Undergraduate Women of Color Majoring in STEM Fields: Sharing Their Stories

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Abstract

In the United States, women, and especially women of color, have consistently been underrepresented in higher education STEM fields of study (Beede et al., 2011). This paper explores the representation of undergraduate women of color in higher education STEM fields of study. The purpose of this research is to better understand the experiences of, and effects of, psychosocial factors on undergraduate women of color currently majoring in STEM fields of study and consider how institutions can support similar students in their academic endeavors in STEM disciplines. The existing research is supplemented with a qualitative study derived from detailed one-on-one interviews with a group of 6 participants who tell the stories of their first hand experiences of being an undergraduate woman of color in a STEM field.

Dedication

This work is dedicated to Hector, Luna, and Nova.

Acknowledgements

I have always considered myself a lifelong learner and that will never change. After earning a baccalaureate of science degree in kinesiology and realizing just how much I value education and enjoy the college environment, I began my journey working in higher education. My experience working at a four-year public university encouraged me to pursue my master of arts degree in education. I have no regrets. Being a part of a positive learning environment that helps create a platform to promote growth and encourage the opening of minds is everything to me. Education should not be considered a luxury and I feel passionately to advocate for those in need in order to help education become more of a reality and a right for all.

I want to sincerely thank the 6 participants who made my research possible by sharing their amazing stories and allowing me to interview them. Without you all, this study would not be possible. You supported my academic journey and, for that, I am forever thankful. You are all amazing and commendable women whom I deeply admire. I wish nothing but the best for you and I know that you will impact this planet in marvelous ways.

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Luna and Nova, you are my world and I cannot imagine my life without you. I love you both more than you could ever know.

Mom and dad, I have always wanted to make you proud. I hope you know just how much I love you both. Without you, I wouldn't be who I am today. I love you with all my heart.

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My colleagues in the School of Education, I want to thank you all for being such wonderful individuals to which I consider myself lucky to get to work with every day. You have been supportive of my academic goals throughout this journey and, for that, I am grateful.

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Chapter One

Introduction

The fields of education that include science, technology, engineering, and mathematics are often referred to by the acronym "STEM." STEM education can be defined as an interdisciplinary approach to learning where concentrated academic concepts are linked with lessons that pertain to real life scenarios as students apply science, technology, engineering, and mathematics to frameworks that make connections between school, community, work, and the global enterprise (Tsupros, Kohler, & Hallinen, 2009). Landivar (2013) states, "Industry, government, and academic leaders cite increasing the STEM workforce as a top concern" (p.1). In higher education, the goal is to develop STEM literacy among its graduates and, with it, the ability for surrounding communities to employ a diverse array of STEM professionals to help the nation succeed and compete in the ever-changing economy. The United States (U.S.) consistently falls behind many developed countries in terms of curriculum quantity and quality in K-12 STEM education and, currently, only about 16 percent of undergraduates in U.S. institutions of higher education receive degrees in natural sciences and engineering, compared to 47 percent of undergraduates in China, 38 percent in South Korea, and 27 percent in France (National Academies, 2010a). A further disconcerting fact offered by Beede, Julian, Langdon, McKittrick, Khan, & Doms (2011) is that, "Women are vastly underrepresented in STEM jobs and among STEM degree holders despite making up nearly half of the U.S. workforce and half of the college-educated workforce" (p. 1). There is an even larger decline in the representation of women of color in STEM professions (Espinosa, 2011).

Ong, Wright, Espinosa, & Orfield (2011) suggest that, "The U.S. education system and research infrastructures systematically undereducated and underutilize women of color. The

daunting magnitude of their underrepresentation in advanced STEM areas represents serious equity concerns that connect with important historical and contemporary issues of social justice in the U.S. education and employment systems" (p. 175). This growing disparity in cultural representation amongst STEM professionals in the U.S. is gradually being seen as an educational and professional epidemic. Landivar (2013) draws attention to this fact: "One focus area for increasing the STEM workforce has been to reduce disparities in STEM employment by sex, race, and Hispanic origin... Researchers find that women, Blacks, and Hispanics are less likely to be in a science or engineering major at the start of their college experience, and less likely to remain in these majors by its conclusion" (p.1). The questions then become, why is there such a shortage of women and women of color going into STEM fields of study and how can we overcome the marginalization of women and, in particular, women of color in STEM?

The political term *women of color* first appeared during the late 1970's in wake of the violence against women movement that aimed to unify all women of non-White or western European parentage, who experience multiple layers of marginalization because of race and/or ethnicity (Women of Color, para. 1).

An important concern for American colleges and universities has been, and continues to be, how to increase gender and racial diversity in math and science fields (George-Jackson, 2014). Increasing enrollment and retention rates in STEM programs in American higher education institutions is an important challenge today. In the progressively globalized world, scientific development and innovation are critically important in order to maintain national security, economic competiveness, and quality of life for citizens (Ong, Wright, Espinosa, & Orfield, 2011). A common stereotype exists suggesting that women, and women of color, are not predisposed to succeed in STEM areas of study. In 2005, Harvard University's President,

