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Experiences of Women STEM Professors Who Are Considering Leadership Positions at Research Universities

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EXPERIENCES OF FEMALE STEM PROFESSORS WHO ARE CONSIDERING LEADERSHIP POSITIONS AT RESEARCH UNIVERSITIES

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Dissertation Abstract
Experiences of Women STEM Professors Who Are Considering
Leadership Positions at Research Universities

Empirical evidence is needed to discern the reasons for inequities among those with doctorates hired in science, technology, engineering, and mathematics (STEM) fields. It is necessary to create a successful and motivational atmosphere for various types of female leaders who are seeking opportunities to become leaders, especially in STEM fields. This qualitative-method study used an exploratory design. The study first sought to gather information about female STEM professors' experiences through open-ended qualitative interviews to explain gaps in details of women's experiences as professors in STEM departments of universities. Second, the researcher sought to discern common themes in interview responses for the study to report on data analysis and findings. This research built on educational-leadership and educational-psychology theories and perspectives where the research problems closely follow the research questions. The data collection involved one-to-one interviews with female professors of universities, and interview responses and observations guided the data analysis and findings. Most interpretation rested on coding similar themes and trends discovered during the transcription of interview responses. This study explored the deep internal vulnerabilities of female professors working on highly competitive campuses.

This dissertation, written under the direction of the candidate's dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements for the degree of Doctor of Education. The content and research methodologies presented in this work represent the work of the candidate alone.

Cheri Liebow	November 29, 2017
Cheri Liebow, Candidate	

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To my participants, professors, and family (ALES): Thank you for your testimonies, dedication, and love.

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Ever since I was 15 years old, I fell in love with the phrase from the Eclogue X of Virgil: Amor vincit omnia, et nos cedamus amori. Being young, I did not understand the entire meaning until my graduate studies in Classical Languages. Instead, as a child, I clutched onto the literal meaning that Love conquers all things. My journey to finding love powerful enough conquer all things has been long and arduous, and in a heartbeat, I would do it all over again. I was privileged to be placed on many shoulders so I could be raised to see the path set before me, and my journey could not have been possible without the vision of the mountain I wanted to conquer: my dissertation. This journey for the doctorate degree in education has taught me so much more than education scholarship and pedagogy; I learned so much about myself and my community of support all around the world.

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CHAPTER I

THE RESEARCH PROBLEM

Statement of the Problem

Women's roles as scientists and engineers have steadily increased over the past 40 years, yet women continue to face challenges that hinder them from full participation in academic faculty positions; even more challenging is aspiration to take on university academic-leadership roles (National Academy of Sciences, 2006). The number of female science, technology, engineering, and mathematics (STEM) doctorates hired for academic positions has increased over the years; however, the low number in female leadership roles may be "due to lack of supply" (National Academy of Sciences, 2010, p. 12). The underrepresentation of female leaders in STEM could be attributed to their decisions not to participate in the application process (National Academy of Sciences, 2010). To fully understand where the leadership component needs to be supported, it is important to fully grasp the context of the most recent findings on female-professor leadership. Low participation is problematic for women because, despite years of academic training, women lack equal access to leadership, due to lower salaries than men and lack of leadership positions open to women who desire to fulfill their social need (National Academy of Sciences, 2006). Gender stereotypes and biases against caregivers also affect women's chances for leadership roles.

Women's overall income levels have increased by 10% since the 1970s, but in the 21st century, women's wages are still lower than men's wages (Organisation for Economic Co-operation and Development [OECD], 2016). U.S. women's employment rates remain well below those of men and have been falling recently such that they are

now lower than those of women in Germany and Japan (National Academy of Sciences, 2006). Although growth has rebounded from the recession of 2008, it remains unequally distributed across socioeconomic groups. Income inequality continues to increase, women typically receive lower salaries than men, and some groups are disadvantaged in the labor market with few prospects to return to work (OECD, 2016).

The decline in participation for prime-age individuals is in marked contrast to elsewhere in the OECD, particularly for women. Certain population groups face greater difficulties in finding rewarding work and removing the barriers they currently face that would help boost chances to obtain employment. Immigration reform presents another means to boost labor supply, though moving forward on different proposals has proven to be politically difficult. The Economic Survey recommended that access to paid family leave be expanded nationally (National Academy of Sciences, 2006). The Survey also recommended improving the flexibility of working arrangements, increasing access to quality preschool and childcare to help struggling families better balance work and family commitments. Federal employment laws mandate that employees can sue and employers can be sued for family-responsibilities discrimination (Title VII of the Civil Rights Leave Act, as cited in National Academy of Sciences, 2006). Second earners, most of who are women, generally would pay a higher proportion of their income in taxes for choosing to work, due to the U.S. family-based tax system in combination with progressive tax rates (OECD, 2016). Improving opportunities not only requires breaking down barriers to finding work but also being appropriately remunerated.

The gender pay differential, measured by differences in median wages for men and women, has fallen in the United States, although substantial differences remain

across states (National Academy of Sciences, 2006). Part of this wage inequality arises from sorting by occupation and firm. Men typically work at higher paying firms and receive larger wage increases when they switch jobs. Further progress in closing gender wage gaps requires changes in job structure and remuneration, particularly if job flexibility comes at the cost of reduced hourly wages (Goldin, 2015).

According to National Science Foundation (NSF) report (2014), women have earned 57% of all bachelor's degrees and about half of all science and engineering (S&E) bachelor's degrees since the late 1990s. However, although women's levels of participation in S&E fields vary, they tend to be consistent over every degree level. In most fields, the proportion of degrees awarded to women has risen since 1993. The proportion of women is lowest in engineering, computer sciences, and physics. Women earn about one-third of the doctorates in economics and slightly more than one-fourth of doctorates in mathematics and statistics. The S&E workforce comprises largely people who earned S&E degrees over 4 decades (NSF, 2014). Because older cohorts of S&E workers are disproportionately White and male, women and minorities constitute a smaller percentage of the overall S&E workforce than of degree recipients who recently joined the workforce. In the past 20 years, participation of women in the academic doctoral workforce has increased considerably. Growth in the participation of underrepresented minorities has been slower. Women and underrepresented minorities in academic employment continue to differ from their male, White, and Asian counterparts in rank, tenure, salary, and federal support.

They found that male faculty members who start families within 5 years of receiving their PhDs are 38% more likely to earn tenure than women who do the same

(Mason & Goulden, 2004). For every three women who take a fast-track (elite or research) university job before having a child, only one ever becomes a mother. In contrast, the group they define as "second-tier" women PhDs—those who are not working or who are adjunct, part-time, or "gypsy" scholars and teachers—have children and experience marital stability, much like men who become professors (Mason & Goulden, 2004). Conflict between work and family is a barrier to women. Male faculty members with young children are 50% more likely to enter tenure-track jobs than comparable women (Stacy, as cited in National Academy of Sciences, 2006).

Another aspect of balancing career and family affects dual-career couples. Such couples face problems in academia in obtaining tenure-track positions at the same institution, particularly if they are in the same field. The dual-career issue is especially salient for female scientists because 83% of female scientists have academic partners who are scientists, compared with 54% of their male peers (Schiebinger, Henderson, & Gilmartin, 2008).

Unmarried women are significantly more likely to have tenure track jobs than unmarried men (Ginther, as cited in National Academy of Sciences, 2006). Marriage provides a significant advantage for men relative to women. Presence of children, especially young children, significantly disadvantages women while having no impact on men in obtaining tenure-track jobs. Also, no significant gender differences arise in the probability of obtaining tenure in life science, physical science, and engineering or in promotion to full professor (National Academy of Sciences, 2006). Female scientists may have fewer graduate and postdoctoral students to support their work than men and less diverse networks (American Association of University Professors, 2009; Murray &

Graham, 2007). In addition, female faculty report fewer referrals from collegial networks to participate in the commercial marketplace by being asked to consult, serve on science advisory boards, and interact with industry.

States with more flexible work arrangements tend to have greater employment rates and smaller gender wage gaps. With women increasingly outperforming men at all levels of education, failure to make occupations attractive to women will constrain the economy and individual well-being in STEM occupations. Substantial gaps in the median earnings of full-time workers also exist across races. Black and Latino male workers earn a bit less than three quarters of earnings by White males. The gaps between female workers across races are less pronounced. Black and Hispanic workers tend to work in lower-paying jobs and their returns are lower. People with disabilities are also underrepresented in the S&E workforce, compared with the college-educated population as a whole. Disabilities acquired at birth or at an early age may influence decisions to pursue S&E studies; those acquired at later ages may influence opportunities to continue or seek employment.

Inequities between male and female instructors or tenure-track faculty persist (National Research Council, 2010). Empirical evidence is needed to discern the reasons behind inequities among doctorates hired in STEM fields. It is necessary to create a successful and motivational atmosphere for all various types of female leaders who are seeking opportunities to become leaders, especially in STEM fields. It is necessary and important to start a discussion of barriers that female graduate students and doctorates face, leading a way to start planning the paths to solutions. It is critical to address successful integration in the academic arena for women studying in STEM fields (Byars-

Winston & Fouad, 2008). Perhaps a major shift in the paradigm is necessary to challenge the hierarchical practices of female faculty in universities to engage in more supportive and positive practices to increase and maintain the female student population in STEM areas. Academics need to seek motivation and knowledge as to why some female faculty persevere and some choose not to stay in academic pursuits in higher education institutions, thereby uncovering why a lack of female leaders persists in STEM fields.

For example, students who possess engineering degrees tend to earn top salaries (Jacobs & Simpkins, 2005). Those students, on average, with 4-year institution degrees and experiences, earn approximately $40,000 per year more than students without a high school diploma (Sum, Khatiwada, McLaughlin, Tobar, & Palma, 2007).

Problems in female leadership may trace back to adult education in general. Merriam and Caffarella (1999, as cited in Bates & Norton, 2002) initiated discussion on the two most cited reasons for lack of participation in adult education: insufficient time and insufficient money. Valentine and Darkenwald (1990, as cited in Bates & Norton, 2002) highlighted the following five barriers that deter adults from participation: personal problems, lack of confidence, high educational costs, lack of interest in the educational process in general, and lack of interest in specific courses offered. These are general barriers women experience as adult learners; for example, female students face harassment in male-dominated schools, society, home, and work-related fields.

The underrepresentation of female leaders in STEM fields could also align with obligations of maternity leave, childrearing, or household duties (OECD, 2016). Women weigh the possibility of relinquishing their desire to have children to enable them to acquire a tenured position at an institution; the alternative many choose is to have

children and request time off (varying numbers of months to a year) to care for their parental obligations. Thus, it would seem the choice to have children undermines the chances of becoming leaders in their fields. Therefore, female learners either postpone or set aside their chances of accumulating continuous experience to becoming leaders, perhaps explaining why so few women reach leadership positions in STEM areas. This paper aims to discern why so few women have leadership positions in such critical areas of academia.

Even through Title IX, 43 years ago, prohibited gender discrimination in any educational program that receives federal funding, the number of female students enrolled in STEM fields in high schools is still quite low when compared to male participation. Even with all legal ramifications to protect female learners, disparities continue and female students suffer due to lack of support.

Background and Need

Gender differences in STEM representation emerge early (De Welde, Laursen, & Thiry (2010). Two-thirds of young children—boys and girls alike—say they like science, but gender differences, attitudes, and interests surface in middle school (American Association of University Women [AAUW], 1992; NSF, 2007b). Girls now take as many high school science courses as boys, and perform as well (AAUW, 2004), but many girls who take advanced science courses in high school do not continue to study science in college. Such disparities continue despite women's interest in STEM fields. For example, African American women have been shown to have higher levels of interest in science than their Caucasian counterparts (Hanson, 2004). Over half of all undergraduate women

select life science majors, but only one fourth of undergraduate women choose physics (NSF, 2007a).

In technology, the gender disparity exists in time spent learning how to use technological tools. Computer interest, use, and skills across genders have been well documented from early studies (AAUW, 2000: Margolis & Fisher, 2002). However, the number of women pursuing computer-science degrees has declined since the mid-1980s (Spertus, 2004; Wolverton, 2015).

The number of women who are earning engineering degrees in colleges have leveled, with no increase since 2007 (NSF, 2007a). However, the number of women earning degrees in the subfields varies: women earn 35% of chemical engineering degrees, but only 14% of electrical engineering degrees (NSF, 2007a). At higher levels of STEM education, the percentage of women continues to decline, dubbed a "leaky pipeline" (NSF, 2007a). As an example, women who are enrolled in colleges and institutions earn nearly half of mathematics bachelor's degrees on average, but only 27% of doctoral degrees in mathematics.

The disparity spreads across the spectrum of STEM majors, although women are catching up to male student numbers in life sciences doctorate degrees, for example, agriculture, chemistry, and geoscience. However, female students are still far behind their male counterparts in earning doctorate degrees in physics, computer science, and engineering (NSF, 2007b). Across all STEM fields, the proportion of women of color is even smaller, almost miniscule. Of particular note, the number of minority women in each STEM field is dropping at each level of degree attainment (NSF, 2007a).

In employment, men far outnumber women (NSF, 2007a). The gap is alarming in that 73% of employees in all sectors of S&E are men. An even larger gap separates men and women employed in business and industry sectors (79% men) and in federal government jobs (73% men). Only in the education sector do women outnumber men in elementary, middle, and high schools; 2-year colleges, junior colleges, and technical institutes, where employees tend to have lower salaries and less societal recognition (NSF, 2007a).

Purpose of the Study

The purpose of this study was to examine the experiences of female academic leaders with academic backgrounds in STEM fields. This research study entailed observing their experiences in their pathways toward leadership as well as the role they see for themselves in fostering leadership of other women from STEM backgrounds in the Silicon Valley and Greater Bay areas. General trends identified through an initial exploratory process was explained through an in-depth interview survey with female STEM professors.

Theoretical Framework

The theoretical framework for this study was rooted in social-cognitive career theory (SCCT), developed to build on the conceptual linkages with other theories of career development, embracing constructivist theory of humans' capacity to influence their own development and surroundings (Lent, Brown, & Hackett, 1994). Development of SCCT was influenced by vocational psychology, cognitive sciences, and other psychological and counseling domains (Lent et al., 1994). SCCT builds on Bandura's (1986) social-cognitive theory, averring that one's own self-efficacy beliefs, outcome

expectations, and personal goals depend on one's interests, abilities, and values, and on environmental factors. Women who are university professors have accomplished overcome a great many obstacles to obtain their doctorate degrees in STEM fields, thus channeling social-cognitive theoretical concepts. Concepts of SCCT could help in building steps to leadership positions that are generally maintained by men in STEM departments.

Social-cognitive theory rests on the ways the mind functions as a "computational program," observing others' behaviors and processes directly as a "conceptual model." According to Bandura (1995), in social cognitive theory, people must develop skill in regulating the motivational, effective, and social determinants of their intellectual functioning as well as the cognitive aspects. Hence, self-influence is the key addition to every aspect of learning process. For women who are learning in an environment with male prevalence in academic STEM spaces, the women's learning is greatly impacted not only by the instructor, but by peers as well. "Self-regulatory skills will not contribute much if students cannot get themselves to apply them persistently on the face of difficulties, stressors, or competing attractions" (Bandura, 1995, p. 18).

Learning experiences, whether direct or vicarious, shape people's occupational interests, values, and choices (Krumboltz, 1979). SCCT acknowledges the influence of genetic factors, special abilities, and environmental conditions on career decisions (Lent et al., 1994). More importantly, SCCT links with other cognitively oriented models of career and academic behavior (Eccles, 1987) and certain theories of work motivation, as well as theory and research on women's and racial-ethnic minority members' career development (Hackett, Betz, Casas, & Rocha-Singh, 1992).

This study considered the hiring practices of various institutions as part of the critical analysis of findings from each participant. This knowledge gave the research paper the ability to inform and guide readers on ways to promote higher tolerance to attain and motivate women leaders for spaces usually occupied by male role models (Montgomery, 2009). The research included the study of women at colleges, universities, and institutions in the Greater Bay area to discern how many female applicants who possess degrees in STEM subjects faced challenges to achieve their goals, and what leadership roles they will be motivated to earn in the future.

SCCT was applied to steer the collection and analysis of data throughout the research study and in-depth interviews described the lived experiences of the women who studied or practice in STEM careers (S. D. Brown & Lent, 1996, 2011). It was necessary to create a successful and motivational atmosphere for all different types of women leaders, and it is important to start a discussion of barriers faced by the female practitioners of STEM. It was crucial to listen to, understand, and offer solutions that focus on the positive interactions for female professors in the universities with STEM departments (Byars-Winston & Fouad, 2008, p. 340). This study will inform future generations of female STEM professors. As academics promote an increased number of female participants in STEM fields, it is important to study the motivations and hindrances female instructors have experienced to aid future female practitioners of STEM.

According to the observation by Lent, Brown, and Hackett,

> Counselors, theorists, and researchers are also well aware that career development is not just a cognitive or a volitional enterprise and that there are often potent

> (external and internal) barriers to choice, change, and growth … a complex array of factors such as culture, gender, genetic endowment, socio-structural considerations, and disability or health status operate in tandem with people's cognitions, affecting the nature and range of their career possibilities. (2002, p. 256)

As Tobias (1993) stated, "mathematics avoidance is not a failure of intellect, but a failure of nerve" (Tobias, 1993, p. 9). Girls choose their occupation based on their values and expectations of how well they succeed in matters or at work. Tobias outlined differences between male and female brain organization and function, especially when solving puzzles, problems, and solution strategies. Women usually become the victims of a gendered view of mathematics due to "sex differences" in brain organization and function (Tobias, 1993). The general perception accepted by the greater society is women have lower levels of confidence and self-esteem in areas generally understood as male-dominated fields, such as mathematics, engineering, and technology. It is important to deeply understand how the lived experiences of female students, instructors, practitioners, and leaders could lead to empowering the underserved population of women in STEM fields. Through in-depth interviews and observations, the researcher will explore the experiences of female instructors of STEM and try to attain a better understanding of their accomplishments and motivating internal beliefs that made them capable of being successful leaders in their STEM work environment.

Research Questions

The following research questions guided this study:

1. To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment?
2. What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?
3. What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?
4. In what ways do female STEM professors' gender identities shape their learning experiences?
5. What do female STEM professors attribute to their success?

Limitations

This study has limitations, particularly because it was one-gender study and will focus on study of female instructors engaged in STEM fields. The sample of participants was gathered from private and public universities and institutions and postsecondary educational settings willing to participate in this research project. The study used anonymous surveys (possibly circulated by e-mail) and some potential participants did choose not to respond. The survey questions may or may not pertain closely to their accurate and precise answers; most responses were limited to Bay Area locations. The geographic location of the study is northern California, the Bay Area, and the research was not generalizable to all areas of the United States. The study also closely considered public and private institutions.

Educational Significance

This study aimed to contribute to a greater understanding of how women professors navigate and make space within traditional academia. Exploring the lived

experiences of women professors before, during and after their training in STEM program and the trajectory that led them to academic institution will add their voices to the literature in the hopes of paving the way for other women who are interested in pursuing STEM professorship in the universities and research institutions. All instructors have unique learning experiences that was inspirational or motivational to be shared and analyzed for the benefit of future generations of STEM students. Having a better knowledge of the motivation and barriers of this particular STEM female population, the institutions and policies can be directed toward better pedagogy to guide future students toward behaviors and attitudes, maximizing their success in attaining their goals in STEM. This research was generalizable to educators by eliciting educators' self-awareness and efficacy in the area of STEM. It could promote school policies and guide general attitudes and outlooks of women teaching and studying in STEM fields. This research guided instructors in their professional development and hiring practices, providing practical applications for educators and future female STEM students.

This study contributed to expanding knowledge on recruiting female professionals and workers in STEM fields. This is important as a means of addressing a societal issue that has been difficult to solve through decades. The research serves as an addition to literature examining the career choices of women studying STEM majors (Byars-Winston & Fouad, 2008; Fouad & Smith, 1996; Montgomery, 2009).

Definition of Terms

The following terms have been operationalized for this study:

Faculty member of a higher education institution: an educator or a professor who works at a college or university.

Gender bias: Sex is the basis for prejudice and presumed inferiority implicit in the term sexism. The term gender bias is more inclusive than the term sexism, as it includes prejudice (attitudes) and discrimination (*Blackwell Encyclopedia of Sociology*, 2015).

> Unequal treatment in employment opportunity (such as promotion, pay, benefits, and privileges), and expectations due to attitudes based on the gender of an employee or group of employees is gender bias. Gender bias can be a legitimate basis for a lawsuit under antidiscrimination statutes. (Hill & Hill, 2017, para 1)

STEM: An acronym that stands for science, technology, engineering, and mathematics; "STEM is an educational program developed to prepare primary and secondary students for college and graduate study in STEM. In addition to subject-specific learning, STEM aims to foster inquiring minds, logical reasoning, and collaboration skills" (Rouse, 2017).

Stereotype threat: A stereotype threat is the experience of anxiety or concern in a situation when a person has the potential to confirm a negative stereotype about their social group. Since the term was introduced into the academic literature in 1995, stereotype threat has become one of the most widely studied topics in the field of social psychology (Rhys, n.d.).

Summary

Chapter 1 provided an introduction to the research topic, the problem statement, the purpose of the study, research questions, and definitions of terms. The research's limitations and significance were also presented. In Chapter 2, a historical perspectives of career decision making will be followed by a review of career literature related to women

and STEM field leadership. Chapter 3 will focus on the proposed methodology, including an overview of the phenomenological design, an introduction to the research setting and participants, and a description of research procedures.

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of this study is to examine the experiences of female professors with academic backgrounds in STEM fields. This literature review focuses on seven main themes: (a) barriers to women STEM participation, (b) factors motivating women students to major in STEM, (c) ways and factors to facilitate leadership in female STEM professors, (d) leadership theories, (e) organizational theory and female faculty, (f) self-efficacy and SCCT, and (g) future of professor leadership. It is crucial to discuss the obstacles and challenges faced by women in STEM departments at the university level, and it would benefit future STEM professors if one could identify the factors that motivate and hinder their degree process. Once women earn their degree, it is also critical to maintain their status in hopes of elevating to leadership positions in the university. These themes will be discussed in detail to help identify the areas of STEM that need to be examined further.

The origin of the underrepresentation of women in STEM programs has been largely structural, created in and through the social structures of institutions, the segmentation of the labor market, and the socialization and internalization of values and beliefs about appropriate gender roles and expectations (Dominguez, 2010). These factors manifest in a host of barriers to women's participation, general and specific to the workplace and academia, particularly higher education. The researcher proposes a thesis to discover findings through carefully interviewing participants who are willing to share their experiences.

The ongoing assault on the public and the growing preponderance of a free-market economy and corporate culture that compounds a culture of consumption, issues of critical education, resistance, politics, and social transformation (Giroux, as cited in Tierney, 2008). The main objective of higher institution and organizations must be to provide a working framework to diagnose culture in colleges and universities so distinct problems can be overcome those inequities: "larger social formations that bear down on the forms of resistance waged by educations, teachers, students, and others attempting to challenge dominant teaching practices as well as systemic forms of oppression, such as tracking" (Tierney, 2008, p. 45). Therefore, any theory pertaining to politics and resistance must address the conditions, the agents, and the current levels of struggle that lead to social formation.

Women—single, married, or divorced—are coming back to schools and joining the work force. They are daughters, sisters, mothers, and aunts seeking a gateway to social integration. For a hundred years, many women have been searching for separation from their ties to the domestic model, and consistently transforming their position in society (Hayes & Flannery, 2000). Just as Solomon (1985) explained the first woman in Massachusetts to receive her A. B. degree, Fryer (2017) created a timeline that illustrates the struggle for women's entry into colleges, seminaries and universities as early as the 1800s; women of today continually look closely at the dynamics of the learning that occurs in academia. Although better motivated and supported by institutions compared to decades ago, this group of graduate students as female learners still face many barriers as adult students. Therefore, it is crucial to address the barriers and obstacles for female STEM faculty and begin to address how to better facilitate and support women in higher

education, as well as to incorporate the necessary steps to create successful female leaders in STEM fields.

Bates and Norton (2002) presented an analysis of the barriers to participating in adult education. Citing the work of Merriam and Caffarella (1999), the authors discussed the two most cited reasons for lack of participation in adult education: insufficient time and lack of money. Valentine and Darkenwald (1990, as cited in Bates & Norton, 2002) listed the following five barriers that deter adults from participation: personal problems, lack of confidence, high educational costs, lack of interest in the educational process in general, and lack of interest in specific courses offered. Although these are general barriers faced by all adult learners, these factors are certainly faced by female students as well.

Public and private institutions must allow successful integration of women in all disciplines and fields. For the past 4 decades, the number of women in STEM fields has been increasing, however, the pervasive stereotypical threats allow men to be dominantly associated with careers in STEM starting from very early stages. These observations can even start as early as kindergarten, when a female teacher exhibits anxiety about mathematics during her instruction (Miller, Eagly, & Linn, 2015). Only 31% of full-time STEM faculty and 27% of STEM deans and department heads are women (National Academy of Sciences, 2006). The University of California, Los Angeles reported in their study that 40–60% of students who originally entered college as engineering and science majors have ultimately opted to switch to another field of study or even failed to receive a degree at the end of their academic years at their university (Christensen, Knezek, & Tyler-Wood, 2014). According to the U.S. Census Bureau (2009, Table 2), men with

college degrees tend to earn about $7,000 more than women with college degrees. It is important to research and comprehensively understand the source of women's experiences in STEM courses of study. Many women want to pursue these courses, yet face barriers and lack of motivation to succeed in these areas or to contemplate any leadership position in colleges and universities in STEM fields.

For women to stay competitive in the job or network in work-related ways, they must have some mathematics or science background. For example, students who possess engineering degrees tend to earn top salaries (Jacobs & Simpkins, 2005). Those students with a 4-year degree and experience earn approximately $40,000 more per year than a student without a high school diploma (Sum et al., 2007). As reported in the proceedings of National Academy of Sciences (2006), bias against hiring female STEM doctorates may have subsided; however, the low number in women in leadership roles may be present "due to lack of supply" (Rydell, Shiffrin, Boucher, Van Loo, & Rydell, 2010, p. 12). Underrepresentation of female leaders today may be due to women's decisions or determination to not participate in the application process, rather than because they are unavailable. Women must weigh the chance of bearing children against securing a position at a university and then ask for maternity leave for 4 months to 1 year; such decisions undermine the years of experience they require to become leaders (National Academy of Sciences, 2006). Hence, female learners postpone acquiring any post or leadership role, along with postponing their years of dedication and study in the subject area. This reason alone may discourage a female applicant with a PhD degree from pursuing a leadership role in her career.

This study can have practical applications for future female leaders and future female doctorate students in STEM fields. Female leaders in STEM areas possess a unique set of learning experiences that needs to be voiced and heard by upcoming female leaders to sustain a continuing culture of understanding and maintain a permanent space in academia. The information from this proposed research can be shared and studied by future female leaders of colleges and universities in the nation. This research will help academics and future leaders gain better insight and knowledge about the motivation and barriers female learners face, especially in STEM areas (Miller et al., 2015; Saucerman & Vasquez, 2014). Not only will this research give a clearer understanding of the situation for female STEM practitioners and educators but will also guide instructors of female students to understand their locus in the academia.

SCCT will be applied to steer the collection and analysis of data throughout the research study. Comprehensive interviews will describe the lived experiences of women who studied or practiced in STEM careers (S. D. Brown & Lent, 1996, 2011). It is necessary to create a successful and motivational atmosphere for many types of female leaders, and it is important to start a discussion of the barriers female doctoral students face and to offer solutions that address the successful integration in the academic setting for women in STEM fields (Byars-Winston & Fouad, 2008). This study will aim to challenge negative connotations of universities' sexist or bias hiring practices as well as to bring topics to light as to why potential female leaders are not taking a stance on representing the minority group in STEM fields. This study will enhance and encourage more female-leadership roles for future generations of female STEM professors. This study supports the critical analysis of hiring practices of various institutions, promoting

higher attainment of female leaders for spaces usually taken by their male counterparts (Montgomery, 2009). The study will peruse information from universities across states and countries in their hiring practices by asking how many female applicants they hire, when compared to male applicants who possess similar if not equal doctorate degrees. It is important to an attain ethical hiring practices in higher education when more than half the population attending schools are women.

Barriers to Women's STEM Participation

Saucerman and Vasquez (2014) discussed the psychological barriers that are already in place for young girls that set a negative undertone and send perceived messages about social roles. Even teachers sharing their mathematics anxiety begin the process of influences from society that undermine a young girl's chances of continuing study in STEM areas. Society needs to address the issue of psychological barriers in place for young girls, to raise their self-esteem, help them develop autonomy, and help them cope with role conflict and discrimination. Changes in social norms and attitudes must take place and focus on providing support services as well as establishing a learning environment free of threat and considerate of the influence of prior socialization (Saucerman & Vasquez, 2014).

It is necessary to create a successful learning atmosphere for all types of female learners, and it is important to start a discussion of barriers women face while participating in STEM, and to offer solutions that address successful integration in academic learning for women. The perspectives of 66 nations strongly associated science with men more than women, even in countries where women were treated equally with men (Miller et al., 2015). Even more surprisingly, countries with the majority of the men

and women with approximately equal stance on college degrees tended to stereotype STEM professions being reserved for men. This perspective emphasizes a paradoxical situation for women in higher leaning, where women are working hard to meet the demands of equal status, family, and their own needs, but also need to work harder than men to be recognized in their workplace and schools: Female STEM academicians often confront multiple responsibilities (Miller et al., 2015).

Jacobs and Simpkins (2005) employed Eccles's (1987) expectancy-value model to provide a historical overview of the research on gender differences and role of beliefs predicting STEM-career outcomes. Female adolescents chose not to participate in subjects leading to careers in STEM because educators failed to address gender and ethnic differences in STEM (Jacobs & Simpkins, 2005). Women were particularly vulnerable because expectancy of female students' roles in these subjects and careers is not favorable. The proposed study agrees with the perspectives gathered from research by Miller et al. (2015).

In taking a closer look at 364 high school students' perspectives and attitudes toward science and mathematics, surprisingly, 11th-grade female academy students on a university campus had more positive dispositions than male students. However, 12th-grade students' results were inverted and male students had more positive responses toward science and mathematics than female students (Christensen et al., 2014). Further investigations may provide accurate and specific detail as to how adolescents blossoming into young adulthood lose the zest of pursuing or studying in STEM fields in colleges or universities.

The role of stereotypic threats in STEM fields is the main underlying theory of the loss of girls' and women's performance and interest (Shapiro & Williams, 2012). Negative stereotypes are one root cause of destabilizing or dislocating female students' attitudes toward pursuing goals in STEM. Supporting findings of Saucerman and Vasquez (2014), Shapiro and Williams (2012) implicated parents and teachers in transmitting negative stereotypes through anxiety or stress related to teaching or acquiring mathematics skills.

Stereotypic threats do not have to be internalized to impact a girl's mind; merely the threats could cause one to believe others might hold these stereotypes. In other words, young girls merely have to know these stereotypes exist to deter or hinder them (Shapiro & Williams, 2012). Female students face factors of internal and external barriers including difficulties of enrolling in a college or university due to various external barriers like expected social role and anticipated marriage and family demands. Understanding the phenomenon of stereotypic threat that can lead to understanding how such challenges undermine women's and girls' performance and interest in STEM domains, even when women and girls have positive mathematics attitudes (Christensen et al., 2014; Shapiro & Williams, 2012).

Factors Motivating Women Students to Lead in STEM

The transition from academic high school to university is not the sole factor to decrease interest in a career in science (Buschor, Berweger, Frei, & Kappler, 2014). An early passion for science at a very young age is key to enhance girls' competence and self-efficacy for identifying themselves as future scientists, technicians, engineers, and mathematicians. The focus should be on reducing stereotypic threat and encouraging

educators to maintain awareness of their own gender stereotypes relating to STEM areas. Parental and teacher support are the main source of girls' positive attitude toward STEM (Buschor et al., 2014).

