject group.

Once the researcher has received IRB approval, recruitment of study participants will begin using snowball sampling techniques. Potential participants will be contacted via e-mail. Once a participant has confirmed her participation in the study, the researcher will schedule the first of two 60-minute in-person interviews. Additionally, the participant will be asked to complete a biographical timeline worksheet to be submitted at the time of the first interview.

All interviews will be conducted using the approved interview guide. All interviews will be recorded digitally. At the beginning of the first interview, the research will introduce herself, review the purpose of the study, and walk the participant through the informed consent process. After the participant has resolved any questions about the study, the researcher will conduct the interview. At the end of the interview, the researcher will schedule the second interview. After each interview, the researcher will transcribe the digital recordings, review field notes and review participants' biographical timeline worksheets.

The second round of participant interviews will be based on each participant's first interview. The researcher will ask specific follow up questions to elicit narratives regarding the participant's views of self or career experiences that were mentioned in the first interview. The researcher will follow the same protocol as the first interview regarding reviewing the purpose of the study and walking through the informed consent process. After conducting the interview, the researcher will transcribe the digital recording.

After all interviews have been conducted and the recordings transcribed, the researcher will begin analyzing the data using narrative analysis and thematic coding techniques. Using preliminary codes derived from research regarding women in science and possible selves theory, the researcher will categorize the data revealed in the transcribed interview texts. The process will involve repeated readings of transcripts, ongoing consultation of the research literature, and detailed note taking in a research log.

Once the researcher has identified the central themes of the research, participants will be sent a copy of their transcript and a description of themes. Based on participant feedback, the researcher will refine the themes and correct any mistakes identified in the interview transcripts.

Next, the researcher will organize the themes that have emerged from data analysis into an outline that makes sense of the participants reported views of self and career experiences. From the outline, the researcher will create a narrative that captures the aggregate experiences of the participants using direct quotes from their interviews. The aggregate narrative will be sent to each participant for review. The researcher will refine the narrative based on participant feedback and include the final version in her report of the study findings.

2. How much time will be required of each subject?

The investigator estimates that each participant will be required to commit approximately 2 ½ to 3 hours to the study, including the two interviews and completion of the biographical timeline worksheet.

D. POTENTIAL RISKS

1. State the potential risks (physical, psychological, financial, social, legal or other) connected with the proposed procedures and explain the steps taken to minimize these risks.

No risks are anticipated.

2. Will there be a request for information that subjects might consider to be personal or sensitive (e.g. private behavior, economic status, sexual issues, religious beliefs, or other matters that if made public might impair their self-esteem or reputation or could reasonably place the subjects at risk of criminal or civil liability)?

The researcher will ask participants to share stories about their life experiences specifically related to their personal career development. Participants will retain primary control over what information to reveal during the research process and will not be encouraged to participate in any aspects of the study which they perceive to be too personal or private.

a. If yes, please describe and explain the steps taken to minimize these risks.

While it is not the intent of the investigator to ask intrusive questions, some participants may have a higher level of sensitivity to revealing biographic information than anticipated. The majority of the information gathered is self-disclosed and gives participants a high degree of control over what information is shared with the investigator.

b. Could any of the study procedures produce stress or anxiety, or be considered offensive, threatening, or degrading? If yes, please describe why they are important and what arrangements have been made for handling an emotional reaction from the subject.

The interviews will ask the participants to reflect on childhood memories, to share self-perceptions and to disclose personal goals and objectives. The process of participation may instigate some feelings of discomfort or uncover past emotional pain. Participants will be forewarned of the risks and encouraged to inform the researcher at any time if they would like to withdraw from the study. Additionally, the researcher will attend to the expressed emotions and behaviors of the participants and offer appropriate breaks or withdrawal from the study to participants who are made uncomfortable by the research process.