Laurence H. Summers, offended many at an economics conference by explaining that the underrepresentation of females in science at elite universities is primarily due to innate and biological differences between men and women and that aptitude is the second most important reason women do not excel in STEM (Hemel, 2005). Sexist rhetoric, especially from the leader of an esteemed institution, where roughly 50 percent of its students are women, was regarded as disheartening. The notion is not only inaccurate but also harmful to women in that it prematurely sets them up for failure and, worse, lack of confidence and diminished sense of efficacy in their ability to excel in math and science. Women of color pursuing non-traditional careers, such as careers in STEM, are less likely to develop the professional confidence levels needed to succeed due to the obstacle of having to overcome the cultural bias that men are naturally better suited for these STEM professions. A recent article was published on The Guardian's online news site in response to remarks by Sir Tim Hunt regarding women scientists. Hunt is a British biochemist, molecular physiologist, and a Nobel Laureate. He received criticism after referring to women as a distraction in the laboratory and further advocated for gender-segregated labs for scientists to work in at a conference for science journalists. According to Ratcliffe's (2015) article, Hunt is quoted as having said, "Let me tell you about my trouble with girls. Three things happen when they are in the lab: you fall in love with them, they fall in love with you, and when you criticize them, they cry" (para. 2). The fact that in the 21st century such renowned scholars, continue to propagate such stereotypical and sexist jargon does not help the marginalization and stigma that many women endure within their STEM professions.

Perceptions of self-confidence and self-efficacy levels have been found to play important roles in the academic and career development of women in STEM (Litzler, Samuelson, & Lorah, 2014). These psychosocial elements are pertinent to any college student trying to excel in their

field of study. Current research addresses the importance and need for having greater equity in gender representation in STEM fields of study within American higher education, however there are gaps within the research that specifically address women of color and their underrepresentation in the fields of science and mathematics. With more research into topics such as gender, racial differences, and the intersections between them, educators can better understand and further suggest steps to eliminate discrepancies and bring more equity to education as a whole.

The purpose of this study is to explore psychosocial factors that affect undergraduate women of color majoring in STEM programs at a four-year institution of higher education, to learn how they got where they are, and what encourages them to persist in pursuing a career path where their gender and ethnicity lack equitable representation. This qualitative research draws on interviews of 6 voluntary participants at a California, public, four-year, Hispanic Serving Institution of higher education (HSI) with the goal of better understanding the personal academic journeys of women of color by listening to their stories and understanding the motivation that drives them to persist in obtaining a degree in a STEM discipline.

At the conclusion of this study, the answer to the following central question will be addressed: What psychosocial factors impact undergraduate women of color majoring in STEM at a 4-year college institution? The answer to this question will aid institutions of higher education, specifically those in California, to gain a better understanding of the cognitive, social, and psychological experiences of this population of female students and provide improved support services to support, assist, and accommodate the needs of women of color in an effort to increase and support equity in STEM programs.

Chapter Two

Literature Review

In the United States women, and especially women of color, have consistently been underrepresented in higher education STEM fields of study (Beede et al., 2011). The lack of representation not only hinders the women who are directly affected, but the nation as a whole. American institutions of higher education are in need of an equitable representation of gender and ethnicity within the STEM fields of study in order to better represent our cultural population, improve global relations and communication, and ultimately achieve equity in education (Landivar, 2013).

According to the Census Bureau's 2009 American Community Survey Report by Landivar (2013), women comprise 48 percent of the U.S. workforce but just 24 percent of workers in STEM fields. Half as many women work in STEM jobs than would be expected if gender representation in STEM professions mirrored the overall workforce. The figures for underrepresentation have remained fairly consistent over the past decade, even as women's share of the college-educated workforce has increased. Women's representation in STEM careers have varied over time. While the percentage of women has declined in computer and math jobs, it has risen in other occupations. In 2009, women comprised 27 percent of the computer and math workforce (the largest of the four STEM components), a drop of 3 percentage points since 2000. Engineers are the second largest STEM occupational group. Only about 1 out of every 7 engineers is female. Men are much more likely than women to have a STEM career regardless of educational attainment. Women in STEM fields earn considerably less than men, even after controlling for a wide set of characteristics such as education and age. The gender pay differential is a harsh reality for many females in their professions, and women in STEM are not

excluded from this discrepancy. Below is the percentage distribution of probable fields of study among first-time college freshmen by gender (fall 1996) that was provided in Landivar's (2013) American Community Survey Report.

Probable Major Field of Study	Men	Women
Arts & Humanities	9.4	10.5
Biology	6.5	7.4
Business	18.1	13.8
Education	6.3	14.2
Engineering	15.2	2.6
Physical Sciences	2.7	2.0
Professional	9.8	20.2
Social Sciences	6.1	11.7
Technical	3.7	1.4
Computer Science	4.3	1.2
Undecided	7.4	8.8
Other	10.5	6.5

Table 1: Probable fields of study among first-time college freshmen by sex (fall 1996): U.S. Census Bureau data - American Community Survey

The physical sciences include fields such as astronomy, chemistry, earth science, mathematics, and physics. The professional category includes fields such as architecture and health technologies. Women are more likely to hold jobs that are less prestigious and have lower wages than those held by men. While many prestigious fields such as engineering, chemistry, physics, and computer science are dominated by men, women constitute the majority of employees in the social sciences and life sciences.

The primary research question driving this study asks: What psychosocial factors impact undergraduate women of color majoring in STEM fields of study at a 4-year college institution? Psychosocial factors and their effects on individuals can be attributed to social psychology's research on attitudes. Attitudes have been described as one of the most important concepts in social psychology, regarded by Allport, (1954) as our "most distinctive and indispensable concept" (p.784). Attitudes are the "relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols" (Hogg & Vaughan 2005, p. 150). There is a structure to attitudes for which a 3 component model was offered as early as 1934 by LaPierre and which endures today. It is composed of affective, behavioral, and cognitive elements, and often simply referred to as the ABC model. The affective component describes what a person feels about the object of their attitude, the behavioral component is the actual response to the object, and the cognitive component is what a person believes the attitude object is like. Although every attitude has all three components, a particular attitude can be based more on one component than the others. Attitudes also have a function. Katz (1960) proposes different kinds of attitude that serve different functions: such as an adaptive function which helps achieve goals; a knowledge function to help structure and organize our social world; a self-expressive function for communicating believes and opinions; a social adjustment function to assist in managing social situations; and an ego-defensive function which helps protect self-esteem.