It is important to acquire early and positive responses for young girls to have a chance at opportunities to connect their interests in STEM fields (McEwen, 2013). Women who started strongly in the male-dominated engineering course at a Swedish University had fathers or close male relatives with strong background in STEM fields. All the women identified and described their fathers as the most important person who had introduced them to traditionally masculine technology. Through these masculine influences, women were able to benefit and thrive in rigorous STEM programs in the Swedish University (McEwen, 2013). These positive factors contested stereotypic threats and negative influences in female students and women pursuing careers in STEM fields.

Ways and Factors to Facilitate the Leadership of Female STEM Professors

In developing the leadership capacity and efficacy of college women in STEM fields, Dugan, Fath, Howes, Lavelle, and Polanin (2013) examined the extent to which college women in STEM majors demonstrated different levels of leadership capacity and leader efficacy compared to non-STEM peers. Their results indicated similar levels of capacity but significantly lower leader efficacy for women in STEM majors. The researchers recommended gathering collective calls from scholars to more refined exploration of the component parts of leader efficacy and exploration of resilient efficacy to navigate across threats to female STEM majors. Such study would allow identification of particular interventions necessary to raise leader efficacy during the varying

development points in the educational process of female students in STEM fields (Dugan et al., 2013).

By sharing strategies and results in a case study format, Gorman, Durmowicz, Roskes, and Slattery (2010) demonstrated a model for what contributes to the success of Stevenson University's track record of 71% female full-time STEM professors and among them, 100% of the academic leadership in STEM being provided by women. Over the years, the enrollment in the School of the Sciences has grown dramatically and influenced the trend in undergraduate students as well. The School of the Sciences at Stevenson University has local and national STEM outreach programs to serve and complement undergraduate programs and strengthen the STEM workforce and education pipelines at multiple points (Gorman et al, 2010).

Gender differences in STEM emerge early (De Welde et al., 2010). Two-thirds of young children—boys and girls alike—say they like science, but gender differences in attitudes and interest surface in middle school (AAUW, 1992; NSF, 2007b). Girls now take as many high school science courses as boys, and perform as well (AAUW, 2004), but many girls who take advanced science courses in high school do not continue to study science in college. Disparities persist despite women's interest in STEM fields. For example, African American women have higher levels of interest in science than their Caucasian counterparts (Hanson, 2004). College women's representation varies by field and by ethnicity or race; women comprise more than half of all undergraduate degree earners in life science, but one-fourth of those in physics (NSF, 2007a). In technology, early gender inequities in computer interest, use, and skills are well documented

(AAUW, 2000; Margolis & Fisher 2002) and the proportion of women among those pursuing computer-science degrees has declined since the mid-1980s (Spertus, 2004).

In engineering, trends have flattened, and are highly variable in subfields: women earn 35% of chemical-engineering degrees, but only 14% in electrical engineering (NSF, 2007a). At higher levels of STEM education, the percentage of women continues to decline; this is the so-called "leaky pipeline." For example, though women earn nearly half of mathematics bachelors' degrees, they earn only 27% of doctoral degrees. Women are well represented among life science doctorates, and approach equity in agriculture, chemistry, and geoscience; women are less strongly represented in physics, computer science, and engineering (NSF, 2007a). Across all STEM fields, the proportion of women of color is small, and drops at each level of degree attainment (Commission on Professionals in Science and Technology, 2006; NSF, 2006b).

Employed men outnumber women (73%) in all sectors of employment for S&E (NSF, 2007a). Gaps between men and women are larger in business and industry (79% men) and in federal government jobs (73% men). Women do outnumber men in educational institutions such as K–12 schools, 2-year colleges, junior colleges, and technical institutes, where they have lower salaries and lower prestige. In the last 25 years, the share of S&E occupations has more than doubled for Black men and women (2.6% to 6.9%) and for all women (12% to 25%), yet disparities by race and ethnicity remain (NSF, 2007a). White women comprise 20% of the 4.9 million S&E workers; Asian American women, 4%; Black women, 2%; Hispanic women, 1.2%; and American Indian/Alaskan Native women, just 0.1%. Because they are represented above their level

in the general population, Asians are not considered an "underrepresented" minority in S&E.

In general, across disciplines and sectors of employment, Whites outnumber all minorities by almost three to one. Women in STEM academic employment is an area of particular concern because faculty educate and influence students. Representation of women in STEM academic careers has improved consistently, but slowly, and remains disparate across disciplines. Some discrepancy is explained by the age structure in academia (Long, 2002) in that faculty careers are long and do not turn over rapidly. The gender gap is closing in many fields at the assistant-professor rank. However, at any given career stage, men in STEM are more likely to hold a higher rank than women. Without aggressive changes to recruitment and retention, the proportion of women among faculty cannot reach parity with the hiring pool (Marschke, Laursen, Nielsen, & Dunn-Rankin, 2007). Women are concentrated in lower-status positions including early tenure-track ranks, nontenure-track academic positions, and lower status institutions, and inequities relate to gender and race/ethnicity (NSF, 2007a; Nelson & Rogers, 2005).

Leadership Theory

The peer-reviewed article by Wise and Wright (2012) focused on the relationship between female leadership and early childhood education. The article's main objective was to extend and continue the discussion about female leadership roles in early childhood education and the gender associated with a giving, caring, and nurturing environment for children. In addition, the article aimed to discuss the connection between female leaders and younger age children who seek emotional support during the early years of matriculation in the educational environment. The authors addressed leadership

models proposed by Gilligan (1982), Beck (1992), and Bloom (1998). Also, working from Kagan and Bowman's (1997) theory, the researchers developed a more comprehensive model to discuss early childhood education by beginning a discourse on the omitted aspect of understanding how women hold their leadership positions. The authors espoused and advocated for the idea that, from a very early stage of formal education, women teach in classrooms whereas men become principals or leaders of schools. Again, the traditional set of patriarchal setting recurs such that the male administrative leader watches over the busy working classroom teachers comprising a majority of women; this culture is emphasized and reproduced for future generation of students to witness and follow (Wise & Wright, 2012). This type of stereotypical education setting needs to change.

Authors interviewed 25 female leaders for 2 years about their challenges and achievements, based on the model of centered leadership (Barsh, Cranston, & Lewis, 2011). The model was constructed from experience-based solutions for women who previously desired to lead, had the talent and knowledge to lead, and possessed the capacity for change. The model for centered leadership hoped to achieve the outcome of leadership effectiveness, sustainable performance, and fulfillment from the achievement of being a leader. The majority of the exemplary leadership portrayed pertained to childhoods that ultimately set the paths for the futures of these individuals with amazing empowerment for women leaders around the world. Although the majority of the women leaders were business oriented, their backgrounds and their individual childhoods were the framework and the foundation for their success. The five-main deep underlying

connections or ingredients to the centered leadership model are meaning, framing, connecting, engaging, and energizing.

Barsh et al. (2011) interviewed approximately 100 possible study participants over a period of 5 years. The researchers used direct observation that entailed exploring a wide range of participants using videotaped interviews and surveys to understand the experiences of leading thinkers from a variety of fields such as management, organizational behavior, psychology, gender studies, sociology, and biology. Of 25 personal accounts from remarkable women leaders, the personal story that stood out most was that of Shirley Tilghman, a molecular geneticist and the first woman president of Princeton University. Throughout her childhood, she grew up with very supportive parents who helped her become a scientist and met phenomenal mentors and professors at Queens University in Kingston, Ontario. Tilghman learned to navigate life as a scientist and then a leader at a university. Her sponsors and mentors took risks in the early stages of her development to provide opportunities for Tilghman to achieve success as a leader. The valuable lessons learned gave her the support to leap from being a scientist to being the leader of an Ivy League university. Barsh et al. described women who leapt and bounded beyond stereotypes of women, supporting a management approach to promote empowerment of women.

Furthermore, in support of remarkable women who are directing and steering organizations as leaders, the authors modeled women with influential connections, providing insights for future women leaders (Barsh et al., 2011). This book inspired and empowered this researcher, as she looks forward to furthering her leadership ability. The stories of remarkable female leaders, known for their valuable work in organizations and

communities, provided a wide spectrum of personal qualities that led to exemplary leadership with pragmatic frameworks built from inferences of the centered-leadership model. Leaders of both genders may apply the concepts and theories discussed, as the authors defined and refined the model of centered leadership. The authors delved into the positive psychology that explained in detail how the centered-leadership model is useful and effective for all leaders.

When discussing leadership, the names of Northouse, Drucker, and Greenleaf loom large. Northouse (2013) understood that even though the discussion of ethics has been ongoing for thousands of years, insufficient formal study or theoretical research supports leadership. Ultimately, unethical leaders do not hold lasting executive positions. The ethics of caring, resonated the most strongly (Greenleaf, as cited in Northouse, 2013).

Greenleaf's (2002) servant leadership provided the necessary elements to uphold the importance of listening, and mentioned prophetic visions that guide future leaders as a true calling that should not be ignored or spurned, especially aligned with the "ethics of caring." Greenleaf emphasized that the key to leadership is to listen to the community of followers, and serve them. Greenleaf's discussion of the "importance of listening" in servant leadership supports issues in one's personal practice and endeavors in learning.

Path–goal leadership is important for a leader to demonstrate the ability to support management with a common goal. Specifically, weaknesses and strengths attributed toward the path-goal leadership were unaddressed in any research on female professors in STEM leadership. Path–goal leadership is quite complex, incorporating many aspects of leadership that make it confusing but also fails to adequately explain the relationship

between leadership behavior and worker motivation. The approach treats leadership as a one-way event where the leader affects the subordinate, placing a great deal of responsibility on the leader and less on subordinates, rendering them too dependent on the leader. Path–goal leadership has received only partial support from many empirical studies. House and Mitchell (1974) addressed task structure as a moderator of college principals' leadership behaviors and subordinates' outcomes. Directive leader behavior had a negative effect on subordinates' job satisfaction when the task was dissatisfying or structured. However, researchers found support for path–goal theory because the leader motivates a subordinate by reducing the negative aspects of the work environment. High participative leadership had a negative impact on job satisfaction with supervision, and subordinates working under highly directive and participative leadership positively impacted motivation when the task was unstructured.

Path–goal leadership provides a useful theoretical framework to understand how various leadership behaviors affect the satisfaction and performance of subordinates. Strengths of path–goal leadership are the following:

- Attempts to integrate the motivation principles of expectancy theory into a theory of leadership. Path–goal leadership is the only theory that addresses motivation.
- Provides a model that is quite practical in certain ways.
- Reminds leaders of their purpose, which is to guide and coach employees as they move along the path to achieve a goal.

Northouse (2013) directed attention toward the minority group in leadership. Women are underrepresented in very high positions in institutions and organizations.

Moreover, not enough ethnicities or minority groups are represented in those places. Northouse suggested the importance of conducting more studies that address women's leadership. Much of the literature discusses women's leadership from the perspective of Western cultures; cross-cultural studies are needed to enlarge the perspective.

The definition of leadership from The Drucker Foundation (2008) "The only definition of a leader is someone who has followers." Drucker took a literal approach to leadership, affirming the definition of a true leader, averring that, without followers, there is no leadership. Leaders who are thrust into leadership positions must do their best. Maxwell (1998) wrote, "Leadership is influence—nothing more, nothing less" (p. 40). Must one be subjected to public scrutiny and criticism as a leader, when the leader was propelled into the leadership position?

Organizational Theory and Female Faculty

A curriculum is an ideological statement that derives from organizational participants' understanding of the curriculum. "The point is less that each institution is different, or 'to each his own,' and rather that knowledge is constantly redefined. One place where these definitions get worked out is at the curricular level in postsecondary institution" (Tierney, 2008, p. 85) found it more important to consider ways for an organization's participants to think of the organizational culture as multi-vocal instead of new rather than a way to assimilate new participants. The key component of culture, that advances or retards organizational learning, is communication when in governance and decision making at multiple levels and in multiple forms (Tierney, 2008). In organizations like a university and higher education institution, communication leads to

socialization, which functions to enable “cultural integrity,” allowing creativity and innovation to occur among participants rather than mere assimilation.

> Reality is not something objective or external to the participants. Instead, Participant reality is defined through a process of social interchange in which perceptions are affirmed, modified, or replaced according to their apparent congruence with the perceptions of others. Rather than a biological or ecological model, the model of the enacted environment is based on a social construction of reality. (Berger & Luckmann, 1967, p. 25)

The role of the college or department leader in understanding and interpreting the environment to different constituencies becomes increasingly important. In particular, how leaders communicate and interpret institutional goals and values focuses participants’ comprehension of the environment (Tierney, 2008). Identity begins with mission but goes beyond it to include vestiges of history and traces of the personalities of many current organizational participants. Organizational identity includes certain capacities inherent in how participants arrange resources and the configuration of values, structure, and environment. Identity contains all elements that define what the organization is and suggests what it could become. Inchoate identity provides the framework for participants to address existential issues of their own words and meaning in the organization. Tierney’s point is not simply to suggest that institutions cultivate the production of knowledge more intensively than do disciplines; rather, knowledge is a discourse constantly reconstructed over time and place (Tierney, 2008). The production of knowledge cannot be separated from the contingencies and continuous reconstruction

of culture that individuals experience in their work lives. As a consequence, knowledge cannot be arbitrarily divorced from organizational ideologies (Tierney, 2008).

Tierney used the term *organizational culture* but did not mention or include further explanation of its subsets, subculture, anti-culture, or disciplinary culture. An investigation of these cultural subsets will provide administrators with useful information about how to increase performance and decrease conflict in particular groups. Scholars must investigate the system of higher education to understand its impact on individual institutions. By developing this framework and improving ways to assess organizational culture, administrators will be in a better position to change elements in the institution that are at variance with the culture. This research will permit them to effect orderly change in the organization without creating unnecessary conflict. Moreover, the continued refinement of this framework will permit research to become more cumulative and will help foster further collaborative efforts among researchers (Tierney, 2008).

The disciplinary view of generating knowledge is limiting and yet a necessary form of learning (Tierney, 2008):

> This view assumes that the accumulation of knowledge is a scientific undertaking that has to be verified by a method based on replicability and predictability. Science is free of any ideological apparatus and, in general works outside of social forces. (Tierney, 2008, p. 86)

Keller (1986, p. 138) stated that the "world is assumed to be lawful, and the role of scientists is to discover these laws and explain how the world operates according to these laws." The cultural view of generating knowledge is accepting that the knowledge that discipline products are neither natural nor objective, and instead, are socially

constructed (Tierney, 2008). “To be part of a discipline means to ask certain questions, to use a particular set of terms, and to study a relatively narrow set of things” (Giroux, as cited in Tierney, 2008, p. 115).

Institutions play a role in interpreting knowledge, and each type of institution has different definitions of knowledge (Tierney 2008). Knowledge emerges through the construction of forms of culture and ideology that need to be analyzed for their wider social and political significance. By attempting to come to terms with how institutional participants define knowledge, researchers raise questions about the historical and material conditions of the world, forcing them to consider whose interests are served by how knowledge is defined and whose knowledge is silenced. Pedagogical practices, teacher–student interactions, faculty–faculty interactions, and a host of other cultural variables come into play because of participants’ definition of knowledge. The discourses produced about knowledge locate specific social practices and relations and how such discussions ultimately link to become a relationship between ideology and culture. To come to terms with the relationship of culture, ideology, and knowledge, researchers need to investigate microscopic aspects of institutional life to gain a fuller version of the constructed realities of participants (Tierney, 2008): “What are needed are naturalistic, descriptive studies guided by research perspectives that emphasize the insider’s point of view” (Tierney, 2008, p. 105). Tierney (2008) called for a

> radical reorientation of how we conceptualize and, hence, act in the organizational worlds of academe. The task of conceiving different theoretical horizons will enable us not only to offer alternative strategies for developing multicultural environments but also to reconfigure the social conditions of power that give

> voice to some and silence others. In doing so, we will be moving away from a model of social integration and assimilation and toward a framework of emancipation and empowerment. (p. 125)

In defense of women's pursuit of scientific enterprise, Mary Lyon, an unmarried chemistry and botany teacher, opened an institution in New England to cater to female students of science, founding the first seminary to focus on the education of women in fields normally regarded for men. The female students were able to learn and research in science majors and curriculum, resulting in graduates going on to earn degrees and doctorates in science and mathematics (as cited in Levin, 2005). The institution's leadership had started with Mary Woolley; then passed on to a male married professor from Yale, Dr. Roswell Ham. This leadership in the institution caused a setback aimed at single women teachers; however, the "institutionalized alliance of faculty members with science" allowed the female students to focus on the importance of science and mathematics curriculum with a secular origin while working and striving to maintain Protestant ideals. As author Levin pointed out, "During 1900s, teaching science was a source of power and means of advancement for the Mount Holyoke faculty and students" (p. 56). Therefore, it was even more significant for women to begin studying mathematics and science to gain a space or place in the expansion and structuring of the U.S. scientific community, where most of the population was dominated by men at the time (Levin, 2005).

Levin (2005) attributed the Mount Holyoke Seminary as shaping the integral part of teaching and learning science and mathematics for women. The New England location provided an appropriate geographical placement to attract many teachers of U.S. higher

education during this period of the nation's industrial development. The institution showed no sign of interest in the feminist movement or feminist idealism in the curriculum and institution; rather, the advantage for faculty and students lay in making common cause with men for a goal that seemed above politics, rather than female-centered practices (Levin, 2005).

Women were grappling with their identity as female scientists at this time, and because women possessed the same credentials as men in science, the head of Mount Holyoke, Mary Lyon, used evangelical assumptions of intellectual equality to claim the male college model for seminary teachers to emulate in educating women. The science faculty assisted in learning by adopting the standards, organizational structures, and status symbols of men in universities for their own, based on the same assumption. The women started to follow every step and means of learning how to be a scientist by observing male teachers, and male and female students were trained to follow with their research and credentials to fully explore the possibilities of this new identity of female science and mathematics learners and teachers. But as the old egalitarian strains of evangelical culture slowly disappeared, competition and coeducation were introduced and shared over the years (Levin, 2005).

Women went on to get advanced university degrees in science and mathematics and taught and worked at jobs that drew on their science training. Mary Woolley was able to channel the common misconception of women being too weak or unfit to perform in ways that were intellectually equal to men and changed misconceptions of the virtues of women that later allowed them to equal and surpass men in scientific endeavors. However, these characteristics would become problematic by refutations of women's

ability to be equal to men in intellect by Charles Darwin and Edward Clark, a U.S. physician. Mount Holyoke College provided an education that would also prepare women for the highest professional roles, as well as for others. The college gave women more options than marriage, motherhood, and missionary teaching. Mary Woolley and Mary Lyon served society by opening the doors to education and of school to women of diverse religious backgrounds and students from foreign countries (Levin, 2005).

Scientists had accepted the notion that women had the mental ability to study the subjects of science and mathematics and acknowledged that women were the intellectual equals of men in the quest for knowledge in science and mathematics. However, during this period of women in science and mathematics, there was an undeniable contradiction where women "grappled with realities of the job market for women in science … limitations on women's abilities to do science and teach it at the highest levels" (Levin, 2005, p. 132). The social vision of the college was to prepare three categories of women: those who would not be scientists who needed general science education; those who would work in science at lower levels such as technicians and primary and secondary school teachers; and those who would do research and teach at the college or university level alongside men (Levin, 2005). In the changing nature of Mount Holyoke as an institution, female science-faculty activities from 1837 to 1940 shaped this scientific enterprise and confirmed women's place in the wider field of science. Levin's (2005) detailed study embodies an overview of the past 6 decades during which scientific educational settings and workplaces in the United States turned coeducational and large numbers of women moved to gain equality with men in what has become the most pervasive, expensive, and highly regarded national enterprise. Decades of work proved

that Mount Holyoke was a sustainable and vital institution that worked in tandem with past traditions and policies to transform women's scientific work in relation to that of men and continues to play the important role of shaping their educational curriculum and direction for future scientific advancement (Levin, 2005).

In describing motivation, Awan, Zaidi, Naz, and Noureen (2011) discussed path–goal-oriented behavior from the degree-granting college principals in 34 districts of the Punjab, Pakistan. The researchers conducted the study using the questionnaire method with focus on four leader behaviors: task structure, acceptance of leader, job expectancies, and job descriptive index. Using the model founded by House and Dessler (1974) and House and Mitchell (1974), the researchers concluded that directive leader behavior negatively impacted subordinates' job satisfaction when a task was dissatisfying or structured. People were more satisfied when leaders were highly supportive in a structured task situation, supporting path–goal theory, where the leader motivates a subordinate by reducing the negative aspects of the work environment. However, high participative leadership negatively impacted satisfaction with supervisors, and subordinates working under highly directive and participative leaders positively impacted subordinates' motivation when the task was unstructured. Future research is needed to address the task structure in combination with other variables including the perceived ability of subordinates: highly skilled workers may work better in nonrepetitive and ambiguous situations (Awan et al., 2011).

Self-Efficacy and Social-Cognitive Career Theory

Bandura's (1986) four major tenets of self-efficacy theory—vicarious learning, verbal persuasion, performance accomplishment, and emotional arousal—substantiated

career decision-making experiences. Self-efficacy is the belief individuals have about performing a particular task that leads to a specific goal with the expectation of reaching or changing the goal (Bandura, 1986). Individuals may have low self-efficacy or high self-efficacy, depending on the experience related to a specific task. If the experience was positive, a person's beliefs about accomplishing a task will be high or the person will be encouraged to pursue the task. If the experience was negative, then the expected outcome will be discouragement. People who expect to experience fear from performing a specific task may decrease the fear by reducing their tension using anxiety-management techniques such as visual imagery, relaxation training, self-talk, and journal writing that relates to positive or negative career behaviors (Bandura (1977a).

Krumboltz's (1979, as cited in Dominguez, 2010) social learning model was one of the first theories that could be applied to all persons, including women and ethnic minority individuals, especially when describing the career-counseling model applicable to minority women. Krumboltz (1979, as cited in Dominguez, 2010) applied social learning principles such as family influences, cognitive-skill development, and emotional reactions to work environment preferences to explain how individuals make career choices. This culminating theory helped simplify the process of career selection that is based on critical and defining life experiences that shape career decision making (Krumboltz, 1979, as cited in Dominguez, 2010). According to this theory, the four variables that influence career decision making involve (a) genetic endowments such as sex, race, and abilities; (b) environmental influences, such as socioeconomic status, labor laws, community influences, and training opportunities; (c) learned experiences, such as consequences of action and observed results of self or other's actions (i.e., vicarious

reinforcement); and (d) task-oriented skill sets, such as problem solving and work-habit development (Krumboltz, 1979, as cited in Dominguez, 2010). Yost and Corbishly, as cited in Dominguez, 2010) explained that personality may develop from reactions and responses to environmental conditions. For instance, if individuals experience pleasure from performing a behavior, they may repeat that action; however, if individuals experience discomfort from performing a behavior, they may avoid that action (Dominguez, 2010). Krumboltz (1979, as cited in Dominguez, 2010) also viewed life as an evolution of a person's interaction and reaction to the environment. This suggests that an individual's interests, personality, values, and worldview inevitably change throughout one's lifetime.

In the early 1980s, career researchers investigated the applicability of Bandura's (1977b) social-cognitive learning theory, also referenced as self-efficacy theory, to the process of goal setting and decision making. Self-efficacy is the belief that one can perform a specific task toward achieving a goal (Bandura, 1986). Bandura asserted that self-efficacy expectations can be learned and modified through four processes: (a) performance accomplishments, for example, being successful at a task; (b) vicarious learning, for example, job shadowing (observation) or exposure to role models—seeing others be successful; (c) emotional arousal, which might encompass a reduction of tension by incorporating anxiety-management techniques, such as visual imagery, relaxation training, self-talk, and journal writing, which relates to positive or negative career behaviors; and (d) verbal persuasion, which may manifest by attending professional conferences and support groups, or by reading texts relating to perseverance and confidence.

To expand Bandura's approach to further understand how self-efficacy expectations may influence women's career development, Betz and Hackett (1981) explored career decision-making self-efficacy among men and women. Significant gender differences emerge in career self-efficacy when pursuing traditional and nontraditional occupations. For instance, in their study, women viewed themselves as capable of completing academic requirements related to traditionally female-dominated occupations such as dental support, teaching, or office work. However, these women viewed themselves as incapable of performing tasks associated with drafting, engineering, mathematics, or other male-dominated occupations, regardless of their advanced skills in mathematics and English. This study suggests the importance of counselors to help clients become more self-aware prior to making career decisions. Additionally, women with high career self-efficacy for nontraditional occupations may be better prepared if the counselor communicates possible obstacles, such as being treated differently based on gender, class, or status when entering nontraditional occupations (Betz & Hackett, 1981). Finally, Hackett and Betz (1981) suggested that it is not only important for counselors working with women to consider individual and social factors, but to explore these women's thoughts, beliefs, and feelings about performing traditional and nontraditional career-related behaviors.

This may also demonstrate support for two of Bandura's (1977a) major tenets of self-efficacy expectations focusing on verbal persuasion and vicarious learning. Linking and complementing the above career frameworks is SCCT, an important evolving theory emphasizing multiple activities that affect individual interests, career decisions, and career-path achievement (Lent & Brown, 1996; Lent et al., 1994; Lent & Hackett, 1987).

Lent and Brown's (1996) research demonstrates how career self-efficacy, expectancy outcomes, and goal setting impact an individual, his or her support systems, and learning factors. Lent et al. (1994) emphasized the importance of extending Hackett and Betz's (1981) career self-efficacy model by adding other social-cognitive components, exploring gender and ethnic and cultural diversities that directly or indirectly influence individual career-development processes. Situational and environmental experiences like access issues, occupational exposure, and performance expectations may positively or negatively impact learning opportunities leading to career choices. However, exploring advantageous social conditions may assist women and ethnic minorities to set goals and take action, thereby increasing career self-efficacy and outcome expectations (Hackett & Betz, 1981).

S. D. Brown and Lent's (1996) SCCT model suggested that (a) individuals develop occupational interests through the belief they have in accomplishing the duties associated with the occupation, which in turn produces behavioral expectations; (b) perceived barriers often determine the relationship between interest and choice; and (c) successful and unsuccessful experiences strengthen self-efficacy beliefs and outcome expectations. Therefore, it is important for counselors to assist women and ethnic minorities through the process of exploring perceived barriers to facilitate exploration of a wider range of occupations and identify career options one may have been avoided due to faulty self- and career beliefs. Counselors should to provide information and options on how to overcome certain obstacles (Dominguez, 2010).

Future of Professor Leadership

Dominguez (2010) defended views about counseling necessary to achieve maximum support for women in higher education and choosing best career options; thus, this research aims to focus on fostering a strong mentorship program for female professors in STEM departments to successfully transition to nontraditional leadership positions in usually male-dominated STEM departments universities. Mentorship programs will provide information and support for female professors who may be interested in future leadership positions. Mentors will be other female professors who have overcome the obstacles to attain the leadership role in STEM departments. The process will lead to ideology similar to a fellowship, such that all professors who are interested in future leadership roles may inquire and receive steps to follow in becoming a chairperson or administrator in a STEM department.

The qualitative study by Subich (2012), describes a prominent professor who enjoyed studying mathematics and statistical measurement and decided to devote her life to a study in psychology. Subich realized that there is an important theme that reappears throughout the professor's early and later years of development of her career. There was a clear indication of strong female role models such as her mother, who was also a psychologist, female and male mentors in universities, and her contemporaries in her career in counseling psychology. Just as the author, Solomon (1985) suggests that (all)women must "not forget each other but act in groups" and "must respect and retain the sense of woman's consciousness and at the same time must not permit society to limit their aspirations as individuals and as womankind" (p. 212).

Summary

Chapter 2 focuses on providing an overview of literary discussion of barriers and motivation for women to major and obtain degrees in STEM. It is of highest importance to address the issue of how society creates psychological barriers in place for young girls and addresses a need to raise self-esteem, develop autonomy, and help students cope with role conflict and discrimination. The literature review delves into the discussion of organizational theories as suggestions for creating space and loci for female professors in universities, while leadership theories in organizational development provide a framework to restructure or create a new path–goal-oriented means for female professors to achieve their goals of leadership in STEM fields and departments in universities. Last, the counseling model of mentorship addresses securing a permanent path for the future of female professor leadership through role models and mentorship from previous female professor leaders in STEM departments.

CHAPTER III

RESEARCH METHODOLOGY

Restatement of the Purpose of the Study

The purpose of this study is to examine the experiences of female academic leaders with academic backgrounds in STEM fields. This research study will observe their own experiences in their pathways toward leadership as well as the role they see themselves playing in fostering leadership of other women from STEM backgrounds.

The study will focus on two main research questions:

1. To what ways women faculty commit themselves to help cultivate women's learning and working environment?
2. What are female faculty in STEM leadership doing differently to shape their learning and working environment in terms of SCCT?
3. What practices facilitate the preparation and persistence of the female professorship while enrolled in the STEM graduate program?
4. In what ways do STEM faculty's gender identities shape their learning experiences? In addition, in what ways do these STEM professors attribute to their success?
5. What do female STEM professors attribute to their success?

Women's roles as scientists and engineers have steadily increased over the last 40 years; yet women still face challenges that hinder them from full participation in STEM professions (National Academy of Sciences, 2006). According to the U.S. Census Bureau (2009, Table 2), women's representation in STEM occupations has increased since the 1970s, but women remain significantly underrepresented in engineering and computer

occupations: occupations that comprise more than 80% of all STEM employment. Women's representation in computer occupations has declined since the 1990s. Among S&E graduates, men are employed in a STEM occupation at twice the rate of women: 31% compared to 15%. Nearly one in five female S&E graduates are out of the labor force, compared with less than one in 10 male S&E graduates. The most recent decades show less growth in STEM employment among younger women. Most growth in women's share of STEM employment among those under the age of 40 occurred between 1970 and 1990 (U.S. Census Bureau, 2009).

Research Design

This is a qualitative method study that uses an exploratory design. The study will first seek to gather information about female STEM professors' experiences through open-ended qualitative interviews to explain the gaps in details of women's experiences as professors in STEM departments of universities. Second, the researcher will look for the common theme within the interview responses for the study to report on data analysis and findings.

This qualitative method research will be based on educational leadership and educational psychology theories and perspectives where the research problems closely follow the research questions. The data collection will involve one-to-one interviews with female professors of universities, and the transcripts of interview responses and observations will guide the data analysis and findings. Most interpretation will rest on coding similar themes and trends discovered during the transcription of interview responses. Because this is a qualitative research study, interpretation is subjective and based on researcher perspective of collected data. The procedure for transcribing audio

data to text for analysis, and the process for coding while reviewing the notes, leads to discovering common themes to describe the phenomenon and patterns, a process anticipated to take about 3 months. As a qualitative study, the open-ended questions and responses will guide and help in making inferences based on gathering as much data as possible for later analysis. The justification for choosing the interview method is to generate participant perspectives about ideas, opinions, and experiences in STEM professorship with leadership in mind. The researcher may use a variety of methods to observe, including taking general notes, using checklists, or time-and-motion logs. Observations are designed to generate data on activities and behaviors, and are generally more focused on setting than other methods (Creswell, 2011). The reactions, perceptions, and feelings of an individual (or group of individuals) as she experienced an event are principally important to the phenomenologist seeking to understand an event *beyond* purely quantitative details. Qualitative researchers analyze any aspect that supports the question asked. Print media has long been a staple data source for qualitative researchers, but electronic media (e-mail, blogs, user Web pages, and even social-network profiles) have extended the data qualitative researchers can collect and analyze. The greatest challenge offered by document analysis can be sifting through all available data to make general observations. Participant responses will also describe various and common STEM faculty members' experiences as participants. This approach will provide a disciplined and efficient means of gathering data from many participants working multiple shift schedules.

Female faculty members will receive e-mail invitations, informing and guiding the research study. By establishing online communication, the researcher will be able to

notify and become familiar with participating female faculty members' positions in academic setting, work experiences, and academic leadership positions. The invitation to participate in interviews will be distributed to potential participants using online e-mail services. The researcher will contact the organizations and institutions to obtain e-mail addresses of female STEM professors who may be interested in participating in the research study. E-mail is a good example of trying to reach prospective participants in "settings that have virtually universal access to e-mail" (Fowler, 2014, p. 16). A survey will measure the objective facts and subjective states of participants (Fowler, 2014). Using answers to the questions, the subjective states of participants will help address the objective facts of female professors in the STEM fields and occupations.