3. How will data be recorded and stored?

All of the information shared is confidential. All interviews will be recorded digitally and via handwritten notes. The data will be stored in the home of the primary researcher. All electronic files will be stored on the researcher's home computer and password protected. All hand written notes will be stored in files at the researcher's home

a. How will identifiers be used in study notes and other materials?

Each participant will receive a pseudonym and the master list of participant names will not be saved in the same file or stored in the same electronic location as the interview data.

b. How will reports will be written, in aggregate terms, or will individual responses be described?

The report will be written with individual responses being attributed to the appropriate pseudonym.

4. If audio or videotaping is done how will the tapes be stored and how/when will the tapes be destroyed at the conclusion of the study.

Digital files will not be associated with participant names and will be stored on the researcher's home computer and backed up to a hard drive. Once the research process is complete, the files will be deleted from the computer and the hard drive.

Is there any deception of the human subjects involved in this study? If yes, please describe why it is necessary and describe the debriefing procedures that have been arranged.

No

E. POTENTIAL BENEFITS

This does not include any form of compensation for participation.

1. What, if any, direct benefit is to be gained by the subject? If no direct benefit is expected, but indirect benefit may be expected (knowledge may be gained that could help others), please explain.

While there are no direct benefits expected from this study, indirect benefits include contributions to the existing body of research regarding women scientists and their career experiences in higher education. Additionally, study participants may benefit from the self reflection promoted by the research process in addition to the opportunity to share the insights of their lived experience.

F. COMPENSATION

Please keep in mind that the logistics of providing compensation to your subjects (e.g., if your business office requires names of subjects who received compensation) may compromise anonymity or complicate confidentiality protections. If, while arranging for subject compensation, you must make changes to the anonymity or confidentiality provisions for your research, you must contact the IRB office prior to implementing those changes.

1. Describe compensation

N/A

2. Explain compensation provisions if the subject withdraws prior to completion of the study.

NA

3. If class credit will be given, list the amount and alternative ways to earn the same amount of credit.

NA

G COLLABORATORS

1. If you anticipate that additional investigators (other than those named on **Cover Page**) may be involved in this research, list them here indicating their institution, department and phone number.

NA

2. Will anyone besides the PI or the research team have access to the data (including completed surveys) from the moment they are collected until they are destroyed.

The researcher's faculty sponsor and peers from her doctoral cohort may be asked to review codes and drafts of the final report. However, no one other than the principal investigator will have direct access to the data.

H. CONFLICT OF INTEREST

1. Do you have a significant financial interest or other conflict of interest in the sponsor of this project? No

2. Does your current conflicts of interest management plan include this relationship and is it being properly followed? N/A

I. ADDITIONAL INFORMATION

1. If a questionnaire, survey or interview instrument is to be used, attach a copy to this proposal.
2. Attach a copy of the informed consent form to this proposal.
3. Please provide any additional materials that may aid the IRB in making its decision.

Project Timeline and Procedures

Project Goal	**Projected Deadline**
Receive IRB approval	Early March 2010
Conduct Pilot Interview	April 2010
Recruit Study Participants	May 2010
Complete Data Collection	August 2010
Analyze Data	November 2010
Complete Final Chapters and Revise	January 2011
Defend Dissertation	March 2011

Researcher Procedures

a) Complete all necessary IRB forms

b) Contact all personal and professional contacts regarding my study and request the names of potential participants

c) Create standard email to send to all potential participants

d) Complete pilot interview

   i) Complete necessary IRB forms

   ii) Locate volunteer to participate in pilot interview

   iii) Send participation email to volunteer

   iv) Create beginning codes for data analysis based on women in science literature and possible selves theory

v) Conduct interview with person

vi) Record and write field notes during the interview

vii) Transcribe interview data

viii) Analyze field notes and transcribed interview with existing codes and when necessary create new codes

ix) Send transcribed interview and initial themes to participant to verify that interview information is accurate and to assess if she agrees with the preliminary themes from the data.