Attitudes can be either positive or negative in that they stem from the psychological tendency of "evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1). Such tendencies can lead to stereotyping in a way described by Franzoi (1966) as fixed thinking about people by putting them into categories without allowing for

individual variation. A reason for stereotyping is to reduce the effort of cognitive processing by creating a simplistic way of perceiving the world, allowing us to distinguish ourselves, and the groups we belong to, from members of other groups (Oakes, Haslam, & Turner, 1994). The negative and harmful side of simplifying the world in such a way is that attitudes are formed before a person is met for the first time, leading to prejudice and discrimination. Prejudice is an unjustified negative (or positive) attitude toward a social group or a member of that group, whereas discrimination refers to behavior or action taken against the other group. The most common prejudices are attitudes based on sex, race, ethnicity, age, sexual orientation and mental and physical disabilities. The victims of prejudicial attitudes are subject to material disadvantage, physical and/or verbal abuse, and suffer psychologically from low self-esteem and social stigma (Edwards, Marangio, Moore, Blaher-Lucas, & Ganino-Day, 2016).

Prejudice can form when social identity is perceived as under threat and there is a need to protect self-esteem and personal identity, often accomplished by elevating the standing of one's own group by 'putting down' or discriminating against other social groups (Tajfel & Turner, 1979). Attitudes about the self and others and the relationship between them are impacted and formed by social schemas. Fiske and Taylor (1991) explained social schema as a mental framework for creating representations about oneself, other people, and specific and common social situations and events. A schema is a cognitive tool to organize the vast bank of information amassed through prior personal experiences, and also functions to classify and encode new experiences. There are four typologies of social schemas: self schemas based on knowledge of oneself; person schemas which are expectations about other people; role schemas that are behaviors expected in particular social situations, and event schemas which stem from sequences of events in familiar situations.

The focus in the literature related to the underrepresentation of undergraduate women of color in STEM is concentrated on several areas: persistence and success; campus climate and sense of belonging; and pipelines and pathways. The theoretical frameworks that shape this study include the following: Grounded Theory (Glaser & Strauss, 1967), Moral Development Theory (Gilligan, 1982/1993), and Transition Theory (Schlossberg, 1984). There are many factors that speak to the underrepresentation of undergraduate women of color in STEM. The areas of previous research are noteworthy and are addressed throughout this study. The criteria used for analyzing and comparing the available literature entailed a systematic review of relevant and published research, each pertained in some respect to STEM fields of study. Scholarly works that were excluded focused primarily on all male subjects, or subjects who were not undergraduate college level students, research which had subjects who were only White women, and those who came from private colleges and institutions rather than public institutions of higher education were also omitted.

The following review of literature summarizes theoretical frameworks used to conduct this study as well as examines previous research that addresses the underrepresentation of women and minorities in STEM areas of study and seeks to report factors that pertain to the dilemma.

Theoretical Frameworks

Grounded Theory. Glaser & Strauss' Grounded Theory is based on sociological studies. According to Glaser and Strauss (1967), Grounded Theory is the discovery of theory from data. The authors believed that the evolution of theory was a major task confronting sociologists at the time. They argued that too many theories relied on strict verification as opposed to comparative analysis derived from the collection of data.

Moral Development Theory. Gilligan's Moral Development Theory explains how individuals make meaning of their worlds. Her work regarding women's thinking and care orientation highlights the notion that relationships with others must carry equal weight with self-care when making moral decisions. Her research found that women often identify care and responsibility as their moral compass. (Evans, Forney, Guido, Patton, & Renn, 2010).

Transition Theory. Schlossberg's Transition Theory is a framework that aims to illustrate an understanding of adults in transition and help aid them in receiving the help they need in order to cope with both ordinary and extraordinary processes of living. Her theory on transitions examined what comprises a transition, various forms of transitions, the transition processes, and possible factors that impact transitions (Evans et al., 2010).

Context of Existing Literature

Women, when compared to men, in science and engineering programs and professions are not necessarily underprepared and do not perform poorly, as is often proposed (Ceci, Ginther, Kahn, & Williams, 2014). Rather, it is alleged that women appear to face psycho-cultural complications as opposed to academic weaknesses which explain their underrepresentation in STEM disciplines (Grandy, 1998). This phenomenon can be linked to a matter of high self-expectations placed upon themselves by female college students, in turn these elevated expectations may be due to gender biases and the stereotypical thinking that asserts females are not cognitively inclined to succeed in math and science programs (Halpern, 2013). The notion of needing to prove oneself academically in order to earn the sense of belonging is a hurdle that many undergraduate women of color face when pursuing a degree in STEM. This attitude ultimately influences retention and attrition rates amongst these underrepresented individuals.

Identity and education are synonymous in many ways, as students ask questions about who people believe they are, what they want to do in life, and how education can help them achieve their goals (Syed, Azmitia, & Cooper, 2011). Tajifel's (1979, 1981) Social Identity Theory is often used amongst social psychologists when looking into themes concerning identity. According to the Social Identity Theory, an individual's identification with certain social groups (race, gender, ethnicity, socioeconomic status, religion, etc.) will intensify when interacting in group settings where the individual views themselves as the minority and a simultaneous perception of threat evolves. The perceived threat will then lead the individual to conform to group norms in order to better identify with the group thereby depersonalizing the individual in order to amplify group unity and self-worth (Syed et al., 2011).