The research study will be an open-ended qualitative interview of eight participants about their experiences; questions will inquire about participants' educational and occupational information. Researchers use a qualitative methodology to support initial data gathered from general information (Creswell & Plano Clark, 2011). This study's effort is to bring together personal informative data and qualitative data to provide a detailed story using unfolding figures from a pre-interview analysis from a questionnaire and individual interviews to support the matching perspective. As Greene (2007, p. 20) explained about the "multiple ways of seeing and hearing" and described by Creswell and Plano Clark (2011), it is important for the researcher to gather multiple ways to view the various perspectives of this topic.

It is crucial to include more than one method that uses instruments to collect preinterview information and connect the ideas and theories related to the qualitative answers by instruments designed to collect words (Greene, Caracelli, & Graham, 1989).

Furthermore, these female STEM professors will be interviewed to share their experiences and knowledge in the qualitative portion of the research using open-ended interview questions. The interview questions will explore the qualitative comprehensive responses of female professors to guide the qualitative analysis.

Research Setting

The setting for this study will be universities employing female professors of STEM in the Greater San Francisco Bay Area, such as the University of California–Berkeley, San Francisco State University, Stanford University, California State University, Hayward and East Bay, and nearby local colleges and community colleges. Focusing the study on STEM professors such as scientists and laboratory directors in institutions will provide a broader scope of female STEM professors' experiences to be collected for the research data, and will allow for a larger convenience sample of participants who are working as researchers in highly competitive STEM fields. More likely chances will emerge to capture various perceptions and concerns shared in the study by the female STEM professors, and the choice of those educational institutions was based on the location of the research institutions, their recognition as an authority in STEM-research innovations, and the rigorously competitive reputation of STEM-research programs. In hopes of reaching regional geographic coverage within a reasonable amount of time and attaining analyzable results, the online survey and the interview process will be implemented in this qualitative methodology study (as suggested by Fink, 2013).

Population and Sample

The convenience sample of female participants in this qualitative portion of the study accrue from the female population working and employed in universities and

engineering departments located in the northern California area. The anticipated sample size for the survey will be about eight female STEM professors. The study will use a homogeneous sample for the qualitative data. For the procedures to select the sample population for the survey data, each will be distributed to female STEM professors in a homogeneous sample, similar to an explanatory sequential design. To attract female STEM professors to interview, the researcher will seek volunteers for the qualitative portion from the survey sample.

Qualitative samples need draw from the invited e-mail sample and the sizes of the two samples will not be the same. The researcher will ask for possible qualitative study participants from the invited e-mail sample where questionnaire data will identify qualifications that match the themes of the qualitative questions. Fewer women will be qualitative participants when compared to the number of the invited list sample. The qualitative sample will be a subset of the broader prescreened sample, and because qualitative data collection consists of obtaining information from fewer participants, it will provide the detailed explanation of female STEM professors' experiences.

An invitation to participate in the interview process with consent forms will be sent to prospective participants using e-mail addresses. The researcher will contact the human-resource departments of public and private colleges and universities in the Bay Area. In addition, the researcher will contact STEM departments of universities prior to the interview.

Validity

To attain internal validity, study participants will be asked questions that pertain to the phenomenon of their own experiences as STEM professors of the university; the

researcher will ensure participants' responses are credible and accurate by checking responses from the interview questions. Triangulation will be applied to this qualitative study to verify accuracy by cross-checking information from multiple perspectives. For external validity, the researcher will make certain the research will be generalizable and can be applied to other similar settings, populations, and situations, so readers can transfer the research findings to other contexts. The researcher will thoroughly describe the context of the research to assist the reader in being able to generalize the findings and apply them appropriately.

Instrumentation

This study will use one instrument throughout the research study, the interview of the participant. The instrument in the research study will use the general interview guide approach, intended to ensure that the same general areas of information are collected from each participant; this process will provide more focus than a conversational approach, but still allow a degree of freedom and adaptability in obtaining information from the participant. The standardized, open-ended interview, with the same open-ended questions asked of all interviewees, facilitates faster interviews that can be more easily analyzed and compared. Telephone interviews enable a researcher to gather information rapidly. Like personal interviews, they allow for some personal contact between the interviewer and the respondent. Many people do not have publicly listed telephone numbers; therefore, the researcher will initially establish contact through e-mail. The researcher will also verify if a tape recorder will be used throughout the interview, and also will take notes as a form of observation. The researcher will write down any observations made during the interview for later analysis and transcription before coding.

The researcher-generated questions will be used to ask participants about STEM experiences in three different contexts: family, school experiences, and professional life. In revision of the instrument, the researcher will also ask participants about any motivation or hindrance they have experienced while persisting in highly competitive STEM occupation.

The first two questions will address the difficulty of college courses in STEM: "Were college mathematics courses very easy for you?" The next four questions will address potential barriers to obtaining or engaging in a STEM-related profession. One such example is, "I have encountered gender discrimination at work." The third set of four questions asks about encouragement and support from school and home. The final set of questions will address self-evaluative assessment of confidence level during the educational and occupational periods. These questions emerged from SCCT by Lent et al. (1994) and a review of literature addressing self-efficacy theory. For the pilot study, the researcher will use the survey data collection in the earlier phase of the research method and for the qualitative part of the research; the survey data analysis will guide questions asked of qualitative study participants (Orcher, 2007). After the researcher finishes conducting the online survey and one-on-one interviews and after validating participants' responses, the data will be transcribed and entered into the computer program, Qualtrics. For the initial part of the study, participant will need to use a computer to access the survey of five to 10 items that will address the questions pertaining to the research topic.

Reliability

The researcher will consider issues of reliability by checking that the scores received from participants are consistent and stable over time. Reliability or

dependability refer to the consistency with which the results could be repeated and result in similar findings. The dependability of findings also lends legitimacy to the research method. Because the nature of qualitative research often results in an ever-changing research setting and changing contexts, it is important that researchers document all aspects of any changes or unexpected occurrences to further explain the findings. Document of this process is important for other researchers who may want to replicate the study.

The researcher will check for the reliability of scores through statistical procedures of internal consistency and any test–retest comparisons while exploring the data. Reliability scores will be established before assessments of their validity can be addressed. In qualitative research, the researcher focuses on validity more than reliability to judge if the account given by the researcher and the participants is accurate, can be trusted, and is credible (Creswell & Plano Clark, 2011). The researcher will use member checking (Creswell & Plano Clark, 2011) as a means of assessing whether the information obtained through qualitative data collection is accurate. The researcher will take the summaries of the findings from the theoretical model and the major themes back to key participants in the study and ask them whether the findings accurately reflect their experiences. The researcher will carefully organize and store the data in a secure location. The goal will be to create transparency and clarity by describing in detail the process of data collection and analysis while seeking emerging themes, and how the researcher arrived at conclusions. The researcher will provide accuracy and dependability by taking detailed notes and interview transcripts, and reflecting on the events of the day as soon as

possible in a journal. The researcher will also continually review emerging themes and note thoughts and revisions to ensure the research is easily replicable.

Data Collection

An exploratory qualitative method study will be used in which the researcher will implement two strands in a sequence: the survey will occur first and will have greater emphasis on addressing the study's purpose; then qualitative methods will follow to help explain the survey questionnaire's results (Creswell & Plano-Clark, 2011). This research study will be implemented in two distinct phases wherein the first phase involves collecting and analyzing surveyed data using an Internet-based survey service, Qualtrics. Based on the need to further understand the survey's binary response results, the researcher will implement a second qualitative phase of the research study designed to provide detailed explanations of the initial survey results. Mainly, the researcher chose to use an explanatory-qualities method to study female STEM professors' persistence in their work and past educational experiences.

First, the researcher will approach colleges and universities to gain permission and inquire about any female professors who may be interested in participating in the standard qualitative interview. Counting on at least 16 participants, the researcher will collect the contact information of those participants who would like to participate in the qualitative part of the study; the researcher then will conduct the qualitative phase. The self-selected eight individuals from the invited sample will be asked to participate in a comprehensive case study of each person's experiences in and perceptions of their occupation and past education in STEM fields. The primary form of data collection will be one-to-one interviews using a protocol that was developed to explore factors found to

be significant in the contact list. The interviews will be performed in places of participants' convenience such as by phone, in coffee shops, or in restaurants, and the approximate total time or duration of the interview will be 40–50 minutes. The researcher will inform participants of their rights in writing using a consent form and verbal notification. Other forms of qualitative data will be gathered including written responses in a journal/diary format.

The analysis will consist of first examining the data for description and themes from each person's experience, followed by a cross-case analysis to identify important themes about persistence across eight cases (Creswell & Plano-Clark, 2011). Interviews will be completed by the interviewer based on what the respondent says. Interviews are a far more personal form of research than questionnaires. In the personal interview, the interviewer works directly with the respondent. Unlike with mail surveys, the interviewer has the opportunity to be proactive, asking follow-up questions. Interviews are generally easier for respondents, especially if what is sought is opinions or impressions. Interviews are time consuming and are resource intensive. The interviewer is considered part of the measurement instrument and interviewer has to be well trained in how to respond to any contingency. Because the interviewer can control the quality of the result, training becomes crucial. It is important to organize in detail and rehearse the interviewing process before beginning the formal study. Interviewers need to know more than simply how to conduct the interview itself; they should understand the background of the study and why the study is important.

The qualitative research interview seeks to describe the meanings of central themes in the life world of participants. The main task in interviewing is to understand

the meaning of what the interviewees say. (Kvale, 1996). A qualitative research interview seeks to cover both a factual and a meaning level, though it is usually more difficult to interview on a meaning level. (Kvale, 1996). Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic. Interviews may be useful as follow-up to certain respondents to questionnaires, such as to further investigate their responses (McNamara,1999).

Ethical Considerations

Prior to visiting STEM institutions in the Greater Bay Area to collect data, the researcher will follow the proper procedures for conducting a research study. First, the researcher will seek approval from the dissertation committee and following approval, the researcher will submit an application for approval to the University of San Francisco Institutional Review Board for the Protection of Human Subjects. The researchers will notify sites and their human-resources departments about the research plan after receiving committee approval. The Request for Review Form will be filed, providing information about the principal investigator, the project title and type, source of funding, type of review requested, and number and type of subjects. Application for research permission will contain the description of the project and its significance, methods and procedures, participants, and research status. The researcher will initiate the process of collecting data after receiving formal approval from the researcher's dissertation committee.

All data and records will be kept confidential on a password-protected computer. Individual identities will not be used in any reports or publications resulting from the study. Using language that is understandable and clear to participants, the researcher will

provide each participant with an overview of and the purpose for the study. Participation in the study will be voluntary and signed consent forms from all participants will be acquired prior to conducting interviews. The study will be conducted in an individual survey-interview format with audio-recording. Participants will be notified of their right to opt out of the survey or the interview at any point and no questions will require a forced response to proceed.

An informed consent form will be developed, stating participants' rights, agreement involved in the study, and acknowledgement that their rights are protected. A statement relating to informed consent will be affixed to the survey and reflect compliance by participation. The researcher will inform participants about the study, and all people involved will be protected from any harm that might ensue from the study. Participants' anonymity will be guarded through the use of pseudonyms, and all answers will be coded. As a benefit, the study will contribute to the profession as a whole and will benefit the research community and society. Individual participants will be notified they will receive no direct benefit from the study.

The anonymity of participants will be protected by numerically coding each set of interview notes and keeping responses confidential. While conducting individual interviews with selected respondents, they will be assigned fictitious names for use in their description and in reporting the results. All study data, including survey electronic files, interview tapes, and transcripts will be kept on a secure password-guarded computer system in the researcher's office and destroyed after a reasonable period of time. Participants will be told summary data will be disseminated to the professional community, but in no way, will it be possible to trace responses to individuals.

Data Analysis

The researcher will visually inspect the data and conduct a descriptive analysis of the mean, standard deviation, and variance of responses to each item on the instrument using the Qualtrics program. Each item in the survey will be tallied and analyzed for the descriptive questions in the research study. The survey items will be matched with the research questions and given numeric scores to explain in depth the responses corresponding to the research questions using descriptive statistics. A codebook that lists the variables, their definitions, and the numbers associated with the response options for each will be developed (as suggested by Creswell & Plano Clark, 2011). The researcher will analyze the data based on the type of questions or hypotheses and use the appropriate statistical test to closely consider descriptive analysis and inferential analysis, leading to a more refined analysis through emerging coded themes.

For the qualitative data analysis, the researcher will prepare the data for review, transcribe text from interviews, and record observations into word processing files for analysis. The researcher will also check transcription for accuracy and enter qualitative data for analysis into a software program such as NVivo (Creswell & Plano Clark, 2011). Data from interview participants will be used to refine and develop any emerging themes by coding specific words and statements from the interview transcripts. Although the data collection will be a continual process, the researcher will also compare each interview and properly transcribe and code responses to the themes. During the coding process, the researcher will divide the text into small units such as phrases, sentences, or paragraphs to assign labels to each unit, with the exact words of participants (i.e., *in vivo* coding; Creswell & Plano Clark, 2011). Then, the researcher will code directly on the printed

transcript and assign code words to text segments on the left margin, with broader themes on the right margin. By coding, the researcher is able to organize the codes into a visual tool, making it possible to see the relationships among text segments. The evidence from the database is grouped into codes, and codes are grouped into broader themes that can be relatable to grounded theory. In the interview and journaling process, the researcher will be able to see, in narrative form, how the individual life of a female STEM professors is composed, using a sequence of codes or themes. The goal is that the themes, interrelated themes, or larger perspectives are the findings and results that provide answers to the qualitative research questions (Creswell & Plano Clark, 2011).

In Phase 2, the researcher will represent the survey data of the analysis in visual summary form in tales or figures, and these summaries may be statements summarizing the results. In the qualitative data, the researcher will represent the findings through maps and figures to describe the different themes. The interrelated themes may be a model, a chronology (narrative), or comparison tables. As for interpreting the questionnaire study results, the researcher will compare the results with the initial research questions to determine how the questions were answered in the study as well as compare with predictions or explanations drawn from past research studies or theories. To interpret the qualitative study results, the researcher will address how the research questions were answered in the qualitative findings.

The researcher will compare the findings with past research studies, but will also add personal experiences and draw personal assessments of the meanings of the findings. In this research study, the qualitative process of data analysis described by Creswell (2011) will be implemented, and the six steps in analyzing and interpreting qualitative

data will be followed. The researcher will collect the data and transcribe the interviews from the recorded information. Then the researcher will read through the data to obtain a general sense of the data. Third, the researcher will code the data by locating text segments and assign a code label to common themes. Finally, the researcher will prepare the information for the research report. As a qualitative researcher, it is important to show that the "research and its interpretations can never be separated from the researcher's personal views and characterizations" (Creswell & Plano Clark, 2011, p. 35). The research questions will be addressed with the results of the findings, and recommendations for future research will be suggested.

Background of the Researcher

The researcher was born in the Jaum-Wung Province of Seoul, South Korea in 1972. She attended through the second semester of second grade in Gu-Jung Elementary School in Gang Nam province in Seoul City. The researcher immigrated to Los Angeles, California, with her family at the invitation of her pharmacist uncle who decided to enter the United States when there was a shortage of Asian American medical professionals during the 1970s. The researcher migrated on February, 1981, with her family of six at the age of 8, and remembers her first U.S. schooling experiences, especially the difference in school curriculum and instruction in both countries. Although in both countries it was understood that children at the age of 5 or 6 years of age came to school knowing the basic fundamentals of reading and mathematics curriculum taught at home, the researcher's father and mother, who taught the researcher how to read and count prior to beginning formal education, were the researcher's mainstay in the education process

prior to beginning elementary schools. Parents were the main contributors to early childhood education at home.

The process of learning in South Korea relied mainly on rote memorization for young children where the 24 phonetic alphabet letters and standard Arabic numerals were emphasized as well as encouragement for children to learn as early as possible. Being able to learn from two different cultural perspectives of mathematics helped the researcher understand the importance behind locus and agency in learning. The researcher relied on her father's endless bedtime stories and fairy tales to guide linguistic sensibilities based on Chomskyan theory on acquiring her mother tongue, and her mother's ceaseless achievement of punctuality and precision in time and daily calculations. Both parents wanted the researcher to become a doctor in medicine, mainly because of humanitarian effort and the nobleness of the profession. Ultimately, the researcher was thrust upon the actual possibilities of taking the path of the medical profession when the researcher's mother became ill, needing triple bypass surgery to fix an aortic artery, and around the same time frame, the researcher's father needed to undergo 16 hours of surgery to remove a benign tumor.

Being the oldest child, equipped with the ability of being bilingual, the researcher immediately became the home nurse and a liaison between doctors and patients at home. The researcher had to quickly learn medical terminology and become fluent in procedures to care for both patient parents. The researcher's efforts in diligently keeping temperature readings every few hours for infections and tapping supplies of various cocktails of intravenous medicines at odd hours of night and after school gained notice from one of the parent's physicians. The researcher gained enough notice from a prominent physician

to secure a promise of a letter of recommendation for a medical school in Los Angeles, if the researcher wanted to pursue a career in the field of medicine. These events occurred during a very important transition time for the researcher, and losing control of the researcher's personal childhood and teen years led the researcher to get a more comprehensive perspective of the world at a very young age.

Simultaneously, the researcher's parents decided to send their oldest daughter to a female parochial high school. Almost the entire high school was organized and run by female leaders with the exception of the priest, monsignor, custodian, and one science teacher, who were the only male members of the school. The researcher originally wanted to attend the coeducational parochial school in a neighboring city, but the parents and sponsor of the all-female high school highly recommended attendance for its rigorous academic reputation. Therefore, the stage was set for the researcher, from her formal years of education, to understand that the female voice and female leadership form the foundation for future missions and endeavors. After graduating from high school, the researcher attended college courses at the University of California–Los Angeles and the University of California–Santa Barbara, where no science and mathematics courses were offered or taught by a female instructor. The only time the researcher had a female leader present in any science or mathematics courses in colleges was during an introductory anthropology class with an emphasis in archaeology; the female teaching assistant assisted the male professor. This was an unnerving experience because the researcher sought a female role model while attending two of the leading medical, mathematics, and science research institutions in California. In the 1990s, most women in colleges were reappropriated to either sports medicine or kinesiology majors rather than to traditional

medical or scientific paths. It is disheartening to learn that this belief continues today, and even women who have tackled all obstacles to achieve the doctorate level are not climbing to the next level of leadership.

CHAPTER IV:

FINDINGS

This study examined the lived experiences and academic journeys of women professors in universities who are academic leaders in STEM programs. I have always believed that a person's story has tremendous power. One of my favorite sociologists is Lawrence-Lightfoot, and in a 1994 interview, Lawrence-Lightfoot shared beliefs about how one views oneself. Lawrence-Lightfoot focused research and writing on understanding education and educational psychology, stating, in the book, *Worlds Apart*, that

> views of women, on one side, as inwardly directed toward home and family and notions of men, on the other, as outwardly striving toward fame and fortune have resounded throughout literature and in the texts of history, biology, and psychology until they seem uncontestable. Such dichotomous views defy the complexities of individuals and stifle the potential for people to reveal different dimensions of themselves in various settings. (as cited in De Witt, 1994, p. or para ##)

In the discussion of social-cognitive theory, Bandura (1991) explained the ongoing exercise of self-influence extensively motivates and regulates human behavior. The major self-regulative mechanism operates through the three principal subfunctions of self-monitoring of one's behavior, its determinants, and its effects; judgment of one's behavior in relation to personal standards and environmental circumstances; and affective self-reaction. Self-regulation also encompasses the self-efficacy mechanism, which plays

a central role in the exercise of personal agency by its strong impact on thought, affect, motivation, and action (Bandura, 1991). As I describe the details of each interview, I assigned all the professor's names a pseudonym where the first letters of each name spells the acronym, "PROGRESS."

The following eight accounts of professors' experiences embody the true meaning and purpose of this research. I chose this format to relate the detailed explanatory qualitative research study that illustrates the hard work and ethics of female professors who are leading the way for future female STEM leaders; to ensure and move forward to attaining their permanence in STEM positions in universities and institutions. In other words, the researcher wanted to use the words of female professors to extend the discourse of their lived experiences.

This chapter is organized by first sharing accounts of participants' backgrounds and workplace environments using their own words, along with personal reflections to answer the three research questions. Second, I delve further into the professors' support frame at work, her personal space, and gender. Then, following the discussion of workplace motivation, leadership, and program accountability, we addressed hiring and retaining women professors. Third, I offer a summary of the findings aligned with the research questions and a summary in the framework of Bandura's social-cognitive theory.

Professor Penelope's Experience

Professor Penelope is an assistant professor and has been working in her department for about 1 year. She is working to obtain her tenure and to satisfy the service portion of the university's tenure track requirements.

Work Environment

According to Professor Penelope, when researching and writing, her sentiment about her work is neutral. Stressors include the ebb and flow of writing papers and taking care of her family. She has a family with one child.

Professor Penelope is on tenure track for her occupation; her goal is to perform the requirements to allow her to obtain tenure and be promoted; one requirement is an obligation to provide service, in addition to teaching. She must take part in the community and mentoring. Because she is of a minority background, she has personal feelings about mentoring women and people from diverse backgrounds. Therefore, her mission is to ensure that people from diverse backgrounds have an environment to work and become resilient to negative feedback in academia, especially in her area of academic research.

Professor Penelope hopes that the outcome will align with the proposed changes in the university. She also states that the university has specific changes planned for minority female professors, with the rhetoric of leadership. The university is opening new offices on diversity and inclusion and is preparing educational programs to teach about unconscious bias. The goal of those program is to teach participants to be culturally aware when mentoring students.

In comparing her university to other universities when discussing diversity in faculty members, the university has taken a very active tone toward recruiting people of underrepresented groups. Because of an intention to recruit people with minority backgrounds, she believes her university is doing quite well. Statistics show that her institution is leading in graduating minority students in the biomedical field.

As to personal success, Professor Penelope would like to be able to obtain grants and be promoted, but also wants to experience an environment that is increasingly inclusive. She wants students to be able to see that the faculty looks like them, which would indicate success in university diversity. Personally, she wants to inspire more people like her.

Research Question: In what ways do female STEM professors' gender identities shape their learning experiences?

Gender

In discussing gender equality, she said "it still feels lonely. I cannot say that there is equal still (where) it feels most of the meetings, that I am alone there. Only woman and only minority, so I don't think there us equality yet." As to STEM motivation for women, her university has a STEM goal for minorities in general. She contributes in being open to having students of minority backgrounds come to her laboratory where she mentors them, gives talks, and discusses women in STEM. She has received invitations from other universities to speak but believes just being present has an impact.

> The minority students and women can just see me when I interview students for coming feel safe and to talk to me about things that they were not able to speak. To speak to others, and you know I am not in a position to make huge decisions like that one in one I am making a difference.

Professor Penelope identified challenges in hiring because sometimes she feels the power gap in the classroom with students from diverse background. At the same time, she must address an internal power struggle among faculty members of predominantly Caucasian, male, and tall faculty in her department. "I do not know if it comes from me

just a personal feeling or challenge even when I hire people … values or stand up for issues among faculties."

Professor Penelope is a junior faculty member feels that she is not yet be able to express her feelings:

> I have (spoken) at the meetings but if there is a question or need clarification something slips out that is not correct or goes against my values either clarify or ask it in different way. I do not have a specific example for that, but I look out for things like that, I am not at a position where I can make both things speak out or do things like that since I am a junior position in faculty in setting and I have been a trainee all year long.

Professor Penelope related that the most difficult aspect of her job is its business nature such that she has to write papers and grants and worries about research and the peer-review process. She is constantly concerned about bias over which she has no power, particularly in the grant process.

> It may be just my internal feeling but everybody writes grant and everybody has rejected papers and everybody has rejected grants but I can't help but feeling internal conflicts as a woman and as a minority had contributed to these decisions. The constant nagging feeling that you fight and struggle with most of the time.

Research Question: To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment? What do STEM professors attribute to their success?

Workplace Support/Motivation

Professor Penelope has mentors and tends to rely on many people in her department as well as outside of her work environment. She labels herself an “aggressive advice seeker” and talks to many people for advice and assistance to help her address issues one at a time. She asks for advice from friends and family on matter unrelated to the university, which helps relieve her personal stress. However, her mentors at the university are mostly men. She does easily identify female professors in her department. She has one woman professor on whom she relies for matters about the workplace and academia.

Research Question: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

According to Professor Penelope, the three aspects of success in teaching, workplace, and academia are mentoring students and faculty, educating the community, and progressing STEM for female professors of all groups to attain tenure. She emphasized all groups: not only minority groups but also ethnic and gender groups. “And that is an addition to things that the university already doing things they are supposed to do in academics and conducting science and teaching.”

Leadership

As to being open minded on campus, I asked about the well-being of female students and female professors who are engaged in STEM fields and departments.

Research Question: What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

Professor Penelope shared that one of the main objectives of the faculty is to have open laboratories for all students where they can meet students and discuss any questions or problems about their work. Professor Penelope is already the staff team member pushing to admit more female faculty members in her department. An initiative is in place in the university to include and hire more female faculty members and admit more students of diverse backgrounds. The professor believes the initiatives are steps in the right direction. She described the campus as being conscientious thinking. Because her department has so many more male members, it is an obvious choice to push for more female professors to be hired.

Professor Penelope recounted one example by describing a monthly event designed to promote and keep female professors on the path to attaining tenure, dubbed "Women on Track." Focusing on women, the group discusses how to get a mentor, how to be a good mentor, how to attain tenure, and many other pertinent topics. She feels very fortunate that this event was already in place before she was hired by the university when few women worked in her department.

> No, not many. My department is huge so it's a very big institution, and big department I can't even tell how many women but there are lot more men than women professors. I think it has been improving lately, I think my department is made up of 200 women faculty members, out of 1,000 members.

When I asked what university leadership can do to improve the discourse on needing more female professor leaders in STEM programs and departments, Professor Penelope suggested that being mindful when hiring would enhance the number of highly qualified women filling positions. The leadership program can give opportunities to

women and provide training to women with good leadership skills. She stated that providing leadership skills, training women to be good leaders, and intentionally hiring women leaders are examples of motivation and sustainment of female professors in academia.

Program Accountability in Hiring and Retention

Presently, the hiring committee comprises mostly men and the university has instituted an intentional push to include women on those committees. The committee has asked Professor Penelope to be an active participant in the hiring process and to contact women applicants who qualify. This process is a way for the department to be mindful of women and their recent push to include more women faculties.

> So that I send them advertisement and encourage them to apply and that is what we are doing at our university. I know some of them and I know of the from conferences and university gives the information and university gives you an advertisement and we have a meeting and give you every detail about what that position entails. And then for a recent one they ask us for names, and most of us we attract are really highly qualified and so they ask us to make our research and use the names that they give us and we give them the potential names of people we make contact and from that list we sit down and discuss those names. And they just we have a list that represent women and minorities and then we get the approval to contact them. But usually the people that I met at conferences, we contact them and given talks, so that is how I know them. The hiring is at the departmental level and less at the university administration level.

It is disconcerting to know that equity in the hiring process has not fully taken shape in Professor Penelope's department and university, which she attributes to her junior level as a graduate student prior, and now a first-year professor at the university. She looks forward to proposing greater hiring equity when she obtains tenure. Professor Penelope also mentioned that to encourage more girls to enter the STEM area, universities need to take an active role in inviting high school students to campus and motivating them to attend conferences.

> When I go to conference, I would invite students and walk with high school students. I am involved with outreach program and once I had a baby, I had to move very far away from the university. I used to be more involved before (in the outreach program) the baby, and I used to do an outreach in the teaching level but not in the planning level, and in terms of maternity leave, understanding with family concerns is important since I still feel like women should have more support where it was only 6 weeks of leave is allowed which is not enough and we can push for more time generally not sufficient time for a leave. My sentiments about my general and overall work in the university is neutral, not having anything to do with my personal life.

Professor Rosita's Experience

Professor Rosita is an assistant professor at her university and has been working on her campus for 5 years. She described working in the Earth Sciences Department with duties primarily being to teach microbiology courses, monitor the laboratory, and facilitate seminar courses for university students.

Research Question: To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment?

Work Environment

Professor Rosita is enthusiastic about her position at her university, despite moments of frustration when huge emphasis centers on publishing research and writing grants. She also mentors graduate students who are on the path to earning their Ph.D. degrees and trains them through projects that will help complete their graduate degree program. The professor is planning to create a laboratory course in which she can hire and train graduate students to work and earn credits toward their Ph.D. degree. Professor Rosita is also trying to tie the laboratory course to her research and teach students about the outcome and results of the laboratory work. Ultimately, she explains she has three main components of her work, and she is trying to make them relatable.

Professor Rosita considers the outreach program to partially fulfill the service requirement for the university, due to internal university funding as she spends time working with undergraduate researchers who come to her laboratory during the summer. She also described a separate program targeting students outside the university to come for the summer, focused primarily on students of underrepresented groups and minorities to try to increase diversity in science.

> I participate in that program as well and those funds come from usually through private companies like oil company as an example. I also give lecture to students and I will go spend the afternoon and have lunch with the students and mentoring them and I meet with them even they are not working in my lab; but they may want to talk to me about my career, or what options are there in terms of being a

> scientist in academia; in terms of what does that mean and what other options are there outside of academia. Like do you need a Ph.D. for everything? You know just like the basic kind of questions that are about career advice, and so this is how I participate in outreach endeavors.

Professor Rosita describes her university as a very large research institution that has not increased in numbers of minority faculty members for 2 decades. She hopes her campus becomes more diverse by hiring more faculty members with diverse cultural backgrounds and admitted more students from underrepresented groups.

Research Question: In what ways do female STEM professors' gender identities shape their learning experiences?

Gender

Professor Rosita has hope that good intentions will lead to proposing changes on recruiting practices and faculty retention, because the university loses many faculty of color. When she first started to work for the university, Professor Rosita was the third woman hired by her department and the only professor of Mexican heritage. Now, her department has hired four more women professors and has come far in making progress.

> So, that in terms of gender, my particular department is one that is making really a lot of progress, and I think it has to do with the area of research that they have been focusing a lot on the climate change. We just had a lot of good female faculty apply. So, going off a little on my department, and so in my school, over science and we also have geology department that has not done very well. And our geophysics department is still struggling a little bit on hiring women and so even though our department is doing really well when compared to other

> department still, and other school compared to the university, still our university is still struggling.

The professor related that approximately 30% of her department faculty members are women. When compared to other science departments, this is a very good progress in hiring female professors over the 5-year period.

Professor Rosita believes her university is moving in a positive direction in hiring female faculty and diversity. She described a progressive university further north that specifically stated they are particularly seeking to hire women of color. Professor Rosita stated she would like her university to have the same initiative, hiring more female faculty of diverse backgrounds. She is somewhat frustrated that her university is able to do so much more to promote not only diversity but also hiring more female faculty in her department. The professor feels that her university is progressive in placing women and diversity as a major agenda.

As a fairly new faculty member, she is quite eager to learn more about the inner workings of the process of hiring and retention. Working with the Dean and Provost, she has 2 more years until receiving tenure and is looking forward to the challenge of voicing her beliefs to discern what leadership role she may be able to take on in the department. She advocates unlimited funding for graduate students with diverse backgrounds and incentivized funding to hire minority female professors. Financial incentives drive many of the possibility and she hopes that, despite the preexisting hierarchical system, the university will find funds to hire more female minority professors in her department.

Work Place Support and Motivation

Professor Rosita stated that the main challenging aspect in her professional career is her focus on obtaining tenure. She also feels that funding is critical for her to obtain more graduate students to work in the laboratory and complete research. She finds her university to be quite supportive in training her as a professor and a lecturer because in her graduate school years, she was only trained to do research and publish work. However, since she started in her position as a professor, without any previous experience in teaching, the university has been supportive, providing workshops and mentorships. The university provided her with resources to become a better teacher while she has continued her research and setting up her laboratory.