x) After process is complete, ask for feedback. Improve the process and move towards actual study

e) Send participation email to all potential study participants

f) Update beginning codes for data analysis based on feedback from pilot interview

g) From responses to email, decide who will participate in study

h) Through email correspondence or phone calls, set up first interviews and prepare interview materials

i) Conduct first round of interviews and schedule follow up interviews

j) Record and write field notes during the interviews

k) Transcribe interview data

l) Analyze field notes and transcribed interview with existing codes and when necessary create new codes

m) Review biographical timeline worksheets, make notes and prepare follow up questions

n) Conduct second round of interviews

o) Complete all items until all participants have completed necessary steps

p) Analyze all collected data in iterative rounds of coding until saturation point

q) Send transcribed interviews and initial themes to participants to verify that interview information is accurate and to assess if each participant agrees with the preliminary themes from the data.

r) Finalize the themes of the data and write a report of the data

s) Begin Chapter 4 and 5 of the dissertation

Participant procedures

t) Participant will respond to email invitation

u) Participant and researcher will schedule a first interview

v) Participant will complete a biographical timeline worksheet

w) Participant will complete all necessary IRB forms

x) Participant will participate in first interview

y) Participant will participate in second interview

z) Participant will read transcribed interview and initial themes

aa) Participant will report thoughts on transcribed interview to researcher

bb) Participant will report thoughts on themes to researcher

cc) Participant will review her participant profile and aggregate narrative presented in researcher's dissertation

Project Procedures

Study Purpose:

The purpose of the proposed research is to explore the career development experiences of women scientists working within higher education. Using narrative inquiry methods, the proposed study is designed to explore the experiences and self beliefs that have helped women create their scientist identities and pursue careers within the academy. Insight gained from this study is hoped to provide adult educators with additional context for understanding the challenges faced by adult women in creating and maintaining a career identity congruent with employment with a science or technology field. In addition, the study may reveal areas for future study related to the intersection of gender identity and science careers.

Participant Recruitment and Data Collection:

Using snowball sampling, I will utilize my personal and professional contacts to identify potential study participants. All potential participants will receive an e-mail invitation describing the study and outlining the participants' time commitment. Once a

potential participant has confirmed that she would like to be involved in the study, I will schedule the first of two interviews and send her a biographical timeline worksheet. Using the IRB-approved interview guide, I will conduct the first interview making sure to begin by walking each participant through the informed consent process. At the end of the first interview, I will schedule the second interview. Both interviews will be digitally recorded and transcribed for data analysis.

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Project Resources:

I will seek the assistance and guidance of research advisors at North Carolina State University in order to produce the best practices in design, method, and analysis. I have computer and technological resources available to support my research project, including recording interviews and storing electronic files. Additionally, I anticipate that I will need to travel throughout the state of North Carolina to collect data. I have built in time to the project schedule in consideration of travel logistics and expenses.

Research Questions and Guiding Frameworks:

My study is guided by two questions: 1) how do women scientists develop views of self? and 2) how do women scientists negotiate their careers?

I have selected feminist standpoint theory as an appropriate theoretical frame for the study. Feminist standpoint theory assumes the existence of women's shared experiences in the practice and study of science. Additionally, feminist standpoint theory asserts that the experiences of women in science must be explored separately from men's experiences. A feminist standpoint perspective supports my choice to focus on the views of self and career experiences of women scientists. Possible Selves theory (Markus & Nurius, 1986) provides a framework for identifying and understanding women's views of self related to their science career pursuits. Specifically, possible selves theory will be used to identify women scientists' desired, feared, and expected selves relevant to their career pursuits.

Data Analysis:

Using Possible Selves theory in addition to other supporting research to derive data codes, I will analyze the transcribed texts from participant interviews. I will also use my research log and participants' responses on the biographical timeline worksheet to identify participants' views of self and their subsequent career behavior. Using narrative analysis and thematic coding techniques, I will repeatedly review the interview texts until I am unable to identify unique codes from the data. I will refine the codes into broader categories and use member checking and peer debriefing procedures to ensure that my codes are true to the collected data.