For college Latina/o students, research has found, peer and faculty support and co-curricular involvement play a role in their retention (Hernandez & Lopez, 2004). The more involved the student becomes in their program, classroom and campus life, the more likely the student is to persist and succeed in their academics. This concept has strong ties with Astin's (1999) Student Involvement Theory. According to Astin, student involvement refers to the amount and quality of both the physical and psychological energy that a student invests in their college experience and is positively correlated to their learning and development. When students do not feel supported and do not feel as though they belong, their academic involvement, motivation, and persistence to complete a degree are ultimately affected due to lack of self-confidence and self-efficacy in their abilities to succeed.

Research has suggested that the campus climate is an influential factor effecting both the learning and social outcomes for minority students. Research on minority students majoring in STEM, conveys that supportive educational and scholarly settings aid in student persistence

(Bonous-Hammarth, 2000), whereas hostile campus climates and other negative experiences have positively correlated with lower levels of students' academic performance (Cole & Espinoza, 2008). Students who face academic discrimination are more likely to perform poorly and possibly withdraw all together due to psychological interferences that hinder the students' perception of personal ability to succeed (Syed et al., 2011).

Pipelines and pathways are an important concept for educators to better assist women of color who are interested in pursuing a career in STEM. Espinosa (2011) urged, "It is imperative that both U.S. educators and education policy makers foster learning pathways for those interested and capable of pursuing education and careers in STEM" (p. 209). These pathways are crucial at the primary, secondary, and post-secondary levels of education. Student academic success and persistence through a pipeline, or support program, has been linked with the importance of having a sense of identity and belonging (Syed et al., 2011). Critical Race Theorists would argue that these pipelines are needed most especially in underprivileged schools where minority students are not receiving adequate resources to flourish in math and science subjects and thereby cannot compare with their White peers who come from seemingly more advantaged areas and experience the benefits of White privilege. Kendall (2002) explains White privilege as:

> …an institutional (rather than personal) set of benefits granted to those of us who, by race, resemble the people who dominate the powerful positions in our institutions. One of the primary privileges is that of having greater access to power and resources than people of color do; in other words, purely on the basis of our skin color doors are open to us that are not open to other people. (p. 1)

Persistence & Success. There have been many studies examining the persistence of undergraduate students in STEM, with a handful focused on undergraduate minorities and undergraduate women and their persistence in STEM but very few that specifically address undergraduate women of color and their persistence in STEM. For this study, persistence is applied to students who continue their STEM major through to their 4th year (graduating year) of college at a 4-year college institution of higher education. Previous studies have linked the concept of STEM persistence with motivation, success, and self-confidence and self-efficacy. The most powerful aspect of human motivation and action in a person's everyday life is the belief in self-efficacy (Bandura, 1986). While self-confidence can be defined as a student's general conviction that he or she has the aptitude to proficiently perform tasks, yield results, and achieve goals. Self-efficacy signifies a person's belief in his or her ability to accomplish certain tasks that are essential to attain specific goals within a particular area (Litzler, Samuelson, & Lorah, 2014). The following studies examine undergraduate persistence and success in STEM disciplines.

In an effort to examine STEM confidence of multiple groups of students in undergraduate engineering programs, Litzler et al. (2014) gathered data from an online survey of 10, 366 undergraduate engineering students. The 2008 survey of students in their 1st, 2nd, 3rd, 4th, and 5th year of studies, was designed to measure the engineering climate at universities in the United States. The research examined student self-confidence in STEM courses, or STEM confidence, and looked for variances by gender or ethnicity. The large data set revealed a positive correlation between self-confidence, self-efficacy, gender, and race and ethnicity, and the intersections between them regarding women in STEM. The influence on college students' academic achievement by the two closely related psychosocial attributes of self-confidence and

self-efficacy were reviewed and it was postulated that self-efficacy informs self-confidence. Of the population surveyed women represented 45 percent of the sample. It was found that women of all races except Hawaiian/Pacific Islander and Native American women had lower STEM confidence than White men. Their results showed that the gender difference in STEM confidence was primarily detected among White, African American, and Hispanic students. The researchers concluded that their study provided an understanding that gender differences are not indifferent to racial and ethnic frameworks. This study stands out because of the use of a social cognitive framework to examine how student confidence in STEM varies across race and ethnicity. However, students surveyed were engineering students only, so the levels of STEM confidence pertaining to the specified gender and ethnic groups cannot be adequately applied to STEM majors as a whole. Additionally, the sample of schools was not random, thus the results cannot be overly generalized.

The notion of women underestimating their abilities in math and science fields of study has been rationalized through campus climate, stereotype threat, critical race theory for women of color, and a theory of gender schema. Evans et al. (2010) explain:

> Gender Schema Theory suggests that students come to college with pre-determined ideas about what majors are appropriate for which gender. Students who go against schemas and enroll in an academic program where they are in the gender minority find themselves one of a few men or women in class. Faculty are disproportionately of a different gender from these nonconforming students and even textbooks may reinforce gender stereotypes of who belongs in an education, nursing, or engineering classroom. (p. 339)

This phenomenon can be very problematic to women of color in STEM who are 'nonconforming' and who are faced by feelings of tokenism and alienation.