Faculty mentors in her department are mostly men and the head of the department, the dean, is a woman who has been very supportive of her work. She has a sense of belonging and encouragement because most of her mentors have been male colleagues in the past. Professor Rosita also mentioned a mentorship program for new professors; however, it is not specifically designed only for female faculty, but is intended for all STEM professors to help in the tenure process.

Professor Rosita had to change her mentor once because she did not feel her first mentor was a good match for her. Then, when consulting with her department chair about this situation, she realized he was a better match as her mentor. Therefore, her first year at the university, her mentor was her department chairperson. In her second year, a female professor had received tenure in the department and took on the role of an unofficial mentor with encouragement from the department chairperson. The chairperson believed it was important for Professor Rosita to have two mentors with different

perspectives. Although the mentorship program is not an official program it is designed to be flexible such that a professor may meet with a mentor as much as desired and needed.

Professor Rosita has expressed concerns because many professors in her department focus on climate-change studies and the government has stopped funding much of this research. The lack of funding has forced many scientists to stop their research or limit their staffing of graduate students. This has caused tremendous stress in the department among researcher who perform climate studies. Because the university has a national reputation in this research, the professors have experienced tremendous pressure to obtain and secure funding to continue their research. Professor Rosita believes one of the most important jobs of scientists is to educate the public with truth and service to the community and the lack of funding will diminish their ability to do so, cutting jobs and opportunities for graduate students and furthering public education.

Leadership

Research Question: What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

Professor Rosita suggested that many women faculty clubs and associations, with a series of speakers and meetings, help female professors discuss address issues in academia and gender diversity. Her university hosts retreats and writing workshops for female professors. However, she is focused on obtaining tenure and also has young children, limiting her time. The university is quite cognizant of families and busy lives of female professors, so female faculty clubs allow professors to feel less restricted. She is limited in time to spend outside of research and teaching.

She confided that the teaching aspect was the most difficult part for a leader because her lack of experience required more structure to overcome the obstacles. She gradually learned other resources like funding and the grant process with the help of university support. She had to learn how to advocate for graduate students because they have little voice in the department; when they needed help, Professor Rosita had to learn to advocate for graduate laboratory assistants who funding to provide transportation from home to school. This advocacy was a learning experience. She had experience advocating for herself, but now needed to learn to advocate for others to complete their doctorate or postdoctorate work. Over the course of a year, her advocacy successfully addressed the issue of transportation for students at every level; she was able to secure transportation funding for all groups of students and graduate/postdoctorate workers.

Programs of Accountability

The university has summer programs for undergraduates from other schools who are encouraged to apply to the university for graduate programs.

> For a way it's a recruitment program where the undergraduates from other schools come for the summer and have them see during the summer, and we have had them come to graduate school here. And then beyond that, it really becomes an individual level, like a visit with a professor, once we start mentoring students, I have a lifelong commitment to that student if they want to be active in the academia, I will be advocating for them and so for my grad students, I make phone calls or I will write letters of recommendations, and I will be making positions for them after their graduation, which will be faculty positions. I would be advocate for them in tenure writing program and writing tenure letters and

> things like that. But in terms of like, recruiting programs, one thing the real goal for my university is to bring students into the university from people of color and diverse background of students.

Professor Rosita believes STEM departments should include more female professor leaders and the university needs to apply extant research on how to improve faculty diversity with effective recruitment and retention retainment of female faculty. She also advocates that the hiring process should be broader to include a more diverse candidate pool. Because hiring practices are departmental, she feels frustrated that when they narrow the candidate pool to the top eight, eight of 10 candidates are White males. She knows department members have conscious biases; most professors are inundated by their research and daily practices and tend to miss or forget that most department faculty staff are White male professors.

> And hiring is very departmental, and I don't know how other departments are doing this and that is just the way our department deals with it. They acknowledge that there is information out there but then we don't use it, and we are actually going through the process and we are surprised when we look at the candidate pool and we have our top eight, and our eight out of ten are white males, we know that thing for not doing that and that is probably how it is for our graduate admissions as well. we rely heavily on our GRE scores and we know that the GRE is more of a predictor of race, gender, and social class than ability to do science. And yet we know this and we acknowledge this in our pack admitted, and we still are relying heavily on our GRE numbers. So, I wish there was more

> application of research and what we know about increasing diversity and that I wish it was applied a little better.

Professor Rosita also explained that many community-building events promote diversity in the university's leadership among female faculty. Some events are mixers, lectures, and public events that aim to encourage women and faculty to become more active and engaged in equity issues.

> I recently went one lecture on equity and justice in academia. It turns out that was a whole series done by the biology department that I hadn't seen since I am not in the biology department, but I had received an email, and I noticed that there was a whole series of talks from this topic. So, they had been going on for a whole year, so I'm sure that there are more things that I am not aware of, but a lot of what I see are the workshops that help build like a skill sets to be a leader in particularly for women that I had seen a lot of but I think there is also a lot for people of color in academia in lectures and talks by bringing in experts from outside and they talk about "what are the issues surrounding gender, racial equity", and things like that in academia.

Professor Rosita also mentioned a high school program in the Earth Science Department focused on bridging the gap between high school and college science studies to promote students from all backgrounds and genders to join and apply to the university. The professor related that the crux of the problem is a system of biases and injustice against certain groups. That agenda stands in the way of bringing women, people of color, and disadvantaged groups to the level of all other faculty.

Research Question: What do STEM professors attribute to their success? What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

According to Professor Rosita, it is important for students and faculty to see people like them and especially see women in the faculty. She had no intention to work in the university or academia until she was accepted into a postdoctoral program where all her mentors were male professors. When she came across her first female professor/mentor, Professor Rosita realized that becoming a professor in a university setting was a realistic choice for her. She was able to observe the female professor in her daily routine and work, giving her a sense of motivation and encouragement to become a university professor. Having a role model gave professor Rosita the empowerment to believe

> you can have work (career) like that (and) you can do it your way. Being a woman without compromising who you are, and that's something that encouraged me to go ahead and go forth with this career path. At a younger ages, I know you just have to do with what will work and so I got my doctorate at a mid-west university with a male mentor who was wonderful and I loved him (as my mentor) and he's great and I had kids during my doctorate, and he was very supportive of that and I would not have been able to do that balance without his support and at a very prominent university, I did a postdoc with a first female advisor, and the only woman mentor that I have had at the time, at that level. And so, she was the woman that I saw her doing her work at Caltech, and I said "that is how I want to do my work too," so that is who influenced me.

Professor Ophelia's Experience

Professor Ophelia has worked for 11 years at her current university in the Computer Sciences Department. She also taught for 3 years at a very prominent east-coast university and had more than 14 years of experience. Professor Ophelia shared that having a supportive mentorship environment was probably the most important element in her becoming a computer scientist. In her graduate studies, she had professors who encouraged her and created a supportive environment for her achieve her career goals. Therefore, one of her main missions in her work is to motivate students as her mentors and professors have done for her. The university can help students succeed in whatever they want to accomplish while attending.

Research Question: What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

Work Environment

Professor Ophelia's sentiments about her job are quite positive. She has changed position from the chairperson of the Computer Sciences Department to full-time faculty, allowing her to balance her three main responsibilities of professor, researcher, and servant leader to the university. Her work allows her to be in contact with undergraduates and graduate students, and, depending on her research, with writing grant proposals, supervising doctoral and master's degree students, and coding and collaborating with professors outside the university, predominantly in the east-coast region where she attend meetings and presents her work for publication.

Professor Ophelia said her work can be frustrating at times because her department is in a period of extreme growth, as so many people want to major in this

field. The faculty and department are trying to keep up with the growing demand. This change has led to larger class sizes and more advising responsibilities. Professor Ophelia's position allows her to be flexible and attend to many of her work challenges while balancing all three main responsibilities as a professor of computer sciences. The overall mission and vision of her university supports her work environment: everyone is united in the goal of attaining social justice and gender equality in computing. This consensus helps her establish her core mission in educating students to be thoughtful and mindful about the issues of establishing diversity and inclusivity in the computing and technological work force.

Professor Ophelia also pointed out that her department is fairly diverse, servicing a larger Latino community than many other universities. Her university statistically matches the national average of 20% female undergraduates. Although her department is committed to gender equity, it still needs to work harder to attain a good balance for all genders.

Professor Ophelia was one of the first few female faculty members to be hired for a full-time position in the computer science department in 2006. Now, 11 years later, her department is close to reaching 50% female professors; she is quite proud of her department its success in recruiting and retaining female faculty. Professor Ophelia believes the university and her department are moving in the right direction and hopes to continuously strive to improve. For example, Professor Ophelia discussed the systemic problems that persist and cannot be solved immediately, such as working with middle school and high school girls who have self-rejected STEM programs due to societal and parental pressures. She feels frustrated that by fifth grade, students have already decided

whether they are inclined toward mathematics and sciences. By the time she observes the population of students coming to the university, too few students interested in STEM fields.

Gender

Computer science studies engenders much systemic bias. She related her mother's experience as a teacher's aide who witnessed many school teachers with implicit biases: teachers encourage all the boys to study mathematics and sciences and encourage girls toward writing and art. Professor Ophelia believes those systemic attitudes shape how small children view themselves early in their academic setting, and feels it is a fundamental problem. Also, parents also project those biases onto their children. Giving positive and encouraging guidance toward STEM to all children should begin even earlier than elementary school age.

Harvey Mudd College provided a good model to follow, making huge progress by encouraging more women to take on a computer science major in college. This encouragement requires resources that Professor Ophelia's university does not have. The professor is aware of other smaller schools that are critically thinking about committing to broadening participation in computing, especially taking initiatives to address the issues of inequality in this field. She knows many universities make great progress and strides to include women in computing. Her personal experiences in her undergraduate and graduate studies also delineated gender equality issues; her previous institution stands out as among those that are progressive in inclusivity. She gave a detailed description of being a professor at one university located on the east coast, describing professors focused on teaching and guiding female students to have a sustainable major

in computing that allows critical-thinking skills, making them conscious learners in the subject. The all-women community was highly communicative and very much connected through a network; professors would invite students to their homes for dinners and work to create a very close community of academic scholars. In that environment, professors and students had a great deal of interaction, serving students for 4 years with a close-knit academic life in a free and interactive learning community, sharing and exchanging information for critical learning to take place.

Work Place Support and Motivation

Research Question: In what ways do female STEM professors' gender identities shape their learning experiences?

Being one of the first women professors to be hired is a challenge because people look up to her as the person who will think about issues in "gender equity and whatever." However, being employed by a department that is committed to hiring women and supporting women makes it easier and the number of women in her workplace has gradually increased, matching the changes and dynamics of growth in her university's computer science student population as well. The face of higher education is changing, and the types of students who come to the university is also changing. She believes the students need to prepare to work hard; when they are unprepared for that challenge, it is difficult for educators to face that reality in the university arena.

Professor Ophelia added that the most difficult aspect of her job is how to effectively address the growth in the number of students who want to major in computer science and the adjustments needed to accommodate and service all students. She also mentioned that the challenges and obstacles change, depending on the various positions

she has held in her department, such as departmental chairperson. Thus, Professor Ophelia faced varying levels of difficulty than would be common for an assistant professor. Presently, the university and her department are trying to fill faculty positions to open more course spaces to accommodate all computer science students. When her department was unable to fulfill the goal of hiring two faculty positions and was only able to hire one professor, fewer class spaces were available and the professor was forced to advise incoming students that they had to wait a semester to start classes in their major. This was quite difficult to do when advising new students.

In Professor Ophelia's opinion, university female professors should focus on STEM, providing the mentorship that gives a structure, ensuring mentoring is available. The university does a fairly good job of assigning a mentor to each incoming professor, but the professor believes they can do a better job in providing a mentorship structure. Because her university is a teaching-oriented school, faculty must balance grants and research activities to help faculty reach their goals; delivering a quality education requires students to be the top priority. The professor believes the university should offer salaries twice as high as her own salary, and be mindful of the disparity that exists in professor's wages versus computer-technology professionals in nearby Silicon Valley.

Computer scientists are difficult to find because they are in such high demand and every university is trying to hire faculty members in computer science. Many companies can offer superior wages with lucrative hiring packages for employees with computer science degrees and background. Thus, the computer science department has difficulty finding competent professors.

Program Accountability in Hiring and Retention

The professor thinks the department and the university as a whole are quite supportive, albeit that hiring professors in computer science is almost impossible. Professors and students who are finishing with a Ph.D. would accept salaries half of what they would get if they worked at Google or Facebook. In addition to the huge challenge of hiring is hiring with a focus on diversity. The professor's university is very careful about the challenges of systemic discriminations and other types of bias; therefore the difficult of the issue diminishes.

To attract and retain female professors, universities need to be aware of the market realities of the field, and the university hiring committee should do a reasonable amount of research on wages and costs associated with living in the Bay Area. At the same time, women should learn to be aggressive about negotiating for the competitive salary. The university and the hiring committees in departments need to come together to do more research as to avoid losing an ideal candidate due to conflicts in earned wages not being enough to afford living in the Bay Area. The candidates and applicants are likely to take a different job or look elsewhere because the offered salary is insufficient to pay area rent. Professor Ophelia believes the university can do better in making initial offers and trying to be more aggressive at negotiating with faculty candidates.

For community-building activities and events, the professor knew of no planned events but the staff organically started unofficial faculty mixers several years ago, similar to a happy hour gathering. Faculty members usually set up meetings of such a nature and do not usually have a specific theme to promote diversity or the empowerment of women.

Leadership

As a computer science professor and leader, Professor Ophelia started a Women in computer science group, and until last year was its faculty adviser. The group creates missions to provide structure for students at the university as well as participating in summer programs. A new female faculty member in the department took the helm of leadership of this group for next year, displaying marked enthusiasm about this group. The university and department are remarkable because they were able to secure enough funding to take 20 high school students to the Grace Hopper Celebration of Women in Computing Conference—an annual event for women in technology— with 15,000 to 20,000 people attending each year. For the past 2 years, the computer science department has been able to take four students to the conference, and the leader of the committee is responsible for the selection of students. This year, the department is taking five times as many students than previously: an amazing accomplishment for the group. Many students report that attendance at the conference is a life-changing experience, seeing 20,000 other women who have interest in technology, learning about the sorts of resources available, and hearing the opportunities that are available in the field. Therefore, Professor Ophelia is very proud of the group's accomplishments and her work to initiate and lead that organization.

She is also chair of the board in an organization called Networking Women, providing mentorship for women to build a support structure for women in her specific research field. The organization also works to gain fellowships for students to attend conferences, organizes an annual workshop, and conducts a variety of other activities. These service activities are Professor Ophelia's focus.

The professor feels that in encouraging more women into STEM fields involves two tiers of activity that must be address independently: encouraging more female students and encouraging more female professors. She believes her department is working hard to attract, attain, and retain female professors through support and mentorship, with infrastructure accommodating the needs of professors. She acknowledges her fortunate state of working for a university that promotes healthy departmental beliefs, ideals, and goals that are part of the university's mission.

She thinks the university could support hiring more female professors in other STEM departments. However, departments must do their own work in that regards and the university is doing well to offer its support. Providing such support to students is a separate question.

Leaders in her university have equity-oriented views. She believes the outward projection of university leaders is that they want to encourage diversity and be more inclusive. She believes all levels of the administration have a goal to do well and always try to improve. Roadblocks are resources and funding. Some encouragements that can be shared with other female professors are modeling behaviors. Professor Ophelia quipped that when one asks a little girl, "What does a computer scientist look like?" quite often, she may say it is an unshaven man in a basement hovering over a keyboard.

Research Questions: What do STEM professors attribute to their success? What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program? To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment?

> And I think that having role models, and having women in the classroom, I've had a student say, 'oh yeah, my first three computing classes were all taught by women' that's remarkable, and that's really remarkable in terms of how computer science is taught nationwide. So being able to model that and being able to have students sit in the classroom and have female role models teaching the class, you know their first two or three computer science classes, is quite an achievement. You know that not all students have that experience but depending on which section and placed into whatever but the fact that most of our students have female professor in their first computer science classes is pretty remarkable. And you know just continuing to project that attitude in the classroom, keeping students aware the fact that everyone has to be respectful of everyone else so everyone's voice can be heard. you know just because a male student has done some programming or does it mean that they are actually going to do better in class than a female student who has never programmed before…and so I think that we are doing a good job at this university and I think that we have sort of the right structures in place and right now our biggest challenge is just dealing with growth and with students who don't know what they are getting themselves into when they come to computer science. But in terms of issues of equity and so forth we are in right track.

Professor Gloria's Experience

Professor Gloria teaches mostly undergraduate courses and two courses on the graduate level. She also has a research group that works on computational techniques for improvement of materials for energy production and storage, such as renewable energy

applications like batteries. She also serves as an associate editor of a well-known journal in chemistry and is a prominent member of various committees at her university. Professor Gloria is the equity advisor for her department and her duties include ensuring all department processes are completed with equity and inclusion. She ensures that university policies are embedded in the procedures in every hiring activity and student admission. The department and the equity advisor collaborate to ensure all students and faculty matters are worked out in an equitable way.

Work Environment

In her university, the three main pillars are service, research, and teaching, and Professor Gloria feels quite positive in her overall sentiment about her job and career. She clearly loves her job and feels extremely fortunate to have the opportunity to work at her university. She was born in a foreign country and came to Boston as a postdoctoral fellow in 2001with one young daughter and another on the way. It was an uneasy beginning and she is quite happy to be a professor in a field she really loves. Professor Gloria enjoys teaching the next generation of students about important findings in her field. She sees students' excitement and commitment to their studies. She loves how, as a community of learners, students and faculty witness new ideas that accelerate the field of materials design.

> Sometimes we get to see it being disseminated to the world in such a way that we actually see that it is accelerating materials design and optimizations so that it has an impact on our community which is the long road goal of course. So, I'm very excited about my job.

For the university as a whole, the three pillars set for professors are service, research, and teaching. Professor Gloria states that her university is unique because the mission is heavily embedded in the idea of providing highest quality research and education of the public so the entire community benefits from the findings of top-category research on many fronts. She reflects back to her previous institution before coming to California, a prominent university on the east coast. She sees the difference in levels of resources of a private university compared to a public one. The people who work at her current university are extremely committed to making top-level education and research available to California residents and students.

According to the professor, her department had to downgrade many staff positions in the department and simultaneously increase the size of the student body, to ensure the university survives. Therefore, much work is allocated to professors, the students are not getting the support they need, and the staff are stressed and overworked, which negatively impacts the school climate and time for teaching and research. Equipment does not get updated, impacting the ability to recruit and attract the best students and faculty as well as the ability to offer the best services, teaching, and resources. Students and candidates will likely to go elsewhere, if given the choice, like Stanford, MIT, or Harvard.

Professor Gloria is not a member of upper level committees at the university but knows her university's reputation in private fundraising has not been strong; administrative staff are trying to learn how to best raise private funds and build a fundraising committee among faculty members in each department. She believes the

department cannot continue to operate on only the public funds allocated by the university.

Research Question: In what ways do female STEM professors' gender identities shape their learning experiences?

Gender

Professor Gloria said the department has four female women faculty members of a total of 17 professors in the department. Although a quarter of department are women, more work is needed to achieve equity. Although the number of women undergraduate and graduate students is greater than the number of men, at the graduate and postdoctoral levels the number of women diminishes. The professor thinks that the pool of women candidates is adequate until graduate studies.

As an equity advisor, Professor Gloria thinks the university is trying hard, with marked commitment to the inclusion of all groups. She emphasizes that in faculty searches, she often comes across female applicants who are shy about the position. Women sometimes need extra encouragement to apply for the position. Professor Gloria also watches for women applicants; she finds they write their application in a different way from men.

> Men tend to write as like, "I'm the best in the world and you should hire me or you are dumb!" in case if I am overdoing a bit, women tend to be slightly more humble. So, you have to read it differently, but yeah, I think this university is trying really hard (to be gender equitable) on all levels too, and try to keep an eye out to do the best we can hiring and encouraging women and underrepresented minorities.

Research Question: What do STEM professors attribute to their success?

Professor Gloria is proud that her university has a strong commitment to delivering equitable and unbiased searches for faculty. She feels that her university takes hiring very seriously and, as an equity adviser, the more pronounced presence of this strict adherence to policy in every aspect of university decisions makes professor Gloria feel empowered and supported. She hopes to retain the ability to continue with top-level research in science education, and to work with the next generation of students, even under severe financial challenges. She anticipates the university will maintain 20 to 50 years of cutting-edge research studies and competitive standing in delivering the best research in the nation and the world.

Research Question: What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

As a woman leader in her department, Professor Gloria is involved in outreach programs for STEM and tries to balance her life between her career and her family with children. She offers small seminars to female professors in similar situations such as women who recently had babies or were thinking about having a baby while they were in the midst of postdoctorate and graduate studies. She offers her perspective because she was in a similar situation many years ago. She also attends dinners for a scientists' outreach programs where any middle school children who perform well in science classes can attend to connect with a real scientist and a professor.. In hopes of becoming a role model, Professor Gloria hosts students at the university; a few women in her undergraduate class have benefitted from such meetings. One woman in her class declared Professor Gloria was the first female professor she had ever had at this

university. She wants many children and students to know that she works in materials science and then the children will say “well, she works here, then I can work here too.” She would then follow up by accommodating student, giving them space to learn and explore the field of materials science.

Research Question: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

Because Professor Gloria was born outside the United States, she had some personal reflections to share. She was unsure if her former country had more female professors in materials science, but she mentioned there was more social infrastructure in place making it easier for women to pursue careers, especially after maternity or family leave. Her birth country has paid childcare, and it would be acceptable for every woman to stay home for a year with paid childcare leave; the employer must maintain women’s job status during the absence. Also, women on child care leave receive a salary, paid by the government. Therefore, every child can stay home for a year with their parent. A very good social network assists mothers to place their children in daycare when they are ready to return to the workforce. The professor noted that in her birth country, when anyone applies for a job, any time one spends at home with young children can be discounted so for tenure purposes the worker’s time spent at home is not counted as a lost year. Therefore, the professor believes that there is an inherent challenge in the United States because women tend to spend more time with their children when the children are young, and lose the time spent on research and teaching as a professor. Ultimately, staying home with children impacts women’s careers. Hence, the professor believes professors in the United States choose not to have children until they are tenured, and

then raise their children and conduct their research simultaneously. She believes female professors end their careers earlier, due to the challenging tasks of balancing workload at home and at the university.

Professor Gloria shared her experiences of growing up in her former country and remembers that all people are treated as independent individuals with a sense of autonomy. Each individual can be whatever they want to be without doubt or question.

> (I grew up) where women and men are all individual, and I never questioned that I could be whatever that I wanted to be, like if I wanted to be a physicist, I can be a physicist, if I wanted to be a nurse, I could be a nurse, it didn't matter that I was a woman or a man, I think my kids here who are grown up in U.S. still feel the same but see that kids from other background see themselves, second generation, they are not treated the same way.

Professor Gloria states that her own daughters tell her their friend's household makes the daughters cook all the meals and the sons get to play soccer during the evening. The professor finds this a very disparaging aspect of gender in the United States because diverse communities are challenged to navigate the differences. Even in her birth country, layers in society treated boys and girls differently, but in education, all were accepted and approved for all career positions. Schools in her birth country tends to be average across the spectrum, whereas in the United States, the gap is wide with the best schools being far better and competitive, whereas the worst schools are low in performance and cannot compete.

> (In my former country), we are very good at pushing everything into the middle, which has its good and its bad side that nobody is going to be terribly educated of the slightest inclination, but it also means that there is very little opportunity to grooming our best. So, the school spend a lot of time picking up the kids that could be doing a lot better on the lower side, but for example, I was always told after finishing all of my work to go and help the poorer students, the ones who weren't doing so well. So, I have never been told to you should accelerate to this chapter or get into that upper class, because there wasn't any. So, the money is differently spent, and I think the perfect model is you want to spend money on all students, that needs to get upwards, and on any level, and U.S. make different choices when compared to my former country.

Professor Gloria also expressed deep concern when her adolescent children reveal that gender differences are clearly outlined and boundaries are set by their home and family.

> Her peers who are very good at STEM, but they are continuously told at home, they are not encouraged, they are told to go into nursing, or veterinary, so I think that if they were brought up differently they could have said "well, I want to become a professor, or an engineer, or I want to lead innovation, or a CEO of a big company." It is already from very early beginning, it starts early. You can always catch it as a teacher or at the college level, well what we can do is we can encourage the women who get there and make sure that they don't lose hope of faith, but in order to really increase the pool, we have to start a lot earlier! I never grew up thinking that there is a limit, and I hope that my kids don't grow up and

> told that either. ".there are stereotypes promoted not in schools but from the parent's side. Because they have grown up certain way, and they think that this is the best way to live, and I can't blame them, I am going to live the way, it's not like that they are being nasty to kids but it is what they believe in and for good or for bad, perpetuating that as a real challenge how do we keep our diversity among our cultural diversity and yet encourage underrepresented minorities to do what they want to do, to become who they want to become despite the fact that their parents might feel differently about things. And still retain their cultural identity, that is a very tough question. And I don't know how to attack that. I really don't.

The professor also mentioned that the university has more women in administration than men, almost indicating that administration is a typically female job. In contrast, in her department, most professors are men.

Work Place Support/Motivation

According to Professor Gloria, many outreach programs welcome students of community colleges and high schools in the area. Different departments and colleges in her university offer copious outreach programs often, whereas her department is fairly small in comparison. Overall, the university focuses on underrepresented minorities to have the student body reflect the diversity of California.

The department and university have community-building activities for female professors. However, Professor Gloria was hired at an accelerated pace and was above the level of those programs. As equity advisor, she accommodates those who need assistance. She is also aware of rallies and planned meetings for all women at the college

and university level but personally finds it difficult to balance her responsibilities as a professor, and believes those responsibilities are equal for male and female professors.

> I think it is juggling everything at the same time. That is the most difficult part, and I don't think it differs for men or women. You know you are juggling, you are teaching, your priorities when you research, reading papers from your students, you can put in an infinite amount of time when you are teaching, there can never be limit to put into read and prepare and talk to the students, you want to do that but on the other hand, you also want to raise money to maintain your research group but I think you have to do all of your services as well, so I guess all these juggling is the real challenging aspect. It is the hardest to know that they are all waiting for you but you have to provide for them and prioritize everything, that is why I have all these notes next to my computer to make sure they all get done, and prioritizing is also challenging part.

Program Accountability

Professor Gloria believes that the most important aspect is research followed by teaching. Third is probably some version of service that contributes to making the department and university a better place for all. The administration has constant interaction and dealings with the department with weekly communication in making any decisions. Professor Gloria has a personal assistant who helps and supports her in hiring professors and managing contracts; she also has an appointed laboratory assistant who supports in hiring and writing proposals. The university's administration is very supportive, helping professors accomplish any administrative service to also help them focus on their research and teaching.

Leadership

In her department, Professor Gloria has been nominated to go to the leadership-building conference for 3 years in a row; each time she is overloaded with work and personal schedule, often booked 2 to 3 months in advance. She believes university leaders can develop equity-oriented views to ensure success for all students, faculty, and administrators by speaking about their own experiences in social activities or events. It is crucial to Professor Gloria that experiences be shared with others so stories empower and demonstrate the ability to overcome adversities through association. She values speaking with students about how she made her choices and how her experiences have helped her achieve her present status.

> I met prejudice but also, I had some amazing opportunities because if you are the only woman at a conference and you go off and start giving a talk, everybody is going to wake up just because you are different. And you get an opportunity to be different, and you should embrace that as well. Occasionally, yes, it does bring prejudice but they will be men but other women will be thinking that you are doing the wrong thing and you are not home with your kids or you are unsuited for what you are doing and you are never going to be successful in, and it is hard and painful but life is hard and painful. So, I think all we can do is share our experiences with each other and be strong and be sort of build our strength and these things whether they are equity base, inclusion base, climate base, or what they are, and I think specifically the young children, young girls, and people coming from financially challenged families, and how do we support them? That is sort of difficulty, and increase the pipeline issue. Because, I think once they get

to college, I do think that most women are really trying to support them and there's no student that gets turned away, if they rely on and need any help from home, I don't know what I am doing here, we really try to help. But it's getting them here, that's the hard part.

Due to prejudices, I was very upset and sad and then angry, sort of all the stages of grief, denial, anger, acceptance, and eventually, you try to make it into something; I've done everything from being discouraged to running around screaming to people, to sitting up all night to writing your rebuttal letter to the person which I've never mailed, or things like that; you get it out of your system one way or another. And I do think that everything that you live through that doesn't break you, just makes you strong, and next time you deal with it better in one way or the other. You grow a thicker skin, you learn not to be quiet when it happens, you actually learn because you sort of one way or another learn with these things while going home, what would have I said, if I had been thinking more clearly, not being so taken aback by that comment, you force yourself to say that out loud as well next time it happens, you really will say it out loud.

Everything from my graduate student days up to when I had meetings with Samsung CEOs, it's going to keep on coming because the world is not equitable! Even in our little world in our city, they are doing their best, but the world is not equitable. And many cultures are not, they don't even see it as something wrong.

Professor Regina's Experience

Professor Regina has been a biology professor since 2004. She had no intention of becoming a professor of biology. Her original career intent had been working in K–12 science education settings until she realized that most K–12 teachers were either fearful or angry about science because of their negative experiences with university professors who made them feel stupid. Then, Professor Regina applied for a position in a university to find out if this was true; instead, she found that scientists in their fields are quite dedicated to their area of study but had no training in teaching science. Therefore, Professor Regina focused, for last 13 years, on supporting scientists and helping them improve as teachers of science. Her research centers on teaching and learning, based on her native assignment of neuroscience. Her philosophy is that learning is about driving physical changes in the brain, and cognitive science is about understanding people's way of learning; science education explores applied aspects.

Work Environment

Professor Regina loves her job, focused on her main role as a research scientist with duties and responsibilities of publishing high-profile research papers and winning grant money to sustain research prospects. Faculty development and teaching are a secondary priority. In addition to teaching, she is also in charge of the assessment laboratory where four to seven graduate students access the laboratory to work on a project or conduct research.

According to Professor Regina, first-generation college students and students of diverse backgrounds are of chief importance, with gender as a secondary priority. She has been involved in many private and multi-million-dollar grants to bring women of color

scientists in contact with young or middle school girls of color. She has written books about gender equity in science and education. However, she feels gender is one of many axes of equity and inclusion, and is complex because the vast majority of students leave the discipline in 4 to 6 years, due to feeling excluded from classrooms. The professor believes that gender is one line of identity by which students can feel excluded from classrooms but is not the most prominent, although it continues to be a problem, even in the field of biology. She believes enormous evidence points to how to change every class session, every laboratory meeting, every faculty meeting, and every seminar with confidence; interactive methods could start with formal introductions.

> Did you have mentors in gender during your graduate and undergraduate study experiences?
>
> Absolutely, yeah, absolutely! So, I think that you know my critical mentors span a whole variety of backgrounds, my most important professional mentor is a lesbian woman who was really involved in lots of gender directly and she was trained as an elementary school educator. Her relationships with gender is really complex so gender is not sort of singular thing, we are living in an interesting era, and I don't really fit the (how shall we say) societal norm of woman in the sense of you know we have transgender folks who put on make-up and put on heels and I don't do any of this so it's an interesting time to think about gender. So, legal thought about gender is a very deep way, so I had really important mentors all throughout my career who were males, that are white males so I wouldn't be where I am today if it weren't for my white male mentor who took a chance and invited me to his lab when I was an undergrad and another white male mentor who was

> incredibly patient and supportive mentor for me entirely through graduate school, so I think that I have been able to find mentors in lots of different places, and I think I see that for my students as well. So, I am not sure if that answers your questions.