Report of Findings:
I will organize the themes that have emerged from data analysis into an outline that makes sense of the participants' reported views of self and career experiences. From the outline, I will create a narrative that captures the aggregate experiences of the participants using direct quotes from their interviews. The aggregate narrative will be sent to each participant for review. I will refine the narrative based on participant feedback and include the final version in her report of the study findings.

North Carolina State University
INFORMED CONSENT FORM

Title of Study: Seeing the Possible and Achieving the Improbable:
The Narratives of Women Negotiating Careers in Academic Science

Principal Investigator: Kimberly C. Tullos **Faculty Sponsor:** Julia Storberg-Walker

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We are asking you to participate in a research study. The purpose of this study is to better understand the experience of college presidents developing a leadership identity while attending a women's college.

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
The purpose of the proposed research is to explore the career development experiences of women scientists working within higher education. Using narrative inquiry methods, the proposed study is designed to explore the experiences and self beliefs that have helped women create their scientist identities and pursue careers within the academy. Insight gained from this study is hoped to provide adult educators with additional context for understanding the challenges faced by adult women in creating and maintaining a career identity congruent with employment with a science or technology field. In addition, the study may reveal areas for future study related to the intersection of gender identity and science careers.

What will happen if you take part in the study?
If you chose to participate in the study, your time commitment would be approximately two and a half hours over the course of two in-person interviews. Additionally, I would request that you complete a brief biographical timeline worksheet as a tool to support our in person meetings. Depending on your schedule, I anticipate completing the interviews by the end of June.

RISKS
While it is not the intent of the investigator to ask intrusive questions, some participants may have a higher level of sensitivity to revealing biographic information than anticipated. The majority of the information gathered is self-disclosed and gives participants a high degree of control over what information is shared with the investigator. The interviews will ask the participants to reflect on childhood memories, to share self-perceptions and to disclose personal goals and objectives. The process of participation may instigate some feelings of

discomfort or uncover past emotional pain. You are encouraged to inform the researcher at any time if you would like to withdraw from the study.

BENEFITS
Most of the research regarding women's participation in science study or science careers has relied upon quantitative methodologies and focused on adolescents or college students. By focusing on the experiences of

adult women currently working as scientists, the goal of this study is to contribute to the existing body of knowledge aimed at understanding women's persistent underrepresentation in science, technology, engineering and mathematics disciplines. Additionally, it is hoped that you may benefit from the self-reflection promoted by the research process in addition to the opportunity to share the insights of your lived experience.

CONFIDENTIALITY
The information in the study records will be kept strictly confidential. Data will be stored securely in the researcher's private residence and will not be associated by name with your specific responses. No reference will be made in oral or written reports which could link you to the study.
After professional transcriber, transcribes your interview, these records will be kept on my computer and the file will be password protected. Additionally, I will send you hard copies of the transcribed interview so that you can confirm that the responses and themes I concluded are accurate. If you would like any comments to be removed after reviewing the document, please just let me know.

This data collected will be published in the researcher's doctoral dissertation for North Carolina State University.

COMPENSATION
There will be no compensation for participation in this study.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Kimberly C. Tullos, at kctullos@uncc.edu, or 704-425-1696.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514).