A study by George-Jackson (2014) examined undergraduate women's persistence in the sciences, focusing undergraduate students' continuance in or switching of majors. Particular attention went to undergraduate women and minorities, male and female, in the STEM fields of study and factors that impact their persistence to continue in STEM. The 4 areas of focus in the study were students majoring in: Physical Science, Computer Science, Math, and Engineering, Agriculture and Biological Sciences, Health Sciences and Psychology, and Non-Science and Engineering (Non-STEM). Data from 11, 944 student participants, using binary logistic regression, analyzed students' persistence in select majors between the years 1999-2005. The study found that students majoring in one of the three STEM categories above had a higher probability of persisting in their major through to graduation as opposed to students majoring outside of the STEM categories. The study also found that students who had a college-educated mother had an increased likelihood of persisting in their major through to graduation. In this study, socioeconomic status correlated with persistence. Students from households earning $60K or less had a reduced likelihood of persisting in their major than students coming from households earning over $100K. The study's findings highlighted the need for intervention programs to be tailored to women in their respective STEM fields, as opposed to a universal approach or a one size fits all model. While this study had relevant findings, the techniques used to measure factors related to socio-demographic characteristics to explain intra-group differences lacked accompanying details exposed through interviews or survey methods.

Interviews were used in a study by Palmer, Maramba, & Dancy (2011), which examined factors promoting the retention and persistence of STEM students of color. Operating from the principle that in order to remain competitive in the global economy it is important to assemble workers skilled in STEM, but as important to increase college access, retention, and persistence

among traditionally underrepresented groups (Black, Hispanic, Native American, and Southeast Asian American) who are pursuing a college education in STEM. Participants in the Palmer et al. study were students of color majoring in STEM disciplines at predominately White college institutions. At the time data was collected approximately 12,000 students were enrolled; 45 percent of enrollees were White, 13 percent Asian, 7 percent Hispanic, 6 percent Black, and 22 percent did not identify their ethnicity. One face-to-face interview, ranging from 90-110 minutes, was conducted with participants. The themes that surfaced as pertinent to STEM majors' persistence included: peer group support, involvement in STEM related activities, and strong high school preparation. It is to be determined if the same results would emerge if from student participants attended a more racially, ethnically, and socio-economically diverse college campus rather than a predominately White institution of higher education.

A quantitative study by Espinosa (2011) focused on the effects of precollege and college experiences on the degree if persistence shown by of undergraduate women of color in the 4th year of STEM majors in comparison to their White peers. The following variables and the relationships between them were considered: persistence in STEM and background characteristics, college experiences, parental socialization, and institutional measures, with the conclusion that the college experience and college environment prove vital in relation to high school performance and family background. The women of color who actively participated in the academic community and STEM activities of their institutions persisted in STEM fields through to their 4th year of study. The recommendations from the findings were that colleges need to create learning environments that promote peer interaction, co-curricular involvement, and access to undergraduate research opportunities for students of all genders and ethnicities.

Cole & Espinosa (2008) conducted a study that examined the academic success of Latina/o students in STEM. The authors contended that Latina/o students would academically perform better when they have cultural congruity within their chosen major. They referenced previous research that suggested Latina/o students are influenced by peer and faculty support and co-curricular involvement when in college, which has a direct correlation with retention rates for this specific population of students. Three concepts were discussed that formed the theoretical background for their study, which included: cultural capital, cultural congruity, and campus climate. The authors looked at students' levels of interracial interactions, comfort and compatibility, and measured it with the college environment. The study's findings indicated that high school GPA had a positive influence on the college GPA of Latina/o students majoring in STEM. The authors explained that high school GPA was the most prominent independent variable explaining the success of Latina/o students after their first four years of study. The data further reflected that Latinas are more likely to report higher GPAs than their male counterparts and are managing to excel academically, despite their underrepresentation in STEM fields. Their study reinforced the notion that supportive educational settings during college were positive indicators of persistence. Faculty mentors and advisors can serve as role models and examples of individuals who have become professionals and successfully navigated the educational system for Latina/o students to look up to, which supports Litzler et al.'s (2014) claim that a lack of comparable role models in the field and little encouragement can result in having lower levels of autonomy in STEM. Another study conducted by Cole (2008) on the role of student-faculty interactions on African American and Hispanic students' educational gains further supports this understanding. Cole (2008) found that constructive criticism, within the educational setting, could offer beneficial opportunities for faculty to improve minority students' academic success

and educational satisfaction. Students who develop bonds with faculty in and outside the classroom are more likely to persist to graduation and these studies have helped to support this notion.

Campus Climate & Sense of Belonging. It is not surprising that most literature ties campus climate and a sense of belonging to persistence and success; it is clear that these would go hand and hand. According to Espinosa (2011), "Relationships among students and their peers, faculty, and other individuals and groups on campus contribute to academic and social normative contexts and related normative pressures" (p. 213). An institution's setting plays a critical role in student success. Predominately White, large, public, research institutions of higher education have been criticized for having large and impersonal classrooms, aloof faculty, and aggressive grading practices due in part to a system that attempts to exclude students from STEM majors (Seymour & Hewitt, 1997). This is an unfortunate reality for many students that are looking to pursue STEM degrees, and it is important that institutions of higher education realize the significant role their campus' climate plays in their students' success stories.