Professor Regina stated that if one is successful at teaching science, then as soon as students walk into a classroom they will see the connection between learning and their home communities and personal characteristics. Universities have professors from various backgrounds. The professor who is facilitating the class, then, they might be able to do their homework and scientist spotlights which has been published in literature that highlight scientists and scientific professional that broadly that are community college graduates who are Black, who are transgendered, who are women, who are new, who have had all sorts of experiences to learning science and not just a parade of White dominant history which is very common in textbooks and presented not because they are trying to endorse it because scientists are taught any other histories, taught any other apprentices to represent their discipline and the diversity of voices that contribute to their discipline. Professor Regina is looking toward educational change some of which are not specific to any one group: she advocates changing teaching and learning to be more inclusive using a “think, pair, share” learning method and interpreting the curriculum.

The biology department has 40% women professors and the first female chairperson in the department. The history department has its first lesbian chairperson, and the biology department’s dean is a woman of color. Professor Regina feels the university has no shortage of female leadership.

The majority of our students are women of color as a matter of fact. So, I think when you look at leave rates, we still have a mass of leave rates but the issue that is more pressing is at our university based on our data is culture and ethnicities. So, if you look at our last 8 years, we have increasing proportions of our graduating student retention among Latino students and which is majority Latina students but our success at retaining African-American/Black students has basically been flat over the last 8 years. In our hands, when we look at our data, the issues are less with gender and more with race, ethnicities, and culture and those sorts of things.

We have an NSF advance grant, and that is modestly active and we have two strong female Provost, including the STEM activist in gender equity in our roster. For this is around gender equity, and I don't use equality and use equity very purposely because it is important to bring attention to who is in the room and bring into inclusion, so, very recently, this would be very helpful to your study, so very recently, I filed a provisional patent on a discovery from my lab, and then I asked the university if they would like to fund the full patent application which is like a multi-thousand dollars kind of the expenditure, and how would I get about getting their decision on that and if they didn't want to do that was fine and I would pay for that. And it was really striking because at this university, we just didn't have a lot of people who do that kind of tech transfer and will be building technology stuff, and so the university wasn't quite sure what to do, so the director of our grants office got together a committee, and had me come in give a presentation and it was first time in long time where I was the only woman in the

room. So, I am standing up and there was like six or seven men sitting around the table, and it was totally fine but I have noticed, and I'm not sure if anybody else noticed. So, one of the things after the patent process was done, I planned on debriefing with my director of the grants office. It is really small stuff like that I think we need to pay attention to, and it doesn't take a grant to say that "hey when I recruit seven people to review the woman professor's patent application, we should probably make sure that we have a diverse set of people in that committee and that you would really think that you have at least one woman and out of seven people and probably have. So, I think that the most important thing that university can have is to keep the conversation going and keep raising awareness. All of us, all of us have blind spot! And fall back in those blind spots, and I have tons of blind spots about tons of issues in equity and inclusion. So, big grants can be some things but I think more importantly is about just setting the culture where we all know from organizational psychology that diverse groups of people come up with solutions to complex problems faster at higher rate. And that's just research, and we need to have that at the ready when we are doing it. And kind of human interaction, and not just solving huge, giant complex problems, but solving problems every day.

But let me just say one thing, because I am quite the activist, that's the first time that's happened to me in this university for 13 years, so once again, I encourage you to think about it, I offer it to as an anecdote because it still happens, and at some level, when you are the person in that situation that doesn't matter if it just happens once in 13 years, but I acknowledge that. At the same time, I just hadn't

had that experience before ever, and so I think that's more kind of that one particular individual doesn't quite have that equity lens sort of flipped on and it wasn't a room full of white men and so there were men of different cultural backgrounds but that's the example that I can pull from the last couple of years and that's rare, super rare! Where we come from place of huge trials of gender equity we have seen trials of micro-aggressions and we still have disproportionate loss of women and we have women who speak less at biology class than men, we have all sorts of gender equity challenges, but at our university that is pretty rare but it happens.

Did You Receive the Patent Funding?

So once again, I think I will be the first person to say that I have been incredibly privileged in my career, whatever set of reasons, they were thrilled to fund the patent and it wasn't an issue so, I think the other colleagues and others had more barriers and walls put up in their careers and for a set of or mostly of luck and some talent and lot of privilege in terms of having learned how to figure out institutions like this and because I was the first generation college going, and yeah, it was just never a question.

The committee called me the other day and said, "of course we are going to fund this," so once again that's why we are literally going in the final version in the next few weeks, and I have learned that if I want to help people become better at their job, (I need to) think about those things and we have to take the time, and so the time it takes to say to my grant directors, "hey, you know for going through

this trials and experience, I would really appreciate plan B," one thing you may want to think about is patent community, so I feel that I have learned a lot over the years from both the students and with colleagues about how you can give people feedback on things that you want them to think about in ways that they could hear them. And right now, it's not the time to do that, but it is on my list, and it will happen. And I sense that it is the reason how we have been able to engage 85 percent of faculty here, because our faculty know that we are on their side and they know that they are going to enter a safe place. They know that they are going to be given strategies that can be tried out and they know that we all expect everybody to mess up like that's not a defect of that's lot like the classroom. So that we cannot treat adult humans any different than sort of semi-adolescent adult humans, certainly not kindergarten humans, they are all humans. So, they all need some of the same things! But somehow that we think that we become the director of the grant office we somehow believe that they don't have any feelings like going in and stopping in and saying "Hey, it really pissed me off that there were no women in that room and how the hell can you do that when you are the director of the grants office?" That is BS and that's not going to help anything! Right? So, I think that's how vitality of each schools and everybody has different approaches so my colleagues are going to say that they are not activist enough and I am a big fan of pragmatism and I know how to get people really change their minds about things and usually being really aggressive doesn't help or be helpful. It took me forever, somebody said that just because somebody said something incorrect doesn't mean that you should go after them, that's what I was

trying to do in grad school, and it took me kind of a long time to kind of figure out how to affect the routine that people are on then, and I'd mess up all the time, I am not saying that I have perfected it but I know some of the rookie mistakes and I would say awful lot of professionals don't, they are just not thoughtful about that and they don't make progress and then they don't understand why. I mean nobody likes to feel like a villain, nobody likes to feel like a horrible person like, that's not going to help anything.

Are you doing anything specifically to promote stem goals in women?

Yeah, I mean sort of my whole lab it's also I'll say once again, if… I've written a book which came out with UCSD press, my colleague titled it "Girls in Science" so what I have learned a which I was talking about, I can get more people to come to the table and do things that will be deeply helpful to women by not necessarily saying it's for women. So, you know I think that by having faculty do more pair discussions in class or have more homework so that if he were to practice, those are the really critical things that are very helpful to women, right, and to connect things and make sure to do an inventory of your syllabus, and like what proportion of the faces are represented in your slides and your readings are women versus men or white people versus peoples of color. So, I think that for me function and having me function on lots of axes of diversity has been critical. And it is why I don't talk so much specifically in terms of gender anymore. And that doesn't mean that there aren't unique things about the interactions that women have absolutely, but at the level I'm trying to get the people to be aware, I don't want them to be competing, I want them to be thinking about including all

students, not just focusing on women or just focusing on disadvantaged students, or focusing on students of color. So, that's a very specific philosophy. And I will say as kind of an aside, I'm in an association for women of science course right now that is, it has a lot of women coming together to figure out how to be entrepreneurs and I'm kind of this is of incompetence, so I would not say this publicly of this, but I'm appalled that what I'm experiencing in women of science organization! All these things that we know about how to help groups work together which you get to know each member of group personally and you set up norms and you have expectations on what, well they just skipped all that because we are all women like this isn't going to be an issue! But you know I feel like that's not the case and so I'm tossed in the group with other women and I can see that some of them are struggling and some of them are all in different action patterns, all perfectly nice peoples but they assume somehow that all women are going to act the same, so I think that I have moved away from some of the gender equity specific organizations because they are not practicing the basics of having all the people included assuming that there are only women involved that's going to solve the problem and it doesn't! So, I got a little bit off track, but what am I doing for university's STEM goals for women, I think that we have a lot of multi-million-dollar grants that help our faculty get smarter about inclusive teaching and I think that's helping our female students. And we are starting to be able to measure that.

So, in your labs, or any educational system that allow women to be able to overcome challenges by being a woman professor leader?

Um, I don't know, and I feel like the university is a very different goal system for example when compared to the tech world. I have colleagues that work in the tech world and they can't get a word wise edge out of meetings and so when they do say something as a woman, then somebody else rephrases it that idea and everybody, you know, ascribes it to the man in the room. Like those stories are very common from my colleagues in the tech field. I don't feel like that I experience that in the university, but awful lot of it is at the vast majority of rooms that I am in at a bubble at a place like my university and its majority women. Right? Or there are very diverse sets of voices, and I think that the biggest problems that we have or one of the bigger problem that I think that would be helpful to you is that women at the university disproportionally do more service than male faculty and that's why the rooms I'm in, like committees and like that are majority women. So, we absolutely have men at the university that don't participate to those things that are not particularly good as advisors and students, they are the 15 percent, they are not in teaching, there's that sort of that 15 percent, at least in biology don't play ball and they don't necessarily pull their weight in the department. They don't focus on research productivity, and tenure production, and they don't really want to pay attention to teaching but they are in a kind of a really small minority now. Um so, in the university, I think is trying to balance out the workload issues around women doing more service, women doing more teaching with the fact that there are people not pulling their weight aren't really invested in these things, and when you put them in a classroom and committee, or you put them in front of students advising, you make everything

worse. So that's a gross generalization. But I think that is one of the challenges that we have in a place like our institution, it's the workload, service, and equity, or advising and equity because many of the, (not all) people who are invested in the issues are women. That's it, we have tons of men who are invested in those issues, even like parental leave issues those are just not specific to women. Like right now, things will shift we just expect that men will take fraternity leave, right? So, to me a lot of the gender equity issues for women professionals are that making sure that we are not just the ones and men are doing just as much as us. So, I think those are the issues in the university, and I just want to acknowledge that they are radically different in the issues in tech! right? Or in business. I'm so sort of dipping my toe into that world, and that is really much less pleasant. I've had guys who calls themselves venture capitalists who are most asinine guys that I've ever had. Is that because they are guys? Well, there was a guy, a man and a woman on that call, or is that just because they are professional culture of venture capital stage and they were trying to be a model? I don't really know but I just want to say that my particular situation in professional environment is not as extreme as the lots of colleagues that I have in different sectors.

Most difficult aspect of your job and how are you working to conquer it?

I think the most difficult aspect of my job is trying to navigate a bunch of different people who are trying to promote inclusion but who are doing it in individual axis and then are frustrated with people who don't value the either axes more. For example, I work with people who are trying to promote gender equity but they get really frustrated when things that I am working on are not on gender.

I have colleagues who are focusing on students of color and get really frustrated when white women bring issues of gender equity to the front of discussion given the extreme situation with students of color in sciences. I have colleagues that premier for them is trying to figure out how to support the gender queer students and transgender students and sexual orientation, and minority students in genetics. This is a landmine for trying to teach genetics and even languages that I taught it myself on this call, interchanging female and women is not acceptable for these gender community for it is a really good reason, right? So, I think the hardest part of my job at my university is people getting frustrated with each other because of the relative focus upon the different aspects of that equity and inclusion. So, that's why our lab has this very where we trying to use very different axes to practice inclusion, so we hear less gender specific stuff out of our lab or hear some cultural specific stuff, so that's really it. So, maybe that's a really weird outlet to this study but I have, I feel like my challenges are about how to help all those leaders many who are women collaborate together to foster change and not sort of compete against each other for their own perspective all of which are critically important, and how do I overcome it? I do a lot of listening, I use a lot of inclusive practices, and then increasingly having conversations with people. Like I mostly put my notes down and it worked and that served me well. Like I would get a lot of money and grants and I really have lots of high profile papers and they are all related to trying to change the seat experience of every student in every biology at least in class but yeah, it's about having much harder conversations than we had before and it's about how people find ways to say, hey yeah, I messed that up and

I really don't see the world that way and doing what I learn from you and we have a whole new center here at our university, that is about fostering that kind of hard conversations and I think that's unfortunately the place where in our country where people are hitting each other with a sticks and they are not trying to have a hard conversations and that's a problem.

Top three things come first in university's stem program?

I think number 1 is trying to have students research experiences and there's just mere in our faculty's mind, it is generally, I think, second in expanding effective in science based in learning that has taken hold in biology and it's now a probably about third of the chemistry department and that physics has hired education researcher so, I think that innovative and inclusive teaching is absolutely in the top three, um, and probably the third is inclusion and diversity more generally like really supporting students who come to our university in being outstanding professionals in their field. So, research, teaching, and inclusion and diversity.

Any improvements that need to be made in the university?

Well, I think we have lots of female professor leaders, where we had a chair of most departments in our college been women the time I've been here, and I think our engineering department and our computer sciences department have the most room for growth so the physical sciences are I think still lag behind biology in the female professor leaders in the departments. I think there has been a huge push on engineering, like I'm not sure if there is a single full professor who is female in engineering. And the profile of the proportion of engineering students follows the

same profile of other places. So, not like Harvey Mudd where they had a major turnaround because I think they have a female engineering leader, so I think there are pockets of places where I think they have variety of crossover into that land as much but the lead Dean here is out of Biology department who thinks very deeply and has been through all of our innovative teaching training and been thoughtful of all I think that things are going to move. I also think that the issues of workload equity are paramount because what happens is female professors do most advising and service, they might have slightly lower publications rates and somebody like points that out during tenure promotion and because it is harder to quantify service, that you can count papers and teaching hours that can flow some people down. So, we have some female professors that are stuck as an associate professor who shouldn't be because they give enormous service to the university um but they have less publications so they do not get advancement so the workload issues are always second piece.

Are there any community building activities or events to increase female leadership?

Yes, I think so, not sure but I think our president had listening conversations regularly where I am going to one next week, um, I think I have conversation with our Provost, our Dean of our graduate studies and Deans, and we meet regularly about how to cultivate some of our younger faculty who are women and people of color conversations about college going and college alums to come cultivate them as leaders but there, it is not very formalized so it is very informal networking of people who have common values, but I think there is definitely one program for

young faculty is specifically geared towards cultivating leaders and that was put into place by our President within the last couple of years. I do think there are some activities like that and they are mostly coming from them, upper administration.

I think asking people, those positions of leadership is super scary and there are lots of unknown like budget issues though I think that encouraging women professors do make risk takers and taking those risks and I think a lot of is cultivating the next generations of leaders because of I think if it is left to who raises the hand to "I want to do this" most of the times, women are going to step back for whatever sets of reasons though I just seen that anecdotally and so it's about cultivating, asking, expecting. It's like having those high expectations in the classroom, of course to be the dean. But I think it's that maybe subtler and less complex than we think. I think it's about promoting people that looks like you and there are many people on this campus because they are very thoughtful about it. It is very similar situation to my patent experience where I don't think the person who organized the meeting it was a mal-intention to the people that he thought of in the committee, or he thought of or people that he thought of happens to have a lot in common with that is often times how interim Deans and interim this and that have happened.

Professor Elizabeth's Experience

Research Questions: What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT? What do STEM professors attribute to their success?

Professor Elizabeth is working in mathematical science research in her institution since 2008, where she holds an administrative position. Her challenges are to ensure her institution gets the funding they need to sustain their research work. Professor Elizabeth is “totally happy” that she chose this position. Before this position, was a full mathematics professor at the University in Arizona. In her occupation, Professor Elizabeth mentioned that her main mission in the institute is to facilitate research in mathematics and to build human capital to make mathematics better understood by the general public. She also mentioned that she is proud that her institution has been around for close to 4 decades, and is a solid institute with a very solid reputation worldwide. Even though the institute is funded through private donations, Professor Elizabeth stated that the short-term mission is to get the funding from the government with extended endowments from private donors for the next 5 years.

> (At first) The institution was funded mostly by the National Science Foundation, and we started to get private donation, from private donation and from private donor, I think since the early 2000, and since then we get around 20 million but we would like to reach more, in the areas of 100 million.

Research Question: In what ways do female STEM professors’ gender identities shape their learning experiences?

Professor Elizabeth works quite hard to include more researchers in mathematics research. In applied mathematics, more women researchers participate in research but women researchers are lacking in other mathematical research fields

> Because the society do a yearly survey in mathematics in terms of women and underrepresented minority, and there are many more women in statistics and applied mathematics than in the fundamental mathematics." She also feels that other research institutions are doing better in including women in to the mathematical research narrative, however, the geographical location has no basis on whether or not more women are represented in one institution from another. In other words, according to professor Elizabeth, there is no indication that being in an institution in California, there is more tolerance or acceptance of women professors' research works. The professors that she works with come to her institution for one-to-three months for research in mathematics and then, goes back to their home institution. Professor Elizabeth also indicated that the most important aspect in terms of success is to achieve excellence in mathematical research and indeed to have full representation of women and minority.

Research Question: To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment?

During the interview, Professor Elizabeth shared that too few women are represented in the higher levels of mathematical research and publishing.

> We are mathematics and papers; that we publish are mathematics research papers, and we are not publishing but the researchers who are doing the research are publishing and we do have a book series and some program and organizers that decide that they would like to have one issue in that book series where in the area that were studied while they were at our institution. The challenges are to be included because we are a very high level of research in mathematics and

> unfortunately as we go up in the ranking for various reasons women drop or women are forgotten. We are there but in a blind spot and therefore, trying to ensure that there is diversity, it is a hard work…one can get very tired of always being the person that has to remind everybody that we have to be careful of using stereotype when we select a member and remind them that this is not correct to think this way and challenge them to go back to organizer and tell them that they are giving us a list of people that are diverse and there are women in the field, and think about it and there are excellent women. Explain to them that we (women) are not compromising on quality and that there are excellent women in underrepresented minority that are doing mathematics and they need to find them. That is very tiring to do that over and over and get pushed back and so on.

Professor Elizabeth shared an experience in which more than 700 people applied for positions; the institution was able to take about 20–30%. People are being rejected for what seems to be the wrong reasons. Another example she shared was the experience of making a list of guest speakers for workshops, and after 5 days of research, lists had only 20 men. She reminded the committee of the importance of diversity in speakers but the names of women were not on the list because the committee did not think about choosing women as guest speakers. The committee members reverted to their natural method of choosing people with whom they needed to work; because they did not know any women in their area of mathematical study, they did not know they needed to invite them. As Professor Elizabeth explained, this is an example of an area in which they did not want to or did not recognize their failing; she asked them to search out women who work in the field to invite them as guest speakers for the 5-day event.

To encouraging diversity, Professor Elizabeth's institution offers two 3-day workshops; one is the *Program for Women* workshop. This program is open to all; speakers are 90% women, creating a network among women in mathematics. Because this workshop is open to men and women, each can see that women are conducting research and are potential speakers for events or potential colleagues for universities and institutions. It is crucial that women receive attention and are visible in mathematical research because the national average for women in graduate schools has dropped below 30%, lower than for the previous 15 years.

The institution also encourages and assists in obtaining positions through the Human Resources Advising Committee when reviewing all applicants who are invited to spend time at the mathematics institute. The committee consists of 10 people from underrepresented minority groups to assist and help professors transition into academic positions doing research work. Committee members are chosen from throughout the United States, and this committee has now existed for more than 25 years. On a rotating term, each group meets on a yearly basis. Administrators discuss who would be a good candidate to invite to replace them.

Research Question: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

Professor Elizabeth said that she believes the dearth of women in mathematics will not have only one solution. Over the years of her experience, she came to understand that problems exist at many levels and women should work to solve the problems at many levels. One problem is that younger women, when they reach developmental age, if they are smart at mathematics are seen as a "geek" or a "nerd," or someone who is not

going to get a boyfriend. Professor Elizabeth identified this social interaction at very young age to be a new phenomenon that she did not experience during her time of adolescence in her country. This points was similar to the discussion with Professor Gloria and Professor Penelope. Professor Elizabeth stated it is important to be critical about who is teaching science or mathematics, and how implicit bias is present, turning away girls more than boys: "And then after that there is so many various step and ways women drop, I fully believe that there is not just one answer for one level, but many various approach at many different levels."

Professor Elizabeth suggested that girls who do maintain their graduate position should consider moving flexibly to various issues in a mathematical career and general academic world. Women need to be strict with publications because fewer publications diminishes the perceptions of her peers. In particular, if a professor is not publishing due to family obligations, the problem is more than merely staying skilled and proficient. Society has to change the way it views women and men differently, changing the mentality as a whole and specifically about publishing.

To motivate young girls and boys, Professor Elizabeth stated society must stop perpetuating the stereotype of saying "Oh, math is not for me" or "I am so bad in math." She also feels it is a complex idea that various levels of planning are needed to tackle the issue of disincentives in mathematics studies. I asked the professor how early educators should start motivating students in mathematics, and what can educators do to keep them in mathematics. Professor Elizabeth stated,

> In your question, to me it implies that we are not motivating them but I think that being interested in mathematic means an intellectual curiosity is there and this

> exists in most children, whether they are male or female. And I think it is there, but I think it is more important for us to not turn them away from the intellectual curiosity and pleasure that is there in most of the children. We should do whatever it takes to interest them, should we be not motivating them in mathematics we need to plan better curriculum.

Professor Sophia's Experience

Research Question: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

Professor Sophia is an assistant professor in the mathematics department of a large university and has been working there for 1 year, contract to continue for her second year. For preparation, she worked on her Ph.D. degree in a prominent east-coast university; after her degree, she was in a postdoctoral position for 2 years outside the United States. According to the professor, her journey took 7 years for her to arrive in San Francisco. She is in a tenure-track position at her university, which requires 50% research and 50% teaching. She is currently teaching two courses per semester and is busy with mentoring responsibilities and supervising master's theses. Her overall sentiment about her job is "really all positive." She especially attributes her positive sentiment to having flexibility in her job. She explained she can teach 3 days of the week and other 2 days she is able to work from home and structure her time to manage her research work.

> The other thing is that the job is quite flexible in sort of that specific set of how I distribute my time between research and teaching so that I distribute nominal my job 50% researching and 50% teaching in practice depending on sort of aspects is

> going on any given time, I have lot of time devoted to my resources in different way and sort of an effective way to sort of make sure that I am actually productive.

Research Questions: In what ways do female STEM professors' gender identities shape their learning experiences? What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT? To what extent do female STEM professors commit themselves to help cultivate women's learning and working environment?

I inquired into Professor Sophia's field of mathematics. In her department are applied mathematicians who look at projects and mathematics to solve real-world problems, statisticians who work on statistics and probabilities, and mathematics educational researchers who focus on how to teach mathematics more effectively. Also, pure mathematicians are those who think about theoretical mathematical problems that are not necessarily intended to solve any real-world problems. An example is a professor who studies geometry and can hypothetically apply geometry to understanding of the world. The professor is more interested in the theoretical aspects of how geometry works; pure mathematics is the field of mathematics that has the fewest female professors: "At least in our department, statistics, women are pretty much balanced, applied math is not that great but depending on application can have an okay balance, but pure math is so far in most universities, is male dominated."

Professor Sophia has been a part of the conversation about the department's goals for hiring during her first year at her university. Her department stated that one of its goals is to hire more female faculty, but has not yet translated that goal into action. The

department is doing reasonably well in attracting students to the mathematics department. The student group known as “Mathematistas” has created a support group for women and other minority groups of students in the mathematics department. Professor Sophia is very proud of the group, and their mission to help organize a lecture series that features distinguished women in mathematics as well as a series of talks by female mathematicians around the world. These events help with outreach to STEM students in the university. Professor Sophia is excited to be involved with the student group and believes it is her obligation as she is the only female faculty member in pure mathematics. She believes in ensuring she is involved in the student-created group and supports students as one of her most important responsibilities.

Research Question: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM graduate program?

When Professor Sophia wanted to ensure departments hire more female faculty, she reflected back to her own mathematics education as a graduate student and discussed her realization of not having a single female mathematics professor.

> I think what we need is to make sure that we are hiring more female faculties. Actually, I originally thought back on my own math education, and I realized that I can’t think of a single time in all my years of college and graduate school and my post doc that I had a female mathematics professor. I think unless, I am misremembering, I think that I may have had a zero-female mathematics professor in my whole career in my mathematic education. Which is kind of crazy to think about which that doesn’t mean that there were no female mathematicians at the university that I was at but there were somehow few enough that I just

didn't happen to have a class with any one of them. And realizing that it is really disheartening and also disheartening that it took me this long to notice that and it didn't stand out to me. Only many years later that I look back and like hey wait a minute, there was something missing in my education. And I do think that it makes a difference, and I think it changes subtly and mostly unconsciously it changes how students view what is possible and what careers are open to them, especially in mathematics. Because I think we build upon something which is hard and so many people don't necessarily think of mathematics as a possible trajectory for them. And if you look at the people you are learning from and they don't look anything like you, then I think they are just ingrained with the idea that it was a whole trajectory. Yeah, so I think that our faculty look a lot more like the students that they are serving so that the students can see something in themselves and the professors can make a huge difference.

Research Questions: What do STEM professors attribute to their success?

And do you have a mission or a vision for the university for now or in the future?

I guess that my broad scale mission really has to do with the way that I teach, I sort of envision mathematics be taught in a way that is really grounded in actual means and experiences of our students at the university, and really try to make sure that it is accessible to all students. But I also see that as a definition to sort of translate beyond teaching and sort of the environment that we build among the faculty so that in the long term, I love to see us build a sort of diverse in hiring faculty so that we could have a community for the mathematical community

among the faculty that is really inspiring to our students and other universities so that we can be a kind of a beacon to other scientific community as to what it can look like.

Do you have a hope or an achievement outcome that will be for the possible changes in the university? Do you have future aspects of other universities?

I say that the long-term vision I have is for the space of mathematics in the university and broader community is to actually represent the world in which we live. I think we are very far from that now but as to long term vision of sort of the equity that I want to achieve will be to have that diversity for among the students and among the faculty.

Do you think your university is going towards that change or think in comparison similar to other universities and colleges?

Um, I would say that my university is far better than average in terms of its commitments to ethnic diversity, I think we have a lot of faculty who are thinking deeply about how to empower students of traditionally underrepresented ethnic backgrounds to pursue mathematics. In terms of gender diversity, we are not doing quite as well. I wouldn't say we are below average, but I would say we are average in that respects, and our faculty has very few female professors and almost none, myself excluded, almost no females in pure mathematics. I think in terms of gender diversity, we got ways to go, but sort of happy to say I think the diversity overall, we have gotten the conversations started.

So, I know that number six (question) is asking what is the most important to you in success for the university, does that include the gender equality?

Yeah! For sure, I think the answers that come to mind to me in terms of that question is mostly empowering our students, but I think the way to do that, one of the important way is to do that is to have a faculty where a student can look to as an example of "who can do mathematics" and right now having a pretty much un-diverse faculty in terms of gender that is a little bit problematic so yeah definitely there's looking forward to the university's future in order to be inspiring to our students, ensuring that we have gender diversity in our faculty is certainly important.

As what part of the educational system, what are some challenges and values that apply to working with the university as a leader?

From my perspective, my challenges aren't really at the university level, not in the experience I had so far, but there are more (challenges) at the departmental level. The math department are the people that I work with on day to day basis. If there is something that we want to achieve in math department, if the department is on board, the change will happen. It is less the university's approval that we need, but more of a consensus among the math department. So, for example when it comes to hiring, we have some faculty members who are really committed to trying to make sure that we interview and hopefully hire people other than the white male mathematicians so we need some kind of gender and ethnic diversity in our faculty. But there are also the other members of the math department that

don’t value that as much. Those who really sort of look at hiring as an opportunity to exclusively to snag the best researcher as possible and so I think that if we can get more consensus among the faculty in the math department to value diversity and hiring more then we can achieve it. I don’t think we need the university’s backing to do that. (we need the department’s consensus). I think that we need more consensus at the department’s level before we can really be successful.

Do you have the most difficult aspect of your job? How can you conquer it?

I think that the most difficult aspect of my job is meeting students where there are, what I mean by that is that I want to challenge and fire my students’ (motivation in math) but often times the different students in classroom have extremely varied levels of preparation. And not all of them necessarily have the background in math courses that you would want that student to have before starting that course. It is respectfully hard when there are other students in class who are in much better preparation who kind of steal the spotlight, so sort of figuring out ways to meet the different students of where they are and serve the varied population in an equitable way is sort of really hard, and the best way that I’ve found to sort of deal with that is to try to spend as much as one-on-one time with the student. Whether that is meeting them during office hours or giving them something to work during class time to walk around to talk to them individually, to finding ways to sort of interact with each student individually is really important for me. And also, to sort of remembering or reminding myself the positive outcome in class is different than positive outcome in each student. To just help them sort of less intimidating in mathematical experience.

Three things important in University's STEM Program?

I had to think about how to answer that question, and I guess it is serving students equitably. Maybe the second thing is supporting faculty scholarship. When I'm thinking about my job to focus on the student focus aspect of it, and one of the university's main focus is to make sure the faculty has the resources to do the research that they want to be doing. (24.47.19) and then you know the first thing is also to building a diverse supportive community which is important both on the student side and the faculty side. Sort of making sure that everyone has the support that they need, and sort of the access to the mathematical opportunity that they want or they need.

Any improvements needed in Female leadership

Yeah, I think the improvements that we need honestly is just to make ethnic explicit priority in hiring to interview more women, I think a way to achieve that is to start the conversation, to just before hiring season rolls around, the university and the department and everyone needs to be having a conversation about explicitly what are our values, and if one of our values is to promote more gender diversity in our department, then we need to decide that that's going to be our priority and make sure or ensure that we are interviewing for the job opening lots of lots of qualifying women. Because if we don't start that conversation, hiring season rolls around where you get a stack of application where tons and tons of impressive qualified men and you sort of forget that you want to express that desire for more diversity, and the next thing you know is that you turn around and

another male faculty member. So, I think definitely getting that conversation started more openly and sooner is more and super important.

Are there leaders in the math department who is a female?

Well, no. somehow there are enough female faculty in our department that we to really achieve that yet, I don't know, I am trying to think of the numbers, maybe across all areas of math we have maybe five female faculty in our department. And three of us are new hires within the last two to three years. And so, we are not in the position yet maybe to take on serious leadership roles so yeah, I think there's among leadership level of faculty, I don't think there's a female leader within our faculty at this point. (changes are happening but at a very slow pace?) Maybe, maybe that's what's happening. Yeah definitely our recent hires have been women, but that's going to take a little while to trickle up to the higher level.

Are there any events or community building events that promote leadership? How did it get started?

I think these are really good questions, and honestly, I don't think I know of such events. I think, I hear a decent amount of that events that are organized to promote diversity among student body, and I think there is a lot of support on that but I don't know of events organized to create diverse number of faculty or leadership level. I think that's a definitely a ____ that should be filled but I don't know of any event going on to that effect now.

What can university level do to address the leadership?

Yeah, I think the university can make sure that we are interviewing more women for positions and I think that it is a conversation that needs to happen before the hiring season rolls around. And so, I could hope that the university can organize a conversation in advance of hiring season say the math department just to sort of guide the conversation, before we start hiring we have talked about how we want the hiring to look and how we are going to make sure of the theoretical priorities and theoretical commitments to make sure diversity, such as how are we going to make sure the actual hiring process that commitment is really valued. I think it will be really useful for our university to organize the conversation and that will be valuable to them.

How can university leaders make sure the equity oriented views?

So, I think that we do some of but we could do more of is to you know talk about the implicit bias more and make sure that maybe the faculty members who aren't so used to speaking about their own implicit bias, you know just to talk to them about how that might affect their hiring decisions and their interactions with their students and everything. Another think also is just the thinking in general of like evaluating more people more holistically on faculty and students. I am thinking about math education where the point was brought up that the different students depending on their background or their level of comfort in their classroom, may sort of communicate their understanding in different ways. Teachers have the obligations to make sure that there are different modes of assessments put in so that student communicating the different mode of communicating the understanding in a different way can, you know like shouting out answers in the

class, or you know explaining answers in writing, so that different students can have different opportunity to show their mastery to their professor. I think that is sort of what we think about our students and definitely it is something that we should be thinking about also when it comes to evaluating our peers. So, that hiring a new professor, you know the typical mode is to just look at someone's research profile and try to hire the person who has written the most research papers. But, I think the part of equity is looking at some person's whole profile understanding that job candidate for example who has made a huge commitment to supporting students and empowering underrepresented students. Like that a professor who has done something like that applying for a job, they might not have a strong profile in research and they might not have had the time and energy to do those things well. If we want to value those things, we need to think more holistically about how we are evaluating those candidates.