Consent To Participate
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Subject's signature_____ Date _____

Investigator's signature_____ Date _____

Proposed Text for E-mail Invitation

Dear [Participant Name],
[Name of Personal Contact] suggested that I contact you. I'm currently a North Carolina State University student working on my dissertation research and hoped you might be interested in participating in my study. The purpose of my study is to explore how women scientists are able to develop self beliefs that enable them to pursue science careers in higher education. The study utilizes a qualitative design and relies on my ability to gather stories from women currently working as scientists.
I am very excited about the opportunity to listen to women's stories about their lives and how they developed careers in science. My hope is that sharing your personal stories is something you too would find interesting and enjoyable.
If you chose to participate in the study, your time commitment would be approximately two and a half hours over the course of two in-person interviews. Additionally, I would request that you complete a brief biographical timeline worksheet as a tool to support our in person meetings. Depending on your schedule, I anticipate completing the interviews by the end of June.
Please let me know if you are interested in participating in the study or would like to discuss the opportunity in more detail. As soon as we have confirmed a date and time for the first interview, I will send you a list of proposed questions along with the biographical timeline worksheet.
If you are not interested in participating in a study at this time, I understand and thank you for reviewing my invitation. However, if you know of someone who may be interested in participating, feel free to forward this e-mail to her for consideration.
Sincerely,
Kimberly C. Tullos

Interview Guide

Purpose of Study: The purpose of the proposed research is to explore the career development experiences of women scientists working within higher education. Using narrative inquiry methods, the proposed study is designed to explore the experiences and self beliefs that have helped women create their scientist identities and pursue careers within the academy. Insight gained from this study is hoped to provide adult educators with additional context for understanding the challenges faced by adult women in creating and maintaining a career identity congruent with employment with a science or technology field. In addition, the study may reveal areas for future study related to the intersection of gender identity and science careers.

Research Questions:
1. How do women scientists develop views of self?
2. How do women scientists negotiate their careers?

Participant Selection Criteria: Participants included in this study will be women scientists employed full-time or part-time at institutions of higher education. Additionally, the participants will be working in science technology, engineering or mathematics disciplines.

Participant Selection Procedures: Snowball sampling will be used to identify eligible participants. Potential participants will be contacted via e-mail. Details about the study will be shared and once participants have confirmed their participation, the first interview will be scheduled. The principal investigator will follow all IRB guidelines and ensure full and informed consent of the research participants.

Interview Protocol

1. Introduction
Introduce myself and my interest in pursuing this research. Thank the informant for participating in the study and review the stated purpose of the study.

2. Informed Consent
Review and sign the informed consent document. Ask the participant if she has any additional questions before beginning the interview.

3. Background/Demographic Information
Collect the following information from the informant: age, race or ethnicity, full-time or part-time employment status, current occupation, number of years employed as a scientist.

4. Interview Questions

First Interview:
When did you first know that you wanted to pursue a career in science?
When you think about your interest in science, what experiences supported you or encouraged you to consider a science career?
What discouragements have you faced along the way?
How did you know that you would be able to successfully pursue a career in science?
What other careers did you consider before deciding on a career in science?
In what ways, do you believe being a scientist is a good "fit" for you?
Describe what it means to be a scientist.
Tell me about your experiences working in academia.
What role, if any, has being a woman played in your choice to pursue a career in science?
Describe the most rewarding aspects of pursuing your science career?
Describe the most challenging aspects of pursuing your science career?

Second Interview:
The second interview is intended to follow up on responses given in the first interview. Specifically, participants will be asked questions regarding their experiences as women in a male-oriented work environment in addition to their desired, expected, and feared possible selves in relation to their scientist identities. Interview questions may include:

Describe a time during your career when you felt singled out or treated differently because you are a woman.
Why is being a scientist important to you?
Describe failure as a scientist.
Describe success as a scientist.
What motivates you to continue working in academia?

5. Closing
At the end of each interview, ask if there is anything else the participant would like share. Thank the informant again for participating and review the next steps of the study.

Timeline of Significant Events

Purpose: This worksheet is a reflection tool to support our in-person interviews by encouraging you to think about important events throughout your life.
Instructions: In the spaces provided below, describe any significant events or relationships you feel contributed (or continue to contribute) to your decision to pursue a science career in higher education. Please feel free to use as much space as you need for each section.

Childhood (age 0 -12 years)

Adolescence (age 13 - 18 years)

Timeline of Significant Events

Adulthood (age 18+ years)