Beasley & Fischer (2012) investigated the impact of stereotype threat on the attrition of women and minorities from STEM majors. They analyzed the effect of group performance anxiety on the attenuation of women and minorities in STEM majors. The authors focused on the correlation between negative stereotypes and anxiety and their impact on students who anticipate stigma. The intersections of gender and race interactions and how female students of color remain a scarce commodity in STEM majors were highlighted throughout the study. Using survey data from approximately 4,000 freshmen students from 28 institutions of higher education, Beasley and Fischer found that minorities experience threat due to negative stereotypes more strongly than their White peers. Gender, however, was not found to be a

contributing factor in their findings. Stereotype threat was found to be positively correlated to attrition in women, minorities, and White men majoring in STEM. Their study was unique in the sense that most prior research focused on the correlation between stereotype and academic performance, whereas their focus was on the relationship between stereotype and attrition.

Johnson (2012) studied perceptions of campus racial climate and the overall sense of belonging among racially diverse women in STEM majors. Several factors were found that are thought to affect women's participation in STEM: self-efficacy, academic preparation and achievement, career counseling and academic advising, lack of role models and mentors, curricular issues and teaching practices, and the seemingly unwelcome climate and/or environment of the STEM fields. Johnson's study utilized cross-sectional, self-reported data collected between January and March of 2004 via an Internet survey for The National Study of Living-Learning Programs. A total of 61 STEM specialized colleges were represented in the study. The study determined a positive association between academic self-confidence and an overall sense of belonging, however the study also explained that being a woman of color had a negative correlation to the overall sense of belonging within STEM fields of study. The study advised that Student Affairs staff educate STEM faculty about women's learning styles and development, with the goal of developing quality mentorships and promoting academic self-confidence amongst female students. It was further suggested that Student Affairs staff help faculty understand their contribution to campus racial climate perceptions in an effort to address racial diversity and students' sense of belonging. The suggestions are pivotal for higher education, where there has been a push for a closer relationship between Student Affairs and Academic Affairs in order to provide greater service to college students.

Brown, Henderson, Gray, Donovan, & Sullivan (2013) conducted a mixed methodological study to uncover issues experienced by African American students in science fields. Their study specifically focused on a comparison of the experiences of 304 students currently majoring in science with those of 307 alumni who had earned degrees in science. The research question was, "Which contemporary theoretical perspectives on access and participation best explain the differences between African American science students in the pipeline and those who have successfully matriculated into STEM careers?" The voluntary subjects responded to a 57-item Likert scale questionnaire about their experiences in science based on theories of stereotype threat, micro-aggressions, and communities of practice, amongst others. Explanations were sought for enrollment issues encountered by each particular group of students. It was found that both participant groups saw race as playing a role in their experiences; the findings told of the prevalent impact of racial bias and the conflict institutions of higher education face as gatekeepers to access to science careers for minority and underrepresented students.

A study by Ong et al. (2011) highlighted the importance of improving U.S. recruitment and retention rates in STEM. They argued that White men, to whom they referred to as the traditional source of STEM professionals, are a declining demographic in the nation and failure to improve the education of women of color and help move them into productive STEM careers, represents a failure of the U.S. to maximize its own talent pool to better represents the ever diversifying population of the nation. The study's aim was to "fill the gap in knowledge regarding individuals who navigate the cultural upheavals and the programs and institutions with whom they interact, with hopes to create a stronger knowledge base regarding which factors promote success for women of color in STEM" (p. 177). This study stressed the importance of the sense of belonging when it comes to women of color and their academic persistence to earn a

degree in STEM. The researchers argued against the disturbing myth that women of color are underrepresented in STEM fields of study simply because they are not interested in pursuing scientific careers. Instead, they proposed, many studies show women of color are just as likely to aspire to pursue an undergraduate degree in STEM as their White peers, yet despite their interest women of color remain underrepresented in STEM degree completion with many scholars attributing this negative correlation of women of color and their interests in STEM and actual degree attainment to educational institutions' failure to develop science talent. Ong and her colleagues referenced educational institutions' "social and structural college environment as the main source of women of color's attrition in undergraduate STEM education" (p. 181). Their study highlights STEM climate as central to the experience of women of color pursuing their undergraduate STEM degrees. The study also stressed the importance of enrichment and retention programs; specifically those offering undergraduate research opportunities, which encourage and support STEM participation for all college students including women of color. The study further cited relationships and influences as primary factors that support women of color in their pursuit of STEM degrees. These relationships included: faculty mentorships, peer involvement that might include networks and/or support groups/clubs, and positive family and community support. The study's findings stressed the vital role that campus climate plays in women's satisfaction and retention in STEM and specified issues of isolation, identity, invisibility, and tokenism when campus climate is not a supportive learning environment.

Pipelines and Pathways. Within the past 5 years the movement to increase STEM representation in the U.S. has increased rapidly. There is an overwhelming agreement that the U.S. needs a more competitive and diverse representation of STEM professionals in the workforce. In support of that perspective, more and more research, literature, and workshops

have evolved to look into pipelines and pathways that promote STEM achievement for K-12 students so they are more prepared to pursue STEM fields at the college level. Lyon, Jafri, & St. Louis (2012) explained:

> As framed by the national education policy priorities, the dominant metaphor describing participation and achievement in science, technology, engineering, and mathematics (STEM) is a 'pipeline.' The STEM workforce requires a pipeline of future scientists, engineers, and mathematicians. This pipeline begins in childhood and carries students through high school, college, and master's degrees, ending with a doctorate and a career in a STEM discipline. (p. 48)

It is anticipated that early access to STEM support programs within K-12 education will help peak younger students' interests and curiosities about the subject matter, and feel more confident and comfortable in their future selected disciplines of study.