And you wouldn't know if the university has taken more accountability to hire more female and retainment?

I don't know of any and I am pretty new to the system, so that may be my ignorance of what's going on. (any changes in maternity leave or changes as part of accountability?)

I know that at our university, the policies of parental leave are totally ungendered and you get the same time away from work, extensions to the tenure clock and things like that regardless whether you are male or female. I don't know of

anything that is specifically put in place for female faculty. I don't know of any changes to that effect.

Professor Stephania's Experience

Research Question: What do STEM professors attribute to their success?

Professor Stephania has worked with the university for over 30 years and overall, has 42 years of experience as a full professor in the department of mathematics. She has lectured and taught students averaging two classes per semester in graduate courses in logic and set theory, upper division courses in algebra, and calculus mathematics for teachers' courses. Thus, she has taught quite a variety of courses. She attributes her accomplishments and successes over the years to a hard-work ethic and dedication to her career. She has been a role model for her students for 4 decades.

Professor Stephania enjoyed observing students learn and apply themselves by solving problems in group activities. She also has a certain vision for how mathematics should be taught, and is a firm believer that students should collaborate in active learning and projects rather than passively learning and sitting through lectures. According to the professor, engaged and active learning is still a work in progress at most universities and has been making slow progress toward the critical-learning process.

Research Question: In what ways do female STEM professors' gender identities shape their learning experiences?

Work Environment

Some challenges Professor Stephania has experienced at the university are that the administrators try to save money by taking cost-saving measures: making huge classes and lecture classes rather than small learning groups. In her university, a pressure

exists to mechanize all learning, and to do as much online learning as possible. This is the antithesis to her vision of creating small learning groups in all mathematics courses that address complex problem-solving techniques. Even though Professor Stephania is proud that her university has risen to the reputation of a leading research university in many fields, still feels more work is needed. Over the 30 years at this university, her university was one of the first, if not the only university at the time to have a women studies department.

Research Questions: What practices facilitated the preparation and persistence of female STEM professors when they were enrolled in the STEM program? What are female STEM professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

She shared her experiences:

> It certainly was always a fight when I came (to the university), there was a nude picture of women in the computer lab where you had to turn in your punch cards where in those days was the only way to work at the computer. That kind of consciousness about helping women feel more at home happened at the time. There was an ad(vertisement) for the physics student party and they had some very attractive scantily dressed women in the ad(vertisement). And I talked to the chair, who said that 'there were more women students than men students and it's was not a problem'. I thought (that) it was a problem. And he didn't see it. And there were more progressive changes in the science department. Being able to feel more at home in the sciences, but I don't think it was totally wonderful. I am thinking (that) they are coming to computer labs and seeing the undressed women

> posters on the wall doesn't make you feel good about being part of this culture for students, and the ad(vertisement) for this student (physics) chapter didn't make them feel at home."

To address the university's STEM goals for women, Professor Stephania averred that the university does not focus so much on women but on increasing and maintaining the number of minority students in the university. Programs used to exist geared toward women that she helped organize. However, for the past 30 years, the transition from women to minority students has occurred because now there are more female graduate students in STEM majors than men. She added that is not the case for engineering majors.

> Certainly, my values at the math department were often different than men in the department. If I pushed for certain things, for example, not having Christmas decorations up because it made Muslims and other minority (non-Christian) members not feel at home, they (men) didn't get it. And I got the feeling that they were saying, 'There she goes again on some ridiculous rant.' So, my values as a woman were different than of those of my male colleagues. That was a challenge.

Professor Stephania has been treated as an equal among her colleagues in her department; however, she attributes her accomplishment mostly to hard work. She said she probably published more than her colleagues, which made it hard for her colleagues to attack her. She also devoted much of her time to the service portion of her university duties, creating a program entitled, *Math Without Fear,* for students who were terrified of mathematics; many of them older women returning to the university. This program

helped them feel more comfortable with mathematics. However, that work/program was disparaged by her male colleagues. Thirty years ago, her male colleagues stated they were “feeling it was beneath their dignity to have such a course.”

One challenge was creating a warm atmosphere for students in the university; toward that end, she believed students needed smaller classes (30 or less). However, the administration consistently advocated pushing up the number. She felt that women, in particular, learned mathematics better in smaller classes where they were able to get to know each other. Over 30 years, this aspect has not improved, and the university moved toward huge classes.

To empower younger mathematicians, the university sponsored an event called *Expanding Your Horizons* for high school and middle school students. This program introduced students to STEM careers, and included fun activities and demonstrations in STEM areas. The program encouraged students to take courses in mathematics and science. An association for women professor met informally for coffee at the university café. A good number of female STEM professors met to discuss social activities to encourage more women to join because very few women served at the time in STEM fields. The association for female professors dissolved over the years, but the STEM event promoting young middle and high school students is still in place and the Girls in STEM Career for high school students continues. Professor Stephania has worked closely with people at Berkeley University and Lawrence Hall of Sciences to promote more girls and women to enter STEM fields since the early 1970s.

Research Question: To what extent do female STEM professors commit themselves to help cultivate women’s learning and working environment?

Professor Stephania stated that the university needed to improve in retaining women in the mathematics department by including students and professors in the conversation, helping them feel comfortable enough to have a sense of belonging. Professor Stephania feels her university has hired more women professors over the years and is attaining higher quality researchers who are well respected in the field of mathematics. However, especially the Math for Teachers area needed to have a place set aside for female professors to relax with refrigerators, microwaves, and comfortable chairs, so they can feel more at home.

> It is a big university and people can make more friends and feel more at home. So, it is nice when these things are set up, and some of the sciences have been setting up similar kinds of places for people to hang out, which I think it would be good to have places for women to feel at home. So, I think they have made some progress. I am not sure what they could do besides, less emphasis on huge classes and online learning, to help women feel more at home.

For a larger educational discourse, Professor Stephania mentioned the university has done well enough in promoting women in the field of mathematics successfully. The department and administration seem to be hiring more female professors so they are no longer such an oddity in the university.

Female Leadership

> Well, I suspect other female professors don't project their research as well as males do. By projecting, (I mean) "LOOK AT WHAT I PROVED…" versus "here is what I proved" um, so they aren't judged to be as high quality as male

> professors often. And therefore, the top ranked universities don't take and hire them (women professors) because they don't see them as good professors or researchers (as males). I don't want to change the way women talk about themselves (women's way of talking about themselves), and I don't want them to become like men, and encourage and go on to hiring committees to take a better, broader look at what good research is.

Professor Stephania stated the department has had no female chair; a position she perceives as a duty to the department. She added there have been female vice presidents during her time at the university but does not perceive administrative roles as comprising leaders. Equity-oriented views projected from university administrators are not favorable, and the kind of affirmative-action goals that have been put in place have worked well, merely indicating that search committees must interview a certain number of women. Unfortunately, it does not mean that they give woman the job, so it does not justify the means.

Overall, she believes that the university and departments are making progress in diversity because more professors are hired and the university has an increasing number of female graduate students. When she started to work at the university more than 30 years ago, the university had no female professors. Women could enter a department when a male colleague got sick and departments and universities had to hire their first female professor because she was the only person available at the time. Now women are present in top universities and the number of women in academic positions has clearly increased.

The professor discussed encouraging more girls to study in STEM majors:

> I think there are lots of research that reason why people drop out of STEM majors is because of poor teaching in STEM subjects. And a lot of it is some of it has been associated with large classes and no active learning… problem solving, the way we teach sciences. The diversity can be achieved!

Summary of Findings According to Research Questions

Research Question 1: To what extent do women stem professors commit themselves to help cultivate women's *learning and working environment?*

The eight female professor participants were dedicated to their scholarly pursuits and worked hard to maintain the best learning atmosphere for all students, especially addressing inclusivity in STEM classes and laboratories. Six of eight professors were also parents who worked diligently to balance their duties and responsibilities at work and home. Two professors either declined to respond if they had children or did not have children. Although the professors have diverse backgrounds and are related by STEM fields, all eight professors were able to attribute their success as a woman leader in a prominent university to positive mentorship and research. The majority of the eight professors also advocated teaching girls from very early ages at home to start thinking about STEM instead of waiting for them to start school.

Clear evidence emerged of university outreach programs for middle school and high school students, and university-sponsored events, groups, and faculty mixers to promote female professor mentorships. However, Professor Gloria mentioned that her position in the university's leadership offered her conferences she was unable to attend for 3 consecutive years due to scheduling conflicts, and Professor Regina expressed that

gender is a secondary problem to race, and cultural issues prevent students from remaining in the biology program at her university.

Seven of eight professors stated their department services 40-60% of female undergraduate students in their program, and acknowledged that at graduate levels, a large number of female students enrolled in department courses. However, Professor Regina tracked the numbers of female students in postdoctorate courses where it falls below the number of men enrolled. This statement from Professor Regina matches the current statistics that female graduate students earn their doctorate but do not go on to obtain a position in a university setting nor do they continue to conduct research in their field.

Stereotypic threats emerged through the interview with Professor Gloria. Parents are dictating and practicing that girls should stay home and learn to cook while their male siblings learn afterschool sports and diversified skills. Professor Gloria shared her experience as a professor and a parent indicating that role modeling must take place at a very young age at home, as also described by Shapiro and Williams (2012). Although a neighbor's daughter displayed a skill in STEM-related classes in high school, her parents chose to keep the daughter learning how to cook and clean the dishes at home while her brother was learning skills in soccer and mathematics. This observation confirms findings by Saucerman and Vasquez (2014), and Shapiro and Williams, that parents can transmit negative stereotypes through anxiety or stress related to teaching or acquiring mathematical skills. According to Professor Regina, professors can also transmit those stereotypic threats to students if professors do not engage in interactive ways to include every student in the classroom. Professors must have professional training to engage all

students. Professors are highly dedicated to their scholarly works and their field of study, but also lack knowledge of how to communicate that valuable knowledge to undergraduate students. She described women feeling angry about treatment at the university, leading to becoming K–12 teachers of science because college science professors "made them feel stupid."

All eight professors had very positive experiences with mentors of both genders. At first, Professor Rosita said no female mentor were available and she had the department chair as her mentor for the first year of employment at her university. However, in her second year, a female professor gained full-time tenure; Professor Rosita was able to keep two mentors with two perspectives. The professors declared their successes resulted from many male mentors who were very positive and supportive during their doctoral studies, postdoctoral work, and tenure. All eight professors related they would not have been able to accomplish their achievements if not for all their mentors and professors, mostly men.

Research Question 2: What are women stem professors in leadership doing differently to shape their learning and working environment in terms of SCCT?

Bandura (1977b) averred that self-efficacy theory expectations can be learned and modified through four processes: when a person witnesses someone being successful at a task, observing role models, perceiving career behaviors, and receiving verbal persuasion for possible career aspirations. Later, Betz and Hackett (1981) expanded Bandura's self-efficacy model to develop a career decision-making self-efficacy model for men and women. In the present study, four female professors discussed the theme of shyness of female candidate applicants: Professors Penelope, Rosita, Ophelia, and Regina

specifically mentioned the need to empower female applicants, helping them through conferences, meetings, and informal gatherings to learn how to advocate for themselves. The four professors used expressions like “need to negotiate better,” “be more aggressive in bargaining,” and “change the wordings used on the application,” when compared to applications completed by male candidates. The four professors shared that female candidates were far more shy and cautious in their word usage and language compared to men. Their answers differed from those of men in expressing confidence in their publications and accomplishments; female applicants used language that was more subtle, modest, and polite. Professor Rosita used the word “confidence” to point out that men exert grater confidence when applying for positions, and Professor Elizabeth contributed that women need to learn how to be uncompromising in research and integrity.

All eight professors were involved in research, proposal writing, teaching, and service, in addition to the external duties of maintaining a family or holding outreach programs promoting STEM goals for students. One professor was retired and came back to teach at the university to connect high school students to the university STEM program. Although she chose not to have a family of her own, she has been teaching in the university for more than 40 years and continues to provide networks for students in STEM programs as she teaches courses at the university and at the high school after-school program.

Professors took positions as equity advisor, department chairperson, student-organization leader, department hiring-committee member, graduate-admissions committee, leading journal editor, graduate-student advisor, and many others. The

professors are exemplary and courageous leaders in their work and accomplishments, serving the community in a public role, modeling for women in prominent universities in the greater Bay Area. All eight professors demonstrated the ability to balance their personal and professional responsibilities successfully, and all shared their means of coping and handling their busy schedules: making post-it walls, creating lists, and relying on the help and support provided by their university and department by relying on mentors, colleagues, administrative staff, associates, and grant/proposal-writing assistants. As described in the literature, the professors were able to learn from and connect with mentors and have valuable networks in place provided by their departments or universities to successfully navigate the stressful and challenging environment of researching, educating, and servicing the public.

Research Question 3: What practices facilitated the preparation and persistence of women stem professors when they were enrolled in the STEM graduate program?

As noted in McEwen's (2013) study, all eight professors found mentorship to be the key to their perseverance and continuance in their STEM graduate program. Professors Rosita, Ophelia, and Regina had no intention of becoming a professor in an academic setting when they started undergraduate studies. The three professors had mentors who inspired, modeled, and empowered them to become academicians. Consistent with my earlier pilot and survey research report on the Experiences of Persistence and Factors of Motivation for Female STEM Professionals, the eight professors revealed that throughout graduate studies and postdoctoral programs, male mentors, colleagues, and professors have been instrumental in their successes in degree attainment or career programs. The qualitative interviews matched answers from the

survey report of STEM professionals. Survey pilot-study participants were professionals employed in prolific STEM organizations and institutions in New York and California.

McEwen (2013) declared that female professionals and academicians in Sweden were successful in their endeavors and careers in STEM due to their familial male role models. In this qualitative research study, all eight participants had more male mentors than female mentors; those of both genders were successful in advocating and continuing their goals of acquiring and obtaining doctorate and professorial levels. Fewer female role models and mentors may have been because when the professors were receiving their degrees, few women occupied STEM professor or leadership positions.

Professors Gloria and Stephania confided they experienced sexual harassment and work-place discrimination. When Professor Gloria was working as the only woman mathematics professor in her department during the 1970s and 2005, a photo of a nude girl was posted in the laboratory. Professor Gloria shared that when she had applied for a corporate position, interviewed by the head of Samsung Corporation, she addressed prejudice and discrimination for being a foreign female with ambition. However, all eight professors responded very positively about experiences in STEM graduate and postdoctoral programs.

Research Question 4: In what ways do female STEM professors' gender identities shape their learning experiences?

Throughout the eight interviews, professor participants responded with percentages of female faculty members in their departments, ranging from 10 to 50% of total professors. The professors who responded with 10 to 20% of female professors in their departments commented they "felt lonely at times" and sometimes "reached out to

women professors from other departments" in the university for support. Another professor commented she felt very privileged when she is the only female voice and everybody paid attention when she spoke in public during functions and departmental events. Here, perspective is very important in understanding the perceptions of female professors in academia. As increasing numbers of women occupy positions in universities, it is crucial to document and understand the constant transformation of their position in society, as discussed in Hayes and Flannery's (2000) study.

As noted by the Bates and Norton (2002) study of barriers to adult female learners, the four professors noted that the self-efficacy model is helpful as is the social cognitive career theory of observing the mentor to know how to overcome barriers that hinder female doctorate applicants from successfully obtaining positions in the university. The four professors said female applicants are more likely to lack confidence due to their nature of selecting or choosing words that seem shy or demure. This issue poses an emotional and personal struggle that can affect the outcome at the professional level. A woman must sound and write in a more masculine style to compete for positions. With a good mentor, she will know the empowered feeling of being able to use a more masculine style to gain employment.

Research Question 5: What do STEM professors attribute to their success?

This research study revealed that professors attributed their successes to parents, mentors, graduate-program and university structures, and supports. The professors' answers aligned with those in a study by Krumboltz (1979): because since rests on critical and defining life experiences that shape career decision making, four major variables genetic endowments, environmental influences, learned experiences, and task-

oriented skill sets. Many of the eight professors related that they had no aspirations or desire to become university professors at first; yet, they persevered and diligently studied and worked to attain their goals, just as Bandura (year) and Betz and Hackett (1981) explored career decision-making self-efficacy among men and women. Significant differentiation by gender took place in occupations of the past, when women worked in dental support, as secretaries, and taught children. Women viewed themselves as incapable of performing tasks associated with drafting, engineering, mathematics, or other male-dominated occupations, regardless of their advanced skills in mathematics and English. This research study suggests that these eight professors evidence the change that women can accomplish and establish themselves in STEM work environments. Women need the courage to communicate distinctly and clearly and have an effective guide and mentor to consider the individual and social factors of setting goals and taking actions to increase career self-efficacy and outcome expectations.

CHAPTER V:

SUMMARY, DISCUSSION, REFLECTIONS, RECOMMENDATIONS, AND CONCLUSION

Summary

Chapter 4 portrayed the stories of eight female professors, contributing to the research literature on the representation of female professors in university STEM programs (Brown-Glaude, 2009; Buschor et al., 2014; De Welde et al., 2010; Dugan et al.. 2013; Levin, 2005). Their stories provide narratives of the dominant discourse about female professor leaders in STEM fields in universities. Like much of the literature on women in STEM fields in higher education focused on the narratives of resilience, the stories of these participants illuminated and explained the models and offered stories of triumph, resilience, and success. Using the geographical advantage and community of professors from top rated and highly distinguished universities near Silicon Valley, the researcher showed how the theoretical framework to analyze the data showed participants navigated their academic and professional careers in the STEM programs and fields. Periodically referring back to the themes presented in the literature, there were numbers of common and significant findings of the individual experience from the female professors that build on the theories to explain some reasons behind the gap. In this chapter, the researcher presents the following: (a) the emergent themes and how they relate to scholarly literature, (b) reflections on the research process and survey methods study, (c) participant recommendations, (d) my recommendations for future research, practice, and policy, and (e) a conclusion.

Discussion

Themes from Interviews

Below are the major themes that emerged from the interviews:

- Participation in postdoctoral studies was paramount in STEM-research and academic-career success.
- Mentorship is of principal importance in the motivation and influence to maintain STEM academic careers.
- Male professors, male mentors, male colleagues, and male associates contribute to a positive and supportive work/study atmosphere to sustain and encourage women pursuing faculty/academic positions.
- The paradigm has shifted considerably from the past 4 decades in STEM female professors' workplace in sheer participation and work environment.
- Research, teaching, and service are the three pillars of university professors' responsibilities. Junior level or tenure-track professors feel challenged but gratified with the experience of working in a university setting.
- Outreach programs to motivate girls in STEM studies need to start even earlier than middle or high school.
- All participants attributed their success to their families.

Post doctorate Studies

Four participants expressed that their involvement in postdoctoral studies positively impacted their academic research and career success. Professor Regina's mentor had a profound influence on her and her perspective about learning in science and teaching science in K–12 school settings. Male and female mentors substantially helped

and supported her studies at the University of California San Francisco and Stanford. She was grateful for the opportunities in her path to earning her doctorate and participating in a successful postdoctoral program due to those who provided support. Therefore, she is dedicated and devoted to working with graduate and postdoctoral students. Postdoctoral students may become assistant-professors or directors of centers of teaching, and learning ways to become research faculty. This finding is resonant with the Bandura's theory of belief individuals have about performing a particular task that leads to a specific goal with the expectation of reaching or changing the goal (Bandura, 1986).

Professor Sophia decided to pursue the study of pure mathematics. She completed her postdoctoral-studies program in Switzerland for 2 years before returning to the United States. Her post doctorate experiences led her to more possibilities for jobs because she was able to work with distinguished professors in Switzerland. According to Professor Rosita, post doctorate program scientists working with her realized many aspects of projects related to NSF and NASA. Therefore, postdoctoral programs serve as a gateway to experience and opportunities to work on impactful research projects with people from around the world and many universities. Professor Gloria had also mentioned that she would have been more connected and tuned into her university if she had been hired directly following her postdoctoral program. She outlined the benefits of being connected with postdoctoral programs and with a prospective university for employment.

Mentorship and Motivation

Every participant mentioned the words "mentor" and "mentorship" multiple times during the interviews. All credited the valuable mentors they had throughout their undergraduate, graduate, and post doctorate program years as paramount and influential

in their academic and professorial success. The professors all spoke quite affectionately of their mentors, some of whom they continue to work with regularly. The participants all spoke with admiration and respect about their mentors in universities across the United States and Europe, where some completed their postdoctoral studies. Participants explained how important mentorship was for them, providing leaders and role models at various stages of their academic studies and careers. Professors Penelope, Rosita, and Gloria credited mentors with encouraging them through the difficult years of graduate studies, their postdoctoral programs, and starting a family, helping them when in difficult transitions or adjusting to a new lifestyle. All three participants credited their mentors for their success through their academic degree and employment prospects. To complement the responses, Gilmer, Tansel, and Hughes-Miller's (2014) study on alliances with other women in STEM found that the professors collaborated and understood each other's issues in life and work and shared certain sensitivities to those issues through mentoring, networking, and leadership programs about the meaning of being academic women in STEM fields. They were able to network and share the challenges they faced inside and outside their departments and colleges (Gilmer et al., 2014). Having a supportive environment to complete their task or goal allows the participant to accomplish their goal with efficacy since there is a belief that the individual's mentor may have about performing a particular task that leads to a specific goal with the expectation of reaching or changing the goal (Bandura, 1986). Individuals may have low self-efficacy or high self-efficacy, depending on the experience related to a specific task. If the experience was positive, a person's beliefs about accomplishing a task will be high or the person will be encouraged to pursue the task. If the experience was negative, then the expected outcome

will be discouragement. Throughout this research study, the researcher was able to hear and document the positive influence that the participants have experienced while under the tutelage of very supportive mentors.

Male Academicians Contribute Toward Positive Support in STEM Academic Careers

Most of Professor Penelope's mentors were male professors, colleagues, and associates because most members of the department are men. She talks to many people and is also known to be an aggressive advice seeker, especially from those mentors. She talks to her mentors about her family and university-related issues and seeks advice on research writing.

Professor Rosita's mentors are mostly men, who comprise the majority of her department. However, the dean of her school is female and plays a major role in helping her learn leadership skills and provide role modeling, presenting a very powerful female administrative example. Although the dean was not her academic-career mentor, she helped Professor Rosita gain motivation to pursue her work with enthusiasm and positive motivation. Having a mentor of the same gender who was an authority figure with power had a marked influence on Professor Rosita.

Professor Ophelia mentioned that, in 11years of working at the university, she has witnessed the hiring of more women. When she was hired, she was the first woman professor in the department; now 50% of the professors in her department are women. Her university has an impactful mentorship program that encourages and motivates female professors in computer science to remain and thrive in their academic research, teaching, and service to the university.

Professor Gloria feels mentorship is important because students of all genders need to be represented by faculty members with whom they can identify and connect. To accurately represent the community that they serve, her university needs to reach out to the surrounding diverse population, especially in materials science. Mentorship cannot even be addressed in importance until the university also addresses the issue of admitting more female undergraduate students, presently at 20% of the undergraduate population studying materials science at her university.

Professor Regina was most enthusiastic and passionate about describing her mentors of all genders. Her most important professional mentor is a lesbian woman who trained as an elementary school educator. She warns universities must be sensitive to how they address gender, not only with faculty but also students of all diverse backgrounds. Most of her mentors were White men who took chances on her abilities to train and teach her about laboratory work, with patience and understanding to help her through all the years of academic pursuit in science. She feels compelled to exert same influence, dedication, and devotion to graduate and postdoctoral students as a mentor, regardless of gender.

Professor Elizabeth has the male head of the department as her mentor. The high level of research in mathematics is of prime importance and most critical to her institution; therefore, it is very stressful environment where she needs to rely on and work closely with her mentor. Because most research applicants are men, Professor Elizabeth feels the pressure and necessity to remind everyone that they need to avoid stereotypes and accept more women into the discussion.

The department of Pure Math has fewer women than the departments of Math Education, Statistics, and Applied Mathematics, which each have a good population of women. Pure Math is, by far in most universities, male dominated, and she relied on male role models and male mentors who supported and motivated her to persevere and challenge herself to become a professor in the field. Professors Sophia and Stephania believe student-centered curriculum is the best way to motivate students to learn and access mathematics at a critical learning level. They advocate for providing a variety of learning techniques and structures for teaching mathematics and believes students should not be taught only in lecture halls or using one-way communication way.

> Professor Stephania witnessed a dramatic change in the mathematics department where when she started 30 years ago, mostly occupied by men. She had to resist and stand her ground as the only woman, eventually becoming one of a few female professors in her department. Like Professors Penelope, Rosita, Regina, Elizabeth, and Sophia, Professor Stephania's mentors were mostly men, which was challenging for her 30 years ago when the mathematics computer laboratories were filled with male professors and students who accepted undressed women posters on the wall. However, she was able to speak up and make changes as soon as she earned tenure and has made revolutionary changes in the department for the past 30 years. Most faculty members are progressive toward mathematics education, and now the departments has more female faculty than male. She had male and female mentors. The survey-method was applied to an earlier research by the same researcher, where the findings from earlier research using quantitative methods seem to match the findings of the qualitative findings of the different population in the same geographical location of the study. The sampling plan and rationale are to follow:
>
> The sample of female participants in the study was from well-known technology companies and engineering firms located in the Northern California area.

> The anticipated sample size for the survey was about 30 female STEM professionals. For the procedures for selecting participants in quantitative data using the survey, the survey was distributed to female STEM professional in a convenience sample where similar to an explanatory sequential design, the quantitative and qualitative will use the same sample, and two groups of participants will have an unequal sample sizes, and to attract female STEM professionals to interview.
>
> The purpose of sampling in this study is to gather information to describe a set of people in specific geographical region where the study can be applied for educational purposes with limited risk of creating any biases or skewed views.

The responses from all eight women professors align with the results from the survey-method study completed earlier, especially in answering questions about male peers in STEM studies in the university setting.

Results of Survey Questions

Following are two examples of the findings from the survey: "I have strong support from my peers, and I have strong support from male peers in college." "Consistent with male co-workers' support at work." As shown in Figure 1, the response rate was $N = 31$ where the $M = 2.35$ and $SD = 0.86$. This finding is interesting because the sample, in responding to the statement, "I had strong support from my male peers in college" had a response rate of $n = 31$ where the $M = 2.55$ and $SD = 1.01$.

Whether through surveys or qualitative in-depth interviews, male colleagues and mentors provided clear support and encouragement for female members of academia. The survey showed results heavily in Strongly Agree to Agree on the 7-point Likert-type scale, as well as responses collected about male mentors, male professors, male colleagues, and male associates of female professors who are beneficial allies to increasing the number of female professors in academia.

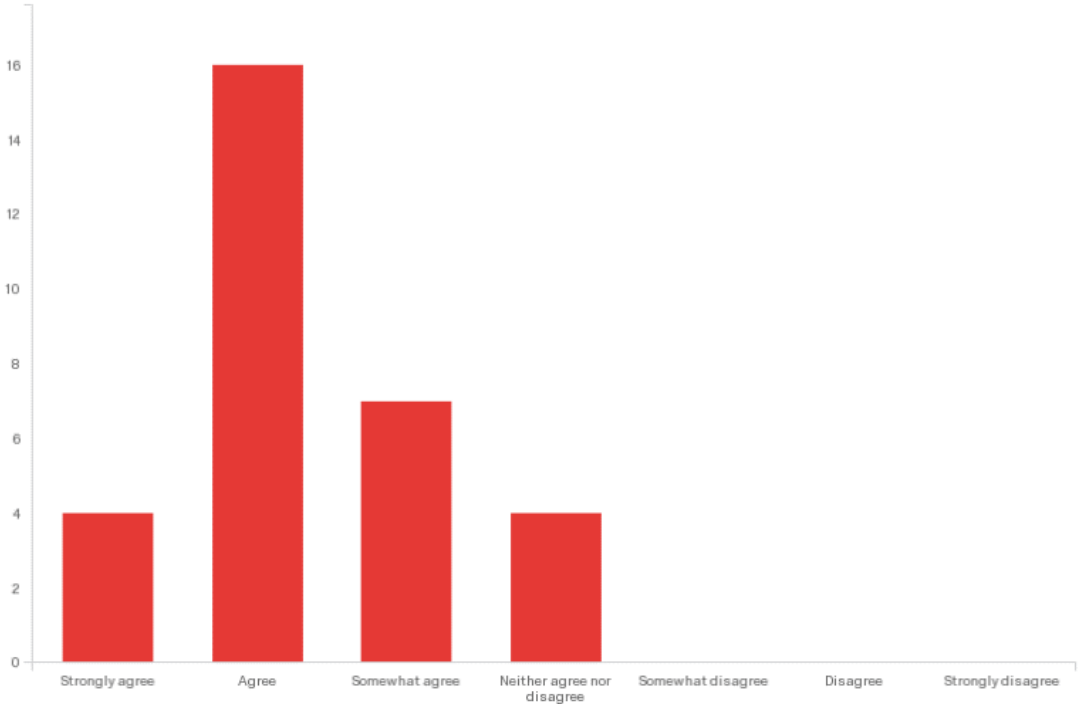

Figure 1. I have strong support from my male coworkers (*SD* = 0.86).

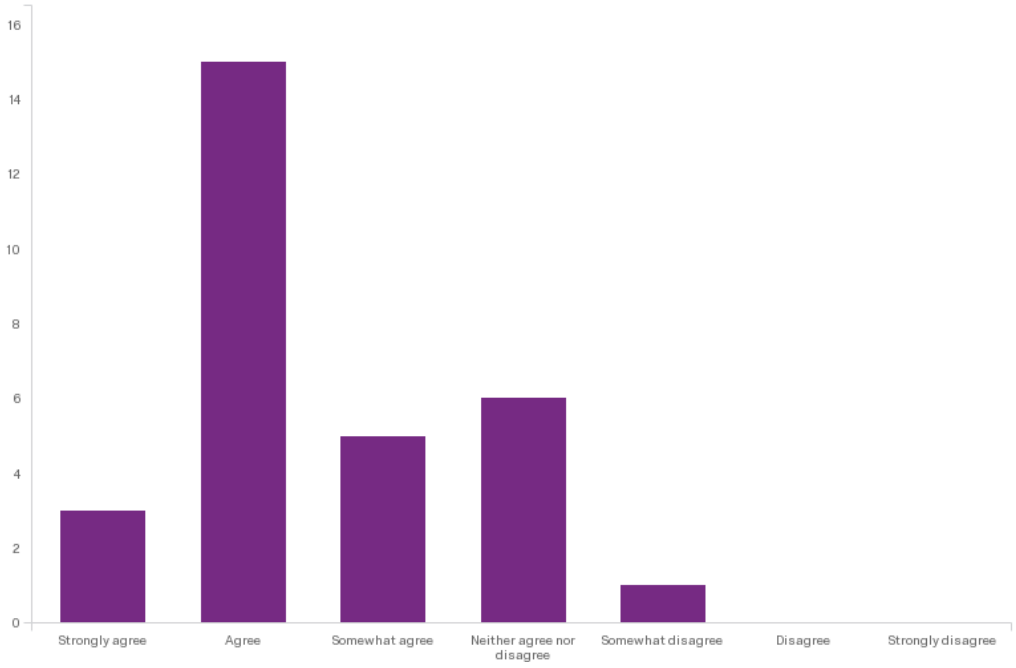

Figure 2. I had strong support from my male peers in college (*SD* = 1.01).