There is, however, a "leaky pipeline" according to Lyon et al. (2012) who draw attention to the disproportionate exit from STEM fields of study by girls and minorities throughout their school and college careers. Literature has shown attrition rates of students in STEM fields of study upon entering higher education, which contributes to the underrepresentation of minority females in the STEM workforce because STEM degrees are a prerequisite for entrance into medical, research, and other STEM professions. Attrition and retention are often linked to persistence. Bonous-Hammarth (2000) claims, "… persistence is directly tied to experiences in K-12 classrooms, with student intentions to major in SME fields peaking by high school and marking a continuous exodus thereafter. For almost all students, inadequate academic preparation is a major factor that limits their achievement in the sciences" (p. 93).

Pipelines and pathways are intended to help students find personal meaning and relevance in STEM at earlier ages so that they can actually envision themselves as a practicing STEM professional (Lyon et al., 2012), despite these benefits students can face challenges when utilizing current pipelines and pathways in STEM. Certain restrictions are in place that deny students opportunities to move forward and continue with relevant coursework, most commonly in Mathematics; students may experience difficulties transitioning from primary to secondary school where there is less support during a time when subject matter and content intensity increases and instructional format becomes more structured (Tytler et al., 2008). Building and maintaining a robust infrastructure of strong pipelines between primary and secondary, secondary and tertiary education sectors is the ideal, but instead some students are casualties of a weak, disconnected system that creates leaky pipelines.

Connections to the Literature

Over the past decade, there has been an increase in research aimed at better understanding the underrepresentation of minorities in STEM, however there remains a significant gap in the research that specifically explores the dilemma of the lack of representation women of color in the field. Current research has addressed the importance of self-confidence and self-efficacy levels of women of color majoring subject areas where they feel isolated and alone. Persistence has been linked to success, campus climate, a sense of belonging, and to socio-economic status. Some studies have proposed the need for relatable mentors and accessible faculty as a means to better support these students that are in the minority amongst their peers. Increasing co-curricular activities and undergraduate research opportunities have been highlighted as ways to get students involved. The creation of more entry pathways and support pipeline programs for

students at earlier ages to help make STEM more accessible are found to be stimulating the enrollment rates of minorities in STEM, and therefore increase representation of women of color.

With the inquiry of this thesis into the psychosocial factors present in undergraduate women of color majoring in STEM at a 4-year college institution in mind, review of extant research makes it is clear that there are numerous psychosocial factors that can affect an undergraduate woman of color and her pursuit of a STEM degree. Whether it is accessible pipelines in her K-12 education, self-confidence and self-efficacy levels, success, stereotype threat, feelings of tokenism, campus climate, undergraduate research opportunities, faculty mentorship, peer support or participation in clubs/networks, etc. psychosocial factors have the ability to help or hinder a woman of color in her pursuit of obtaining a STEM degree.

There is a need to expand on contemporary research into this specific population of students in order to better serve our local schools, communities, and nation as a whole to help diversify our STEM representation in the international workforce. Qualitative research on the psychosocial elements that affect women of color in STEM, how they are developed, and what steps these women take to persist in the field would benefit K-12 schools and institutions of higher education by bringing a better understanding of the challenges these women face and how their needs can be best supported to increase retention and decrease attrition. Most research available provided quantitative data collected through large electronic databases, which does not give voice to the lived experiences and personal perceptions of the subjects. The qualitative research presented in this thesis provides for these explanations, which are garnered through face-to-face interviews guided by open-ended questions thereby allowing a deeper understanding of how psychosocial factors affect undergraduate women of color in STEM.

Conclusion

Previous research has moved forward our understanding of psychosocial factors that affect women of color during their undergraduate STEM education as a means to better understand their lack of representation in STEM career fields. While these studies have referred to the presence of specific psychosocial factors that influence the retention and attrition rates of minorities in STEM, more research is needed in this area to specifically address women of color. In the U.S. higher education system, it is imperative that institutions provide equal access to all students in all majors of study. The need for qualified STEM professionals in the nation has dramatically increased in the first decades of the 21st century, while the education system is not providing for an equitable representation of STEM graduates. This notion is fundamental to the context of this study, which hopes to answer the research question: What psychosocial factors impact undergraduate women of color majoring in STEM at a 4-year college institution? This study includes in-depth one-on-one interviews with 6 undergraduate women of color who share unique stories of their STEM experiences. It is important to explore the factors that affect women of color and their representation in the STEM fields of study, so that educators and policy makers can work to promote adequate resources to support this population of students and help them to succeed as STEM professionals. The next chapter presents the methodology for this study as being qualitative and narrative in nature, and provides information pertaining to study participants, setting details, and data collection.

Chapter Three

Methodology

Overview

There is a documented underrepresentation of women, and specifically women of color, in STEM fields of study within the U.S. as shown in the literature review in Chapter Two. Women lack representation in the most mathematically concentrated college majors and graduate programs, however women tend to have higher representation in other scientific fields that are more related to the humanities and social sciences that tend not to attract as many male students (Ceci et al., 2014; Ayalon, 2003). This shortage of women, and particularly women of color, in STEM is detrimental not only to the education system and the fight for equity, but also to the nation as a whole. The U.S. population is considered a melting pot of ethnicities and cultural backgrounds, yet our nation does not reflect that same diversity in its population of STEM professionals. The demographics of the U.S. have shifted to the point where White males are no longer the leading majority in terms of both population and of college graduate numbers with more women and minority ethnicities earning baccalaureate degrees at higher rates than past decades. The relevancy of the term *minority* pertaining to non-White male persons is no longer accurate. As the diversity of the nation continues to increase, failure to address the need of STEM education for women of color and move them into professional careers in the field represents a failure of the U.S. to maximize its own talent pool (Ong et al., 2011). Bonous-Hammarth (2000) notes, "Aside from the individual benefits of low unemployment and competitive wages found in [STEM] employment, as a nation we reap rewards by having a workforce that is more representative of all our citizens" (pg. 92). This qualitative study aims to uncover and understand the possible influence and effects psychosocial factors have on

undergraduate women of color currently majoring in STEM fields of study. What is learned from their experiences will have the potential to impact institutions of higher education and how they think about student retention, success, equity, and degree attainment.