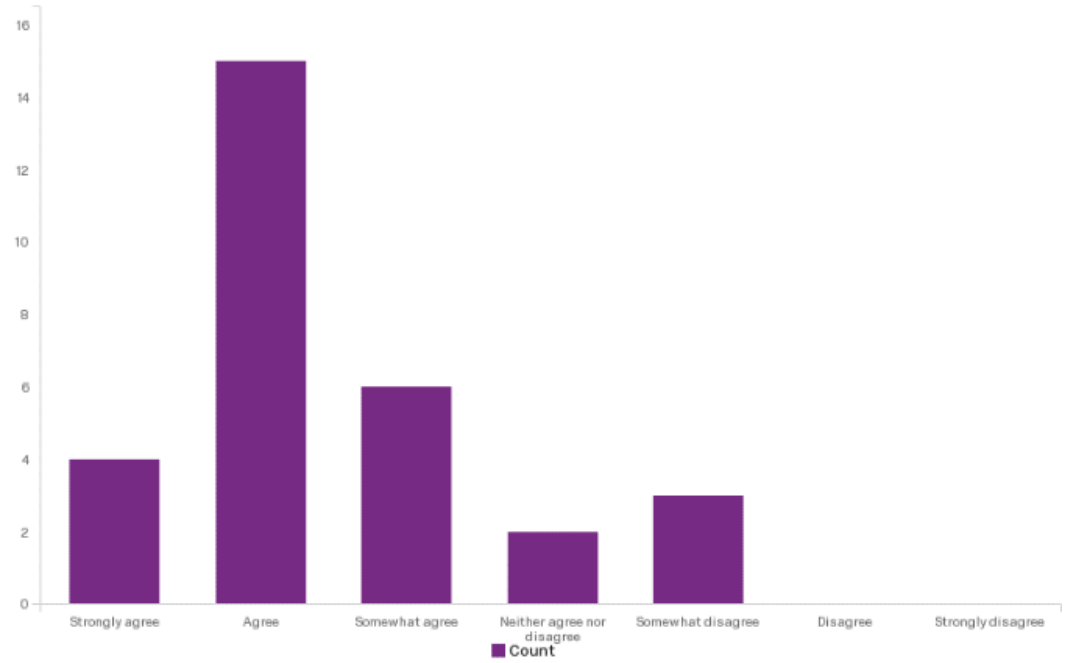

Figure 3. I have strong support from my male peers (*SD* = 1.13).

Paradigm Shift

The paradigm has shifted considerably from the past 4 decades in the numbers of STEM female professors in participation and work environment. All of the professors were enthusiastic about the future of female academics in STEM fields in their universities. Seven of eight professors had positive responses when asked for their sentiments about their work place, ranging from “I love my job!” to “I am so happy and fortunate to be doing what I am doing!” Those professors all have experiences ranging from 5 to 30 years of work and research experience.

However, in contrast, one professor, Professor Penelope, did not have the enthusiastic response of the other female professors. Professor Penelope said her feelings are “neutral” about her work; she has just been appointed to a professor position a year and a half ago. She also recently relocated to an adjoining city to accommodate her

growing family. Her response may have been attributed to the major changes and adjustments in her life.

In the years the seven professors have served in the university, the number of female professors has increased steadily but slowly. However, Professors Stephania, Regina, Gloria, and Rosita mentioned that the focus is less on women and girls entering STEM programs. Rather, the program is more geared toward increasing minority and underrepresented populations' participation in the university.

Three Pillars

Research, teaching, and service are the three pillars of a university professor's responsibilities. Junior level or tenure-track professors feel challenged but gratified with the experience of working in a university setting. Professors Ophelia and Regina chose not to comment on personal responsibilities for dependents, but Professors Penelope, Rosita, and Gloria declared they are mothers as well as professors, whereas Professors Elizabeth and Sophia hinted about family obligations and maternity leave in the interview conversation. Professor Stephania is the only female professor who declared she did not have any children by choice, dedicating herself to her profession of teaching and research for 42 years.

Professors Penelope, Rosita, and Gloria clearly stated that their respective universities practiced "top notch" and "cutting edge" research as of prime importance and teaching as secondary. In contrast, Professor Ophelia declared the importance of service to the university through teaching, community involvement, and mission. Professors Penelope, Rosita, Gloria, and Sophia mentioned they are tenure-track professors who have junior status in their department. Professors Penelope and Rosita are working hard

to achieve tenure position and feel the pressure of not participating fully as a female professor until they have gained tenure. Professors Gloria and Sophia are overwhelmed and working to obtain funding to support graduate and postdoctoral students; therefore, they do not see too many opportunities to voice their opinions or have much say. However, through their networks of leadership groups and forums, they perceive an outlet to discuss their roles at the university.

Early Outreach to STEM

All professors believed outreach programs to motivate girls into STEM studies needs to start even earlier than middle or high school. Most adamantly, Professors Stephania, Gloria, Regina, Elizabeth, Rosita, and Ophelia stated that STEM education begins at home and at an earlier stage than middle or high school. The professors believe STEM education should begin in elementary school with classes in science, mathematics, reading, and writing, using technology. More importantly, Professor Stephania wanted to encourage more girls to go into STEM majors. She stated,

> there are lots of research that reason why people drop out of STEM majors is because of *poor teaching* in STEM subjects. And a lot of is some of it has been associated with large classes (class size) and no active learning, problem solving, the way we teach sciences. The diversity can be achieved.

Family

All participants attributed their success to their families, and all told stories about how their families instilled in them the value of perseverance, hard work, and the importance of education. Some mentors were viewed as extended family members because female professors have worked together for so long with them and have kept in

touch over the years. Every participant lovingly shared the influential support they received from their families, and many were motivated by positive associations with their studies and department as a sign of overall positive direction for academia.

Summary of Interviews

The seven themes that emerged in the research study were (a) Postdoctorate studies; (b) Mentorship and motivation,;(c) Male professors, male mentors, male colleagues, male associates, and positivity; (d) The paradigm shift; (e) Three pillars; and (f) Earlier outreach to the STEM family.

1. Post doctorate studies: Participants mentioned networking at the post doctorate level was paramount in STEM research and academic-career success. Participants added that they gained leadership and collaborative skills that they have taken into their academic careers that have been quite valuable.
2. Mentorship and motivation: Participants unanimously averred that mentorship is of principal importance in the motivation and influence to maintain STEM academic careers.
3. Male academicians and positive atmosphere: Male professors, male mentors, male colleagues, and male associates contributed to a positive and supportive work/study atmosphere, allowing participants to sustain themselves and providing encouragement to pursue faculty/academic positions.
4. Paradigm shift: Over the last 40 years, participants served as a testament to ever-changing STEM fields in universities. The paradigm has shifted considerably in professors' workplace in participation and work environment.

5. Research, teaching, and service are the three pillars of the university professor's responsibilities. Junior level or tenure-track professors feel challenged but gratified with the experience of working in a university setting.
6. All professors thought an outreach program to motivate girls into STEM studies needs to start even earlier than middle or high school.
7. All participants attributed their success to their families and stated their families were a huge source of support during their academic and career endeavors.

Reflections

Research Process

Although female professors have indeed gained a footing in job positions in various competitive universities, the professors are still silenced or muted in addressing slow-moving equality in the workplace setting and hiring process. It was clearly evident that female professors sensed pressure from years of being junior professors rather than senior professors. Of those who responded to my request for interview, junior professors look forward to obtaining tenure; senior-level professors either did not respond to my request for an interview or delegated and referred the request to a colleague or other associate. Timing also played a role in the lack of response to the invitation because the months of May through August are prime time for professors to be away from campus for vacation or seminar assignments.

Survey Method Research Group

The overall idea for this research study started when taking methodology, statistics, and survey in research courses. The necessary and compulsory components of

those three courses culminated in writing the first three chapters of this dissertation and presenting survey results. From the surveys collected, I identified far-reaching agreement that women view male colleagues and associates to be supportive in their work and in the STEM environment. Yet, a discrepancy remained when the question asked about gender discrimination at work and at college. I wanted to study the research questions further by conducting a qualitative study as well. The strength of the survey pilot test were that the survey-instrument statements are of a good length, as well as clear and concise. The survey took only few minutes to complete and by using Qualtrics software, the survey was easily accessible through most technical/hand-held devices. The weaknesses of the survey instrument were that some questions needed revision. With a minimal risk of bias, nonresponses averaged 2–3 missing responses per question. The lowest response rate was 29 of 33 possible, and the highest 31 response count was reported by the Qualtrics online survey software program.

The piloted explanatory mixed-methods survey's purpose was to investigate the lived experiences of female professionals and identify factors that influenced the extent to which female STEM professionals persist in the Silicon Valley and the Greater Bay Area. General trends identified through an initial quantitative survey process were to be explained through in-depth interviews with female STEM professionals.

The study was created to focus on two main research questions:

1. What motivates and hinders female professionals to participate in seeking employment in the STEM program?
2. What are the factors that facilitate the preparation and persistence of the female professionals while enrolled in the STEM graduate school program?

Recommendations

Participants' Recommendations

The powerful stories that emerged from participants allowed their voices to be heard. I am extremely humbled to have been given the honor to share them. These encounters are valuable and insightful stories, helping to women all around the world who want to achieve their goals in life. They help inform how professors think about recruitment and retention practices for female doctorates in STEM. The following are recommendations from participants about what institutions and universities can do better to retain students and female professors in STEM programs. Following their recommendations, I offer my own.

Professor Penelope

> We need to encourage more high school students to the university's campus and motivate them to attend conferences. When I go to conference, I would invite students and walk with high school students. I am involved with outreach program and once I had a baby, I had to move very far away from the university. I used to be more involved before (in the outreach program) the baby, and I used to do an outreach in the teaching level but not in the planning level, and in terms of maternity leave, understanding with family concerns is important since I still feel like women should have more support where it was only 6 weeks of leave is allowed which is not enough and we can push for more time generally not sufficient time for a leave.

Professor Rosita

That it was more about having a role model that gave professor Rosita the empowerment to believe that "you can have work (career) like that (and) you can do it your way. Being a woman without compromising who you are, and that's something that encouraged me to go ahead and go forth with this career path. At a younger ages, I know you just have to do with what will work and so I got my doctorate at a mid-west university with a male mentor who was wonderful and I loved him (as my mentor) and he's great and I had kids during my doctorate, and he was very supportive of that and I would not have been able to do that balance without his support and at a very prominent university, I did a postdoc with a first female advisor, and the only woman mentor that I have had at the time, at that level. And so, she was the woman that I saw her doing her work at Caltech, and I said "that is how I want to do my work too!" so that is who influenced me.

Professor Ophelia

And I think that having role models, and having women in the classroom, I've had a student say, 'oh yeah, my first three computing classes were all taught by women' that's remarkable, and that's really remarkable in terms of how computer science is taught nationwide. So being able to model that and being able to have students sit in the classroom and have female role models teaching the class, you know their first two or three computer science classes, is quite an achievement. You know that not all students have that experience but depending on which section and placed into whatever but the fact that most of our students have

female professor in their first computer science classes is pretty remarkable. And you know just continuing to project that attitude in the classroom, keeping students aware the fact that everyone has to be respectful of everyone else so everyone's voice can be heard. you know just because a male student has done some programming or does it mean that they are actually going to do better in class than a female student who has never programmed before … and so I think that we are doing a good job at this university and I think that we have sort of the right structures in place and right now our biggest challenge is just dealing with growth and with students who don't know what they are getting themselves into when they come to computer science. But in terms of issues of equity and so forth we are in right track.

Professor Gloria

I met prejudice but also, I had an amazing opportunity because if you are the only woman at a conference and you go off and start giving a talk, everybody is going to wake up just because you are different. And you get an opportunity to be different, and you should embrace that as well. Occasionally, yes, it does bring prejudice but they will be men but other women will be thinking that you are doing the wrong thing and you are not home with your kids or you are unsuited for what you are doing and you are never going to be successful in, and it is hard and painful but life is hard and painful. So, I think all we can do is share our experiences with each other and be strong and be sort of build our strength and these things whether they are equity base, inclusion base, climate base, or what they are, and I think specifically the young children, young girls, and people

coming from financially challenged families, and how do we support them? That is sort of a difficulty and increase the pipeline issue. Because, I think once they get to college, I do think that most women are really trying to support them and there's no student that gets turned away, if they rely on and need any help from home, I don't know what I am doing here, we really try to help. But it's getting them here, that's the hard part.

Professor Regina

According to Professor Regina, first-generation college-going students and students of diverse background are of chief importance and gender is secondary in priority. She has been involved in many private and multi-million-dollar grants to bring women of color scientists to come in contact with young or middle school girls of color. She has written books about gender equity in science and education but believes gender is one of many axes of equity and inclusion, but is a complex issue because the vast majority of students will have left the discipline in 4 to 6 years due to feeling excluded from classrooms. Gender is one kind of identity by which students can feel excluded from classrooms and although gender is not the most prominent issue, it clearly continues to be a problem, even in the field of biology. Professor Regina believes every class session, every laboratory meeting, every faculty meeting, and every seminar should use an interactive method, perhaps beginning with formal introductions.

Did you have mentors in both gender during your graduate and undergraduate study experiences?

> I think that you know my critical mentors span a whole variety of backgrounds, my most important professional mentor is a lesbian woman who was really involved in lots of gender directly and she was trained as an elementary school educator. Her relationships with gender is really complex so gender is not sort of singular thing, we are living in an interesting era, and I don't really fit the (how shall we say) societal norm of woman in the sense of you know we have transgender folks who put on make-up and put on heels and I don't do any of this so it's an interesting time to think about gender. So, legal thought about gender is a very deep way, so I had really important mentors all throughout my career who were males, that are white males so I wouldn't be where I am today if it weren't for my white male mentor who took a chance and invited me to his lab when I was an undergrad and another white male mentor who was incredibly patient and supportive mentor for me entirely through graduate school, so I think that I have been able to find mentors in lots of different places, and I think I see that for my students as well. So, I am not sure if that answers your questions.

Professor Regina stated that if educators successfully teach science, then as soon as students walk into a classroom, they will see a connection between learning in their home communities and their personal characteristics. Thus, universities will have professors from different backgrounds. Professor who is facilitating the class, then they might be able to do their homework and scientist spotlights which has been published in literature that highlight scientists and scientific professional that broadly that are community college graduates who are Black, who are transgendered, who are women, who are new, who have had all sorts of experiences to learning science and not just a

parade of White dominant history which is very common in textbooks and presented not because they are trying to endorse it because scientists are taught any other histories, taught any other apprentices to represent their discipline and the diversity of voices that contribute to their discipline. Professors seek educational change that is not specific to any one group, changing teaching and learning broadly to be more inclusive, perhaps using a "think, pair, share" learning method and interpreting the curriculum and how it is represented.

Professor Elizabeth

> I don't think that there is only one solution, what I came to understand over the years that I have been here, there are many problems at many levels. We should work at many levels at the same time rather than work only one level, and think that there is one problem, and that therefore only one solution. There is a problem for the younger women and when they reach the age the mathematics has developed and if you are smart at doing mathematics, then you are seen as a geek or as a nerd, or someone who is not going to get a boyfriend, so this seems to be something new and I did not see this in my time, and the social interaction at very young age is important. Also at university, it is important to think about who is teaching the science or mathematics how the implicit bias is really present and make them turn away girls more than the boys and then after that there is so many various step and ways women drop, I fully believe that there is not just one answer for one level, but many various approach at many different levels.
>
> Those girls who do push through, how do we retain and keep them in the academia? Again, by many ways, we move flexibly to family issues, to also in

reality in sense mathematical world and in general academic world is very strict with the respect to publication. When you diminish your level of publication, in the mind of your peers you are not as good, you are not publishing due to family obligations; there are family leave, before there is mentality very much attached on the guys as whole is in publications and whatever men or whereas the women it is an upheaval battle because its more than just being flexible about family leave and maternity leave, but it is about changing the mentality as a whole and that about for example about publication.

Institution leader how do we develop equity-oriented views to ensure the success of all mathematics researchers? It takes a bit sort of in the line of what I was saying, it's a lesser by many people but many level maybe the ways not work so it is not clear how to change mentalities, it needs to change the mentalities of all women and men. I mean educate these girls and boys and there are many women who have been perpetuating the stereotype and say things like "Oh, math is not for me" or "I am so bad in math" so it's a very complex thing and I think the various levels are important or it is a good idea to have an overall plan. This is a very complex topic and it is important to understand the complexities in all levels, and it is important to have plans for many different levels.

In terms of STEM and Mathematics for girls, how early should we start to motivating them in mathematics and what can we do to keep them in mathematics? In your question, to me it implies that we are not motivating them but I think that being interested in mathematic means an intellectual curiosity is there and this exists in most children, whether they are male or female. And I

think it is there, but I think it is more important for us to not turn them away from the intellectual curiosity and pleasure that is there in most of the children. we should do to interest them should we are not motivating them in mathematics but I think that being interested in mathematics.

Professor Sophia

I guess that my broad scale mission really has to do with the way that I teach, I sort of envision mathematics be taught in a way that is really grounded in actual mans and experiences of our students at the university, and really try to make sure that it is accessible to all students. But I also see that as a definition to sort of translate beyond teaching and sort of the environment that we build among the faculty so that in the long term, I love to see us build a sort of diverse in hiring faculty so that we could have a community for the mathematical community among the faculty that is really inspiring to our students and other universities so that we can be a kind of a beacon to other scientific community as to what it can look like.

Professor Stephania

Other female professors don't project their research as well as males do. By projecting, (I mean) "LOOK AT WHAT I PROVED" versus "here is what I proved" um, so they aren't judged to be as high quality as male professors often. And therefore, the top ranked universities don't take and hire them (women professors) because they don't see them as good professors or researchers (as males).

So, in that type of deficit-thinking, do you think it effects hiring practices, and overall performance in obtaining leadership positions? What can we do to fix this problem with your reflective practice?

I don't want to change the way women talk about themselves (women's way of talking about themselves), and I don't want them to become like men, and encourage and go on to hiring committees to take a better, broader look at what good research is.

I think there are lots of research that reason why people drop out of STEM majors is because of poor teaching in STEM subjects. And a lot of it is some of it has been associated with large classes and no active learning… problem solving, the way we teach sciences. The diversity can be achieved on.

In summary, participants made these recommendations aimed toward women professors and universities interested in retaining future female students and faculty members:

1. Provide ample opportunities for mentorship and conference opportunities for students
2. Obtain rights for longer maternity leave and other familial duties for all genders
3. Have the right structures in place for the biggest challenge addressing growth in student populations
4. When you get an opportunity to be different, you should embrace the opportunity rather than thinking about loneliness

5. Looking toward educational change, some are not specific to any one group; rather, they are about changing teaching and learning very broadly to be more inclusive. One simple way is to use a “think, pair, share” learning method and interpret the curriculum and how it is represented
6. It is more important to not turn them away from the intellectual curiosity and pleasure that is in most children
7. Mathematics should be taught in a way that is grounded in actual experiences of students at the university, working to ensure it is accessible to all students
8) Do not change the way women talk about themselves, and do not ask them to become like men; encourage women to join hiring committees to take a broader look at what comprises good research.

Researcher’s Recommendations

I wholeheartedly agree with participants’ recommendations. Understanding how to build community cultural capital and experiential knowledge can be an effective tool that professors and administrators can use to provide academic support, social support, and mentorship, keeping the track record of women steadily increasing in STEM programs.

I agree with Professor Gloria in feeling different or lonely in the department as a female professor, one ought to change the fear into a positive motivation. As Professor Gloria mentioned, when one has an opportunity to be different, they should embrace the opportunity rather than thinking about loneliness. Even more specifically, I underline the importance of being a woman. Professor Stephania stated women should never give up their way of speaking about themselves. Rather than changing who women are, they must

work to change the world and how other people think. I especially appreciate that the professors believe women should never compromise and should stand up for themselves.

1. Create systems of support for female professors with resources for their professional and academic development.
2. Formalize mentorship programs across universities and graduate programs, hold department responsible for mentorship by tracking mentorship activity into the tenure path, and factor this into professors' promotions.
3. Recognize and honor the sentiments and perspectives of female professors and students by creating a survey for every semester/quarter system in the university; include all professors and graduate students in decision making around university policy, curriculum, admissions, and selection of future members of faculty and administration.
4. Create an inclusive and respectful environment that is nurturing and fosters collaboration across all STEM programs.
5. Create workshops that cater to postdoctoral students, female professors, and graduate students to attend and network in universities across the country and the world.

Recommendations for Future Research

As mentioned earlier, this dissertation had a qualitative research study component designed to transform to a mixed-methods research study. Future research may consider the same research questions for other universities with different geographic locations, or focus more on minority groups like Asian American, African American, Latina, and Native American Professors. This study can be broadened to consider success rates of

educational-pipeline programs in medicine, law, and other majors with a limited number of women entering the program. Another area for future research is gender variations in STEM companies in career development and job retention. Future research examining these issues in the lesbian, gay, bisexual, and transgendered student and faculty populations in STEM programs would prove to be a valuable contribution to the discourse. Future research in this area can also focus on men in STEM programs and their experiences.

Recommendations for Practice

Recruitment efforts must include retention programs. The following thoughts are about how STEM programs should improve efforts to retain professors of all genders and sexual orientations. First and foremost, STEM programs in universities must address safety on campus, mitigating microaggressions, racism, and social belonging to ensure the university has an optimal environment for learning where students and faculty of color can experience inclusion in their departments and universities and achieve academic and professional success. As mentioned in the study of Latinas/or in health sciences (Dominguez, 30), faculty of color often carry the burden of serving on many committees or task forces that can detract from their research, teaching, or clinical practice.

Leadership and administrators in universities must create ways to bring parity in mentoring opportunities, providing leveled fields and equitable opportunities for faculty of color to serve in leadership roles to bring about changes that will incentivize all to remain at the university. Based on study findings, the most important recommendations

are mentorship, leadership, and student recruitment/retention. Diverse faculty will bring diverse groups of students who will later serve the greater diverse public.

Conclusion

This study contributes to academic acknowledge on how educators think about recruitment and retention of female professors in STEM programs in universities in the Bay Area. Given the small sample size, this study captures a geographical snap shot of female trailblazers in top-notch universities in the Bay Area. The research study addressed five specific questions which all of the eight participants responded to the questions in regards to the learning environment and persistence of the STEM program from female perspectives. To address the question that deals with the female STEM professors' commitments to help cultivate women's learning and working environment, the professors' responses liberate the future female STEM professors from concerns of sexism, racism, and other discrimination when being compared to responses of professors who have seen results of four decades or more. Through this study, it gives hope that the participant who has had over four decades of experience was able to relate how important to note the accomplishments of women professors in her department. Even just by sheer growth in their numbers, women are now dominating not only the university campuses but they are also taking record number of STEM classes. It is the maintaining of those numbers consistently to the graduate level of STEM study was the key question that derived from the study. After conducting the interviews, there is far greater hope than ever before, as the responses from the interviews show that majority of the female professors answered that we need to pay more attention to attaining and maintaining the minority undergraduate students rather than the specific gender of the population.

The finding is this research are consistent with the findings in the research rendered by Dominguez (2010) where the researcher defended views about counseling is necessary to achieve maximum support for women in higher education and choosing best career options; thus, this research aimed to focus on fostering a strong mentorship program for female professors in STEM departments to successfully transition to nontraditional leadership positions in usually male-dominated STEM departments universities. Mentorship programs have provided information and support for female professors who were interested in future leadership positions. Mentors varied from other female professors to male professors who have overcome the obstacles to attain the leadership role in STEM departments. The process did function to ideology similar to a fellowship, and all professors who are interested in future leadership roles received steps to follow in becoming a chairperson or administrator in a STEM department.

In addressing the question in regards to the leadership of the female STEM professors, through this research study, the researcher discovered and learned that the answer to this question varies from each and individual professor's level and skills. It seems that the findings in this research help explain the different levels of involvement between two individual STEM professors, and yet they are both a female role models for undergraduate students in their field. As theories in STEM fields, Dugan, Fath, Howes, Lavelle, and Polanin (2013) examined the extent to which college women in STEM majors demonstrated different levels of leadership capacity and leader efficacy compared to non-STEM peers. Their results indicated similar levels of capacity but significantly lower leader efficacy for women in STEM majors. The researchers recommended

gathering collective calls from scholars to more refined exploration of the component parts of leader efficacy and exploration of resilient efficacy to navigate across threats to female STEM majors (Dugan et al., 2013). However, after observing and interviewing eight female STEM professors in the Bay Area, the findings seem to point towards the opposite of the literature review findings. This research makes it clear that female professors are leading the way and paving the path for the future female STEM professors and academicians at the same time they are able to accomplish and achieve their goals as a full-time research professor with families.

Therefore, the leadership is offered at most if not all of the institutions, and it is up to each female professor to either seek for or accept the leadership challenges as they are presented. The majority of the professors enjoyed and embraced their leadership roles along with their teaching and researching responsibilities. As a research observer, it was encouraging to know and find out that the professors are motivated and optimistic for the future of women STEM professors and professionals. This finding stays consistent and similar to the result of the pilot survey study of STEM professionals that the researcher conducted just months before the interviews. Although, there are still mentions of verbal harassments and difficulties faced by the female professors initially entering the Doctorate levels of their study, still the majority of the respondents answered that they would not have persisted or even started their career as professors, if it were not by the support of their male mentors, professors, and academicians. This correlates exactly with the Swedish study mentioned in the literature review, that 359 women STEM professors and professionals of Sweden were influenced by their male role models. As it was found by McEwen in 2013, that it is important to obtain early and

encouraging responses for young girls to motivate further opportunities and interests in STEM fields, and the research further noted that positive male role models, women were able to thrive in the competitive academic STEM environments in the Swedish Universities. These positive factors contested stereotypic threats and negative influences in female students and women pursuing careers in STEM fields.

In addressing the question about the practices that facilitated the preparation and persistence of female STEM professors as they were working on their academic work in STEM fields, the researcher discovered that the female professors' environment of learning had much to rely on trials and errors that strengthened their intents and goals. This is very similar to the theories of Bandura since Bandura's (1986) four major tenets of self-efficacy theory—vicarious learning, verbal persuasion, performance accomplishment, and emotional arousal—substantiated career decision-making experiences. Self-efficacy is the belief individuals have about performing a particular task that leads to a specific goal with the expectation of reaching or changing the goal (Bandura, 1986). The intent of this study was not for these eight women to represent the entirety of female professors of STEM around the world; rather, this study offers a glimpse into the experiences and lives of eight remarkable individuals who are changing the face of universities and STEM professorships. Bandura's (1977b) self-efficacy theory and social-cognitive learning theory provided a way for academics to consider modeling and mentorship as a mode of obtaining one's goals and pursuits. As described earlier in the literature review, the individual female professor, such as few of the professors that were interviewed had mentioned that at first, they had no desire to become a professor at all. Just as individuals may have low self-efficacy or high self-efficacy, depending on the

experience related to a specific task. If the experience was positive, a person's beliefs about accomplishing a task will be high or the person will be encouraged to pursue the task. If the experience was negative, then the expected outcome will be discouragement. People who expect to experience fear from performing a specific task may decrease the fear by reducing their tension using anxiety-management techniques such as visual imagery, relaxation training, self-talk, and journal writing that relates to positive or negative career behaviors (Bandura (1977a).

The social learning model was definitely the majority of the participants were able to become part of the STEM community that were originally occupied by mostly men in the 20th Century. As studies have described that applied social learning principles such as family influences, cognitive-skill development, and emotional reactions to work environment preferences to explain how individuals make career choices. This culminating theory matches the participants' process of career selection in this specific research study that is based on critical and defining life experiences that shape career decision making as similar to the study's conclusion in the Dominguez's study (Dominguez, 2010). The researcher further explained that personality may develop from reactions and responses to environmental conditions. For instance, if individuals experience pleasure from performing a behavior, they may repeat that action; however, if individuals experience discomfort from performing a behavior, they may avoid that action (Dominguez, 2010). The theorist, Krumboltz viewed life as an evolution of a person's interaction and reaction to the environment. This suggests that an individual's interests, personality, values, and worldview inevitably change throughout one's lifetime.

The gender identity did have an effect in shaping the professors' learning experiences, and just as it is important to be viewed as an equal in all areas, the female professors admit to the daily challenges as women in the sphere known previously to be dominated by men. It is still imperative to work diligently as possible as Miller et al, 2015, emphasized the paradoxical situation for women in higher leaning, where women are working hard to meet the demands of equal status, family, and their own needs, and they need to work harder than men to be recognized in their workplace and schools: Female STEM academicians often confront multiple responsibilities (Miller et al., 2015). The eight female professors have worked harder than others to reach the goals that they have set for themselves, and they also recognize the importance of being a mentor and a role model for other students of all genders, all types of leaners, and all demographics of population. Their devotion towards their students are exemplary as two of the eight professors shared with the researcher that they have chosen their profession and research over the decision of starting their own family.

In terms of gender, there are barriers to women in STEM participation and Saucerman and Vasquez (2014) discussed the psychological barriers that are already in place for young girls that set a negative undertone and send perceived messages about social roles. As described, even the teachers sharing their mathematics anxiety begin the process of influences from society that undermine a young girl's chances of continuing study in STEM areas. The research study has reported that the female professors are aware and acknowledged in this area since they too had to endure such criticisms and stereotype threats during their earlier years of academics. In the study, the professors reported that the changes are already in place but we as a society need to change the

social norms and attitudes in order to focus on providing support services as well as establishing a learning environment free of threat and considerate of the influence of prior inequitable distribution in STEM fields.

The purpose of this study was to examine the experiences of female professors with academic backgrounds in STEM fields. This literature review focuses on major themes like: (a) barriers to women STEM participation, (b) factors motivating women students to major in STEM, (c) ways and factors to facilitate leadership in female STEM professors, (d) leadership theories, (e) organizational theory and female faculty, (f) self-efficacy and SCCT, and (g) future of professor leadership. These themes were discussed in detail to help identify the areas of STEM that needed to be examined further.
As discussed in Dominguez's study, the origin of the underrepresentation of women in STEM programs has been largely structural, created in and through the social structures of institutions, the segmentation of the labor market, and the socialization and internalization of values and beliefs about appropriate gender roles and expectations (Dominguez, 2010). These factors manifest in a host of barriers to women's participation, general and specific to the workplace and academia, particularly higher education. The researcher discovered findings through carefully interviewing participants who were willing to share their experiences.

It was important to understand the stories and narratives of eight individuals who have earned a place in academia; their voices often represent many untold stories and narratives of female professors. I am forever grateful to Professors Penelope, Rosita, Ophelia, Gloria, Regina, Elizabeth, Sophia, and Stephania for taking time in their busy

schedules to share their experiences. It was necessary to create a successful learning atmosphere for all types of female learners, and it was important to start a discussion of barriers women face while participating in STEM, and to offer solutions that address successful integration in academic learning for women.

Public and private institutions must allow successful integration of women in all disciplines and fields. This study has practical applications for future female leaders and future female doctorate students in STEM fields. Female leaders in STEM areas possess a unique set of learning experiences that needs to be voiced and heard by upcoming female leaders to sustain a continuing culture of understanding and maintain a permanent space in academia. The information from this proposed research is shared and studied by future female leaders of colleges and universities in the nation. This research guides academics and future leaders gain better insight and knowledge about the motivation and barriers female learners face, especially in STEM areas. Not only does this research give a clearer understanding of the situation for female STEM practitioners and educators but it also guides instructors of female students to understand their locus in the academia.

This study aimed to challenge negative connotations of universities' sexist or bias hiring practices as well as to bring topics to light as to why potential female leaders are not taking a stance on representing the minority group in STEM fields. This study revealed that more female-leadership roles were encouraged and supported by all male peers and academicians who were mentors for future generations of female STEM professors. This study supports the critical analysis of hiring practices of various institutions, promoting higher attainment of female leaders for spaces usually taken by their male counterparts (Montgomery, 2009). The study shared information from

universities across states and countries in their hiring practices by asking how many female applicants they hire, when compared to male applicants who possess similar if not equal doctorate degrees. It was important to observe and attain ethical hiring practices in all areas of higher education through interviews and women professors resoundingly agree that male professors, male peers, and community were a tremendous support to achieving their goals as academicians at prestigious universities in the Bay Area. Most of all, the responses to their successes in their fields were unanimously owed to their families and mentors first. This is in alignment with the literature review findings of SCCT where the comprehensive interviews described the lived experiences of women who studied or practiced in STEM careers, where it was necessary to create a successful and motivational atmosphere for many types of female leaders. As it was important to start a discussion of the barriers female doctorates face and to offer solutions that address the successful integration in the academic setting for women in STEM fields through this qualitative research study.

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APPENDIX A

INTERVIEW QUESTIONS

1. What is your job position, and how long have you been at the university?
2. What does your job entail? What are your duties and responsibilities? What is your overall sentiment about your job?
3. What is your mission and vision for the university, now and in the future?
4. What do you hope the outcome will be for these proposed changes in the university?
5. How do you think your university is doing in comparison to other similar colleges? What are you doing at your university that is not comparable to other schools in gender equality?
6. What is most important to you in success for the university?
7. What are you doing to reach your university's STEM goals for women?
8. As part of the educational system, what are some challenges and values that apply to working with the university as a leader?
9. What is the most difficult aspect of your job? How are you working to conquer it?
10. Name the top three things that come first in the university's STEM program. Please briefly explain why.
11. What improvements do you think should be made in the university in including female professor leaders in STEM departments?

12. Are there any community-building activities or events in which the university promotes diversity among leadership? What are these events? How do these events get started?
13. What can university-leadership programs do to address “the larger educational discourse” that we need more female professor leadership in STEM departments?
14. How have programs of accountability displaced deficit thinking in the areas of hiring practices and retention?
15. How can university leaders develop equity-oriented views to ensure the success of all students and professors?

APPENDIX B

LETTER OF INTRODUCTION TO POPULATION

Thank you so much for your interest and participation in this study! Your participation and candid responses are truly appreciated! Please know that your responses will be kept completely confidential. Any research that is associated with this study will be kept in a locked file and access will be strictly limited to the researcher of this study. No one other than the researcher will have access to your individual responses or the ability to trace your individual responses.

As the purpose of this study is to examine the experiences of female academic leaders with academic backgrounds in STEM fields. This study will illustrate their own experiences in their pathways toward leadership as well as the role they see themselves playing in fostering leadership of other women from STEM backgrounds in the Silicon Valley and the Greater Bay Area. General trends identified through an initial exploratory process will be explained through an in-depth interview survey with female STEM professors.

Please complete acceptance of this invitation by _____, 2016. The interview is not timed, so please take your time when answering your questions, and choose a calm environment in which to talk. There are two sections of the interview, and it will approximately take 40–45 minutes to complete.

Thank you for your participation!

Best,

Cheri

APPENDIX C

APPLICATION FOR IRB REVIEW OF NEW RESEARCH INVOLVING HUMAN subjects

If you believe your study meets the criteria for expedited review or full IRB review, complete the following form and upload this document to the online IRB system in Mentor.

1.RESEARCH PROJECT DESCRIPTION

Provide, in lay terms, a detailed summary of your proposed study by addressing each of the following items:

Clearly state the purpose of the study (Usually this will include the research hypothesis)

The purpose of the qualitative research is to examine the experiences of female academic professors with academic backgrounds in STEM fields. This study will illustrate their own experiences in their pathways toward leadership as well as the role they see themselves playing in fostering the leadership of other women from STEM backgrounds in Silicon Valley and the Greater Bay Area. General trends identified through an initial exploratory process will be explained through an in-depth interview survey with female STEM professors.

Background (Describe past studies and any relevant experimental or clinical findings that led to the plan for this project)

The National Academy of Sciences reports that the bias against hiring female STEM doctorates may have subsided; however, the low number in female leadership roles may be present "due to lack of supply." In this research, the hiring practices of various institutions will be considered as part of the critical analysis of the findings from each participant. This information, in turn, will give the research paper the edge to inform and guide readers on promoting higher tolerance to attain and motivate female leaders for spaces usually occupied by male role models (Montgomery, 2009). The researcher will study colleges, universities, and institutions in the Greater Bay Area in search of how many female professors who possess degrees in science, technology, engineering, and mathematics subjects faced challenges to get to their leadership position, and what leadership roles they will be motivated to earn in the future. Bandura's social cognitive theory will guide interview questions, data collection, and data analysis as the researcher tries to understand information from professors through interviews.

Research plan (Provide an orderly scientific description of the intended methodology and procedures as they directly affect the subjects)

The proposed study will be an open-ended qualitative survey of eight participants about their experiences, with questions inquiring about educational and occupational information. Questions were determined from an extensive literature review and will be used to guide the one-to-one interview.

According to Creswell and Plano Clark (2011), researchers use a qualitative methodology to describe a phenomenon in each participant's experiences. This study's effort is to bring a generalized perspective and story from each participant to explain in detail the situation of female professors and their leadership endeavors in STEM professorships. As Greene (2007, p. 209) explained the "multiple ways of seeing and hearing" and Creswell and Plano Clark (2011) explained, it is important for the researcher to gather multiple ways to view various perspectives on this topic. It is crucial to the researcher to include more than one possible explanation, using instruments to collect preinterview information and connect the ideas and theories related to the qualitative answers by instruments designed to collect words (Greene, Caracelli, & Graham, 1989). Furthermore, these female STEM professors will be encouraged to share their experiences and knowledge in the qualitative portion of the research using a survey of interview questions. The interview questions will explore the qualitative in-depth responses of female professionals to guide the qualitative analysis.

Give the location(s) the study will take place (institution, city, state, and specific location)

San Francisco, Berkeley, Santa Clara, San Jose, Palo Alto, the Greater Bay Area.

Duration of study project

Approximately 3 months to 1 year.

2. PARTICIPANTS

2(a) Participant Population and Recruitment

Describe who will be included in the study as participants and any inclusion and exclusion criteria.

Female professors of STEM, college or university instructors of STEM.

What is the intended age range of participants in the study?

The intended age range is from 18 to 99.

Describe how participant recruitment will be performed.

The researcher will contact universities' science, technology, engineering, and mathematics departments and ask the chair to grant permission to share the survey. Participants will be contacted through e-mail and the one-to-one interview process.

Do the forms of advertisement for recruitment contain only the title, purpose of the study, protocol summary, basic eligibility criteria, study site location(s), and how to contact the study site for further information? X Yes ☐ No

*If you answered "no," the forms of advertisement must be submitted to and approved by the IRB prior to their use.

2(b) Participant Risks and Benefits

What are the benefits to participants in this study?

This study may have practical application for educators and future female science, technology, engineering, and mathematics students. The information and data gained from this study may impact the ways and process of how mathematics and science subjects are taught in male-dominated spaces. The experiences of female participants will guide and instruct socially accepted practices to pave a path or create new ground for how to improve pedagogy to motivate future female students, professors, and professors' leadership in STEM.

What are the risks (physical, social, psychological, legal, economic) to participants in this study?

None. There are no risks.

If deception is involved, please explain.

No deception is involved. All the questions are stated in the permission form and research paper.

Indicate the degree of risk (physical, social, psychological, legal, economic) you believe the research poses to human subjects *(check the one that applies).*

X MINIMAL RISK: A risk is minimal where the probability and magnitude of harm or discomfort anticipated in the proposed research are not greater, in and of themselves, than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

☐ GREATER THAN MINIMAL RISK: Greater than minimal risk is greater than minimal where the probability and magnitude of harm or discomfort anticipated in the proposed research are greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests. If you checked "Greater than Minimal Risk", provide a statement about the statistical power of the study based on intended sample size, design, etc. to test the major hypotheses)

2(c) Participant Compensation and Costs

Are participants to be financially compensated for the study? ☐ Yes X No If "yes," indicate amount, type, and source of funds.

Amount:	Source:	Type (e.g.,. gift card, cash, etc.):

Will participants who are students be offered class credit? ☐ Yes X No ☐ N/A

If you plan to offer course credit for participation, please describe what alternative assignment(s) students may complete to get an equal amount of credit should they choose not to participate in the study.

Are other inducements planned to recruit participants? ☐ Yes X No If yes, please describe.

3.CONFIDENTIALITY AND DATA SECURITY

Will personal identifiers be collected (e.g., name, social security number, license number, phone number, email address, photograph)? X Yes No

Will identifiers be translated to a code? X Yes No

Describe how you will protect participant confidentiality and secure research documents, recordings (audio, video, photos), specimens, and other records.

For the interview, participants' identities will be protected using pseudonyms and all the audio, video, or photos will be locked away and disposed of and erased properly after completion of the study.

4. CONSENT

4a. Informed consent

Do you plan to use a written consent form that the participant reads and signs? X Yes ☐ No

*If "no," you must complete Section 4b or 4c below.

If "yes," describe how consent will be obtained and by whom.

It will be physically hand delivered.

If the participants are minors under the age of 18 years, will assent forms be used? X Yes ☐ No X N/A

If "no," please explain.

Upload to the online IRB system the consent form(s) that the participants and/or parent/guardian will be required to sign, and the assent forms for children under the age of 18, if applicable.

Note: All consent forms must contain the following elements (quoted directly from Office for Human Research Protections regulations, available at: http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm#46.116). The IRB has consent templates containing all required elements, and we ask that you use these templates.

If you believe it is important to create your own consent form, you are free to do so but please ensure that your consent form has each of the following elements and indicate you have done so by checking this box:

☐ I have chosen to create my own consent form and have ensured that it contains the 8 essential elements listed below:

(1a) A statement that the study involves research, (1b) an explanation of the purposes of the research, (1c) the expected duration of the subject's participation, (1d) a description of the procedures to be followed, and (1e) identification of any procedures which are experimental;

(2) A description of any reasonably foreseeable risks or discomforts to the subject;

(3) A description of any benefits to the subject or to others which may reasonably be expected from the research;

(4) A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;

(5) A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;

(6) For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;

(7) An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject; and

(8) A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled."

4b. Waiver of documentation of written informed consent (Complete only if answered "no" to 4a)

The regulations allow instances in which the IRB may waive the requirement for documentation of informed consent, that is, the collection of a signed consent form. If you are requesting a waiver of written documentation (signed) of informed consent, please answer the following questions:

Will the only record linking the participant and the research be the consent document and the principal risk to the participant would be from breach of confidentiality? ☐ Yes ☐ No

Do you consider this a minimal risk study that involves no procedures for which written consent is normally required outside of research (see 2B above for definition);? ☐ Yes ☐ No

Explain why you are requesting waiver or modification of documentation of written (signed) informed consent and how you plan to obtain consent.

4c. Waiver or modification of informed consent (Complete only if answered "no" to 4a)

The regulations also provide an opportunity for the IRB to waive the requirement for informed consent or to modify the informed consent process, provided the protocol meets the following criteria:

(1) The research involves no more than minimal risk to subjects (see 2b above for definition);

(2) The waiver of alteration will not adversely affect the rights and welfare of the subjects;

(3) The research could not practicably be carried out without the waiver or alteration; and

(4) Whenever appropriate, the subjects will be provided with additional pertinent information after participation.

If you are requesting a waiver or modification of informed consent (e.g., incomplete disclosure, deception), explain how your project meets the requirements for waiver or modification of informed consent, as outlined above.

APPENDIX D

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Below is a description of the research procedures and an explanation of your rights as a research participant. You should read this information carefully. If you agree to participate, you will sign in the space provided to indicate that you have read and understand the information on this consent form. You are entitled to and will receive a copy of this form.

You have been asked to participate in a research study entitled **Experiences of Female STEM Professors Who are Considering Leadership Positions at Research Universities** conducted by Cheri Liebow, a doctoral student candidate in the Department of Organization and Leadership at the University of San Francisco.

The faculty supervisor for this study is Dr. Patricia Mitchell, a professor in the Department of Organization and Leadership at University of San Francisco.

WHAT THE STUDY IS ABOUT:
The purpose of this qualitative research is to examine the experiences of female academic leaders with academic backgrounds in STEM fields. This study will illustrate their own experiences in their pathways toward leadership as well as the role they see themselves playing in fostering leadership of other women from STEM backgrounds in the Silicon Valley and the Greater Bay Area. General trends identified through an initial exploratory process will be explained through an in-depth interview survey with female STEM professors.

WHAT WE WILL ASK YOU TO DO:
During this study, the participants will be interviewed by the researcher. Please let the researcher know if you will be interested in continuing to be interviewed for this research.

DURATION AND LOCATION OF THE STUDY:
Your participation in this study will involve answering the researcher's questions and may take approximately 30–45 minutes.

POTENTIAL RISKS AND DISCOMFORTS:
We do not anticipate any risks or discomforts to you from participating in this research. If you wish, you may choose to withdraw your consent and discontinue your participation at any time during the study without penalty.

BENEFITS:
The possible benefits to you of participating in this study are that the study may have practical applications for educators and future female professors of STEM.

PRIVACY/CONFIDENTIALITY:
Because you will not be providing any information that can uniquely identify you (such as your name or the institution), the data you provide will be completely anonymous.

Any data you provide in this study will be kept confidential unless disclosure is required by law. In any report we publish, we will not include information that will make it possible to identify you or any individual participant. Specifically, we will lock and store away all the data from anyone else, and your privacy and confidentiality will be protected by destroying all the notes and recordings after the completion of the study. The master list with participants' names and codes linking your name to the data will be locked throughout the ongoing research study until completed and then destroyed properly after the study has been completed. All consent forms and identifiable data will be properly stored in a locked safe. The IRB requires the researcher to keep consent forms for 3 years, but any data linking to a participant's answers or data will be permanently destroyed once the study has been completed.

VIDEO AND AUDIORECORDINGS:
This study will use audio recording of participants who choose to be interviewed after the survey. The recordings will provide accurate details provided by the participant to aid in the accurate transcription of interview findings. The recording and the recorded information and notes will be safely stored and locked away in a safe. When the research study is completed, the archived information and transcription will be erased and properly destroyed.

COMPENSATION/PAYMENT FOR PARTICIPATION:
There is no payment or other form of compensation for your participation in this study.

VOLUNTARY NATURE OF THE STUDY:
Your participation is voluntary and you may refuse to participate without penalty or loss of benefits. Furthermore, you may skip any questions or tasks that make you uncomfortable and may discontinue your participation at any time without penalty. In addition, the researcher has the right to withdraw you from participation in the study at any time.

OFFER TO ANSWER QUESTIONS:
Please ask any questions you have now. If you have questions later, you should contact the principal investigator: Cheri Liebow at (925) 234-8403 or cliebow@dons.usfca.edu. If you have questions or concerns about your rights as a participant in this study, you may contact the University of San Francisco Institutional Review Board at IRBPHS@usfca.edu.

I HAVE READ THE ABOVE INFORMATION. ANY QUESTIONS I HAVE ASKED HAVE BEEN ANSWERED. I AGREE TO PARTICIPATE IN THIS RESEARCH PROJECT AND I WILL RECEIVE A COPY OF THIS CONSENT FORM.

_____ _____

PARTICIPANT'S SIGNATURE *DATE*

Experiences of Persistence and Factors of Motivation for Female STEM Professionals
(Title for the Survey Research Report as according to Orcher p.113)
Pilot Test Paper
Introduction

Created survey instrument

The researcher created the survey instrument with questions from a pre-existing survey, followed the guidelines of the Qualtrics online survey creating software, and adhered to the guidelines of textbooks and class lectures by Dr. Baab in Survey Research Methods course. The adapted instrument was developed into survey item statements with closed ended design and the instrument was pilot tested. There were a total of 60 survey invitations sent to the sample population and a total of 33 surveys were completed. There were total of 60 emails sent out and there may be more that the researcher may not be aware of since the sample participants could have referred more associates or colleagues outside of the email list of addresses.

There were 26 questions in the survey pilot test and most of the questions were answered by all participants, with at least one or two missing answers. The sample population was given an introductory letter in their e-mail, and it explained the nature of the survey. In the letter, the female STEM professionals were assured that their responses would remain anonymous and confidential as it accompanied the survey link. There were no changes made to the survey throughout the process of the pilot test, and the survey used the 7 point Likert statements, ranging answers from Strongly agree, Agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Disagree, and Strongly disagree.

The survey link is https://usfca.co1.qualtrics.com/SE/?SID=SV_8qBvWCOj1PiUhdX the word document format is included as an appendix. The email message detailed the pilot test

and also asked participants to share the survey link with others who may also be interested in participating in the pilot study survey.

Mainly the researcher chose to use explanatory mixed methods in order to study the female STEM professionals' persistence within their work and past educational experiences. The researcher is building on the social cognitive career theory (SCCT: Lent et al, 2010) guided data collection and analysis in the study and the Albert Bandura's general social cognitive theory (Bandura, 1986). The main purpose of the researcher is to identify the factors that contribute to female STEM professionals' persistence in STEM organizations and corporations and to explore participants' views about these factors. As noted by Ivankova and Stick (2007), the researcher will be looking for the quantitative data to provide the general picture of the research problem, while the qualitative data and its analysis will refine and explain "those statistical results by exploring the participants' views regarding their persistence more depth" (p.97).

Research Questions are:

1) What motivates and hinders female professionals to participate in seeking employment in the STEM program?

2) What are the factors that facilitate the preparation and persistence of the female professionals while enrolled in the STEM graduate school program?

Pilot-test:

- The survey research purposes are to study and gather information on female STEM professionals' factors of motivation and persistence
- To gather information about support they received from their past experiences in college STEM courses and their workplace.

Participants

The survey was distributed to the female STEM professionals by contacting local STEM companies in the Bay Area. There was a total sample of 33 professionals who responded to the survey. The female STEM professional participants who responded ranged in age level of 20-69 years of age, where 66.6% of the population reported to be in the range of 20-39. They also possessed a bachelor's degree or higher. The women were all college educated and had taken courses related to science, technology, engineering and mathematics profession. . The education statement on the survey revealed that 41.94% of the respondents completed the undergraduate study and 6.45% were Master's Degree recipients, and 22.58% had earned the doctorate degree. There were 3.23% who earned a professional degree and 3.25% who earned the associate degree and 22.58% of respondents who answered "other" under education statement section.

Instrumentation Subsection:

The method for this survey research used a researcher created survey instrument, and it was guided by Qualtrics system and the textbooks on survey research. There were total of 26 questions where 22 of 26 questions used 7-point Likert scale as answer choices ranging from Strongly agree, Agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Disagree, to Strongly disagree. In order to ask participants questions about their past educational experiences, ten questions using 7 point-Likert scale will be developed employing language that female STEM professionals used in focus groups.

Each of the questions follows the format and guidelines within the expectation that adult panelists will comment on any changes needed. The first two questions will address the rigor of the college courses in STEM. One such example was: College Math Courses were very easy for me. The next four questions will be addressing the potential barriers to obtaining or engaging in STEM related profession. One such example was: I have encountered gender discrimination at work. The third set of four questions asks about encouragement and support from school and home. The final set of questions will be addressing self-evaluative assessment of confidence level during educational period and occupational period.

Results

A sampling of the findings from the pilot survey: I have strong support from my peers, and I have strong support from male peers in college. Consistent with male co-workers' support at work. As shown in Figure 1, the response rate of N=31 where the M=2.35 and SD=0.86. I thought that this finding is interesting since the sample responded to the statement, "I had strong support from my male peers in college" had the response rate of N=31 where the M=2.55 and SD=1.01.

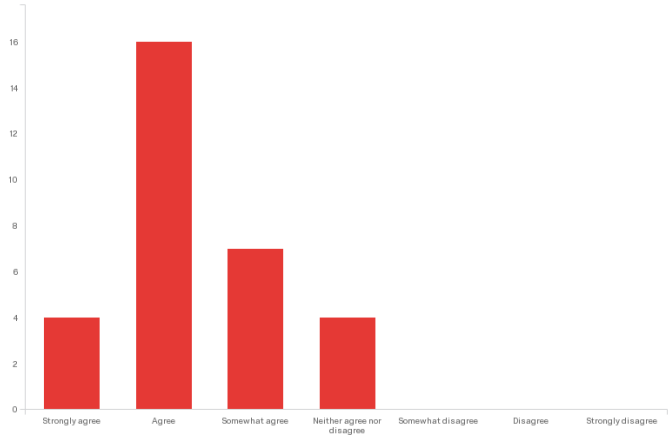

Figure 1. I have strong support from my male co-workers. SD 0.86

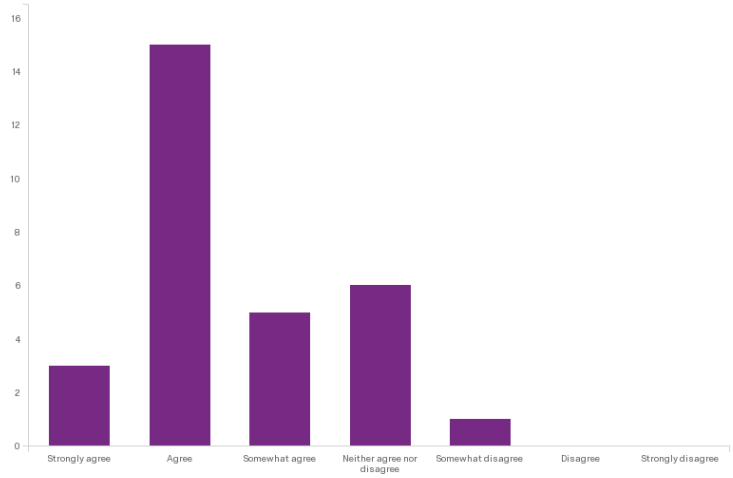

Figure 2. I had strong support from my male peers in college. SD 1.01

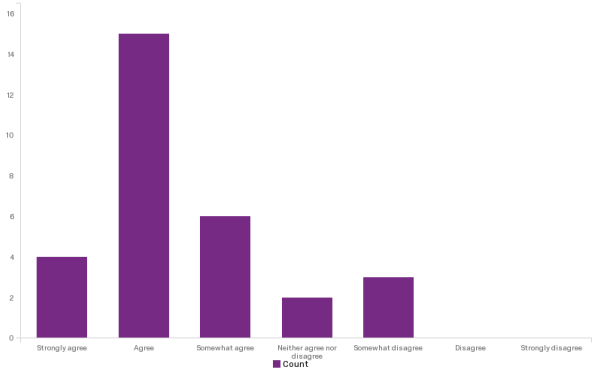

Figure 3. I have strong support from my male peers. SD 1.13

There was a similar result for all three questions about support from male peers, male college peers, and male co-workers at work. Notice that the statements about the male support from the three bar graphs, the "disagree" and "strongly disagree" is kept empty in 31 responses from sample of 33, suggesting that there is a strong support from male peers in all three environments, college, work, and personal (home). However, when the female STEM professionals were asked to respond to the statement about gender

discrimination, there was a distribution on all levels or responses of the 7-point Likert scale. Unfortunately, there was a larger percentage of female STEM professionals who experienced gender discrimination at work and in the college environment than those females who responded to disagree to strongly disagree responses.

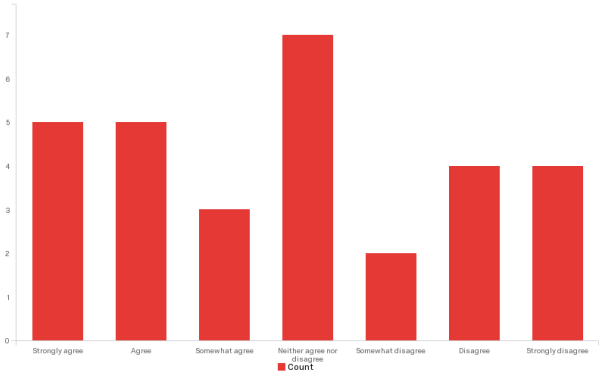

Figure 4. I have encountered gender discrimination in college. SD.2.01 with M=3.80 and N=30

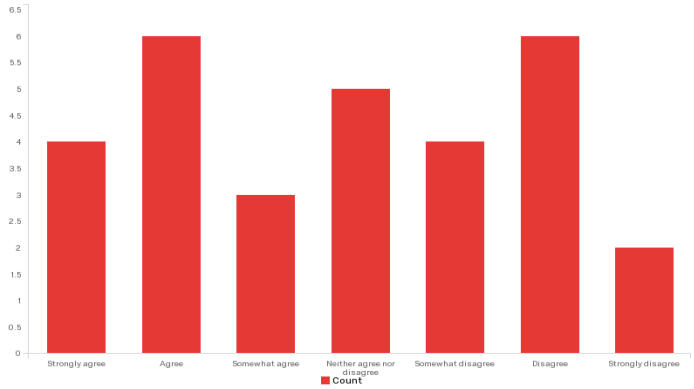

Figure 5. I have encountered gender discrimination at work SD. 1.9 and M=3.83 and N=30

In the survey, there are questions about self-efficacy where the sample responded to statements about college STEM courses. Math courses are easy for me and Science courses are easy for me statement answers are distributed fairly equally around the Likert scales. The distribution on the bar graph looks very similar to the distribution on the bar graph about discrimination experienced at work or college. Perhaps, I need to research

and read more about the specific type of barriers in self-efficacy and the possible effect of the barrier, such as STEM related courses. However, the sample agreed mostly on the statement about their strong confidence level in their career. The respondents also answered as being strongly confident in college as a STEM student. Once again, the confidence level addresses self-efficacy model and confidence level response result seems to compare closely to male peer support. Response result: "I felt very confident to succeed in my career/work". N=31 with M=2.58 and SD 1.07

Focus Area	Theoretical Framework	Research Questions	Survey Items
Support from STEM employment	Social Cognitive Theory Model of Bandura	1	1,5,7,10,16, 20,23
Support from STEM college courses	Social Cognitive Career Theory Lent et al., Brown & Hackett	2	2, 3, 4, 6, 8, 15, 17-20, 22, 24
Gender discrimination from work	Social Cognitive Career Theory Lent et al., Brown & Hackett	1	13
Gender discrimination from college	Social Cognitive Career Theory Lent et al., Brown & Hackett	2	14
Rigors of STEM (college level) Coursework	Self-efficacy Social Cognitive Theory Model of Bandura	2	11, 12, 22
Support from Home	Self-efficacy Social Cognitive Theory Model of Bandura	1 & 2	19, 21

Figure 6. Table of Survey Instrument aligned to Research Questions and Theoretical Framework

Personal Reflection:

It was a challenging experience to learn about survey methods but it was a very enriching experience since I could relate and understand the processes and steps that researchers experience to publish a work using surveys. I learned most in creating a survey instrument using Qualtrics software, and yet, I was very hesitant and apprehensive

at first. After two weeks of collecting data from Qualtrics software, I would definitely recommend to researchers because it has helped tremendously in retrieving statistical data. If I were to do this using paper surveys, it would take me weeks and months to organize, calculate, and present the data.

The purpose of my overall aim is learn and ask right questions to figure out how to create more successful and motivational work places for all types of women workers who are seeking opportunities to become employees, especially in the fields of science, technology, engineering, and math. It is important to start a discussion of barriers that female STEM employees face so that we may start planning a way to pave a path to more inclusion of women in STEM workforce. I believe that it starts here, especially when it comes to being not afraid to learn new software and products to stay updated and competitive with what is out there, especially in the STEM job market. It was interesting to observe that in my Information Systems in Educational Management class, there were three female individuals who protested in learning about database system, something technological and new to the three female students. I must admit that in my dissertation proposal, I would have to admit bias as a female researcher. I also learned that the barriers may include technology or new set of skills in particular to the STEM field or employment. This is one of the weaknesses in my pilot study and by using Qualtrics, it helped me to gain more knowledge about my future research.

There seems to be agreement across the board that females view males to be supportive in work and STEM environment. Yet there still is a discrepancy when the question asks about gender discrimination at work and at college. I would like to study the research questions further by conducting a qualitative study as well. The strengths of

the survey pilot test were that the survey instrument statements are in good length, as well as clear and concise. The survey takes only few minutes to complete and by using Qualtrics software, the survey was easily accessible through most technical/hand-held devices. The weaknesses of the survey instrument were that some questions needed revisions, and there is minimal risk of bias with non-response averaging 2-3 missing response per question. The lowest response rate was 29 count out of 33 possible, and the highest of 31 response count as reported by Qualtrics online survey software program.

APPENDIX

STEM

Answer Invalid Logic Click Here to Edit Logic

Q1 I have felt isolated at work due to being female.

- ❍ strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q2 There was very strong emotional/academic support service provided by my college counselor

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q3 There is very strong emotional/work-related support service provided by my supervisor

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q4 I have felt excluded at college courses due to being female.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q5 I have strong support from my female peers.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q6 I had strong support from my female peers in college.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q7 I have strong support from my female co-workers at work.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q8 I had strong support from my male peers in college.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q9 I have strong support from my male peers.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q10 I have strong support from my male co-workers.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q11 College Math Courses were very easy for me.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q12 College Science Courses were very easy for me.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q13 I have encountered gender discrimination at work.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q14 I have encountered gender discrimination in college.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q15 At times, I felt that I needed to behave in masculine ways to prove myself to male peers and educators in college.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q16 At times, I felt that I needed to behave in masculine ways to prove myself to my peers and supervisors in my career.

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q17 I graduated with a degree and I am currently working in the same field as my degree.

- ❍ Yes (1)
- ❍ No (2)

Q18 There was very strong college career support services.

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q19 There was very strong career support services in high school.

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q20 There was strong support from my family in terms of my school/education.

- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q21 There was strong support from my family in terms of my career choices.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q22 During my course of study, I felt confident as a female STEM student.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q23 While in profession, I felt very confident to succeed in my career/work.
- ❍ Strongly agree (1)
- ❍ Agree (2)
- ❍ Somewhat agree (3)
- ❍ Neither agree nor disagree (4)
- ❍ Somewhat disagree (5)
- ❍ Disagree (6)
- ❍ Strongly disagree (7)

Q24 Highest level of education completed
- ❍ Associate Degree (1)
- ❍ Bachelor's Degree (2)
- ❍ Master's Degree (3)
- ❍ Professional Degree (4)
- ❍ Doctorate Degree (5)
- ❍ Other (6) _____

Q25 Age level

- ❍ 20-29 (1)
- ❍ 30-39 (2)
- ❍ 40-49 (3)
- ❍ 50-59 (4)
- ❍ 60-69 (5)
- ❍ 70-100+ (6)

Q26 I am a STEM Professional and I would like to be interviewed for the research in the future.

- ❍ No (1)
- ❍ Yes (2) _____

Appendix

Research Questions Analysis					
Research Questions	Mixed Method Approach	Theoretical Framework	Timeline	Participants	Survey items match with Research Questions
1) What motivates and hinders female professionals to hold on to their employment in the STEM program?	Quantitative First using the STEM survey questions Qualitative means-the researcher interviews	Social Cognitive Model of Bandura dealing with supports and barriers	Will be conducted and completed in 2-3 months after the IRB approval 2-3 weeks quantitative survey and 1 week qualitative questions	8-9 female STEM professionals volunteering to be interviewed after taking the survey	Survey Items 1-12
2) What are the factors that facilitate the preparation and persistence of the female professionals after completing the STEM graduate school program?	Quantitative means-using the STEM survey questions Qualitative means-the researcher interviews	Social Cognitive Model of Bandura dealing with self-efficacy	Will be conducted and completed in 2-3 months after the IRB approval 2-3 weeks quantitative survey and 1 week qualitative questions	STEM professionals from organizations and academic institutions	Survey Items 13-26

Pilot Study - Survey Instrument

Focus Area	Theoretical Framework	Research Questions	Survey Items
Support from STEM employment	Social Cognitive Theory Model of Bandura	1	1,5,7,10,16, 20,23
	Social Cognitive Theory Model of Bandura	1	
Gender discrimination from work	Social Cognitive Career Theory Lent et al., Brown & Hackett	1	13
Support from STEM college courses	Social Cognitive Career Theory Lent et al., Brown & Hackett	2	2, 3, 4, 6, 8, 15, 17-20, 22, 24
Gender discrimination from college	Social Cognitive Career Theory Lent et al., Brown & Hackett	2	14
Rigors of STEM (college level) Coursework	Self-efficacy Social Cognitive Theory Model of Bandura	2	11, 12, 22
Support from Home	Self-efficacy Social Cognitive Theory Model of Bandura	1 & 2	19, 21