In order to discover the effects of psychosocial factors on undergraduate women of color majoring in STEM and how they may have influenced their motivation to persist and complete an undergraduate degree in the field, a brief survey and audio recorded one-on-one interviews were used to gather data from the voluntary research participants. The participants were asked to recount their personal stories and academic experiences as women of color in the STEM field, and to describe how they sustained their interest and maintained perseverance over time. This method was chosen to enable students' voices, unique experiences, and personal skillsets to be recognized. It was regarded as the most appropriate approach to gain data that would answer the guiding question: What psychosocial factors impact undergraduate women of color majoring in STEM at a 4-year college institution? Discovering how the educational system is navigated by this minority sub-group of students in the STEM fields can aide institutes of higher education to ensure that steps are taken to encourage and support more women of color as they follow their passions and persist in STEM education.

Research Design

This qualitative and narrative research study focuses on the stories of 6 undergraduate women of color who are majoring in STEM fields of study. Palmer et al.'s (2011) study "Qualitative Investigation of Factors Promoting the Retention and Persistence of Students of Color in STEM," strongly supports this method of research. The goal of this current work was to gather exploratory data from 6 women who met the research criteria, and conduct a comparative analysis across the data. I did not have a hypothesis going into this study. Studies continue to

show that there is a shortage of women of color in STEM. Why? I wanted to hear the stories of the experiences of women of color who are currently in STEM, and listen. How did they get to where they are? Why did they choose a STEM field? Do they know that they are a minority in the field? These are examples of the questions that guided the conversations. Glaser and Strauss' (1967) Grounded Theory supports this mode of data collection stating, "We believe that the discovery of theory from data-which we call *grounded theory*-is a major task confronting sociology today... Most important, it works-provides us with relevant predictions, explanations, interpretations and applications… A major strategy that we shall emphasize for furthering the discovery of grounded theory is a *general method of comparative analysis*" (p. 1).

The instrument choices for this study are most appropriate to gather personal accounts from the participants and to attain a better understanding of why these students chose to pursue an educational career in STEM and how they persisted when evidence shows that the odds of success are stacked against them. Conducting one-on-one interviews provided me with the opportunity to get to know my participants, and create a setting in which they were able to tell their stories in an unconstrained and more open-ended setting (Creswell, 2012). I was certain this approach was a more personable way for participants to connect with the researcher. The participants were able to control how much information they wanted to share with me, which increased the comfort level both of the interviewer and interviewee. I wanted the students to feel at ease when speaking with me, not have to engage in conversation they perceived as forced or contrite, and although participants were asked a series of set questions to help guide them in narrating their story, a conversational dialogue did occur. The interviews were organic, with further topics of individual importance and interest transpiring as questions were asked and answered. I listened to the student participants speak of their experiences in a manner consistent

with Gilligan & Eddy's (2017) *Listening Guide*: "In listening for what is unspoken as well as for what is said, for contradiction and for the ways in which one voice can interrupt or silence another, and in recognizing that we often do not say what we mean or say it indirectly, the Listening Guide is a psychological method" (p. 76). Listening to gather data without a hypothesis or preconception of the outcome was further confirmed as most appropriate for this research study by Glaser and Strauss' (1967) contention that, "Theory based on data can usually not be completely refuted by more data or replaced by another theory. Since it is too intimately linked to data, it is destined to last despite its inevitable modification and reformulation" (p. 4). Grounded theory and the listening guide both helped guide me as a researcher allowing me to understand the importance of listening to the spoken and unspoken words of my participants and not formulate possible conclusions in advance of gathering data.

Participants & Setting

The participants in this study were 6 upper division (junior and senior standing) women of color majoring in STEM disciplines, attending a public state university located in Sothern California which considers itself to be a multicultural campus and which has earned the designation as a HSI. The University is located between remote agricultural areas and mountains and yet is only one hour from one of the nation's largest metropolitan cities. To help me better comprehend the number of women who declared their major in the STEM fields of study over the previous 5 academic years, I obtained the female STEM major demographic data from the participating university which is reported in the following table (Table 2).

Female STEM Counts by Ethnicity					
Ethnicity	**Fall 2012**	**Fall 2013**	**Fall 2014**	**Fall 2015**	**Fall 2016**
Asian	40	48	50	58	50
Black or African American	12	11	18	17	18
Hispanic or Latino	191	228	277	321	347
Native American/Pacific Islander*					14*
Two or More	28	29	27	31	36
Unknown	27	33	30	25	29
White	184	175	179	172	161
Total	482	524	581	624	641

*14 total for all 5 semesters; data had to be combined since if separated out by semesters, the numbers would be too small

Table 2: University demographic data

Participants responded to a posted flyer that was distributed across campus, which can be viewed in Appendix F. A total of 7 students responded to the flyer and made initial contact with me within 2 weeks of the flyer being posted. One prospective participant chose not to move forward. Table 3 provides a summary of the 6 participants' academic profiles.

Participant	Major	Minor	Academic Standing
A	Biology	Chemistry	4th year Senior
B	Biology		3rd year Junior
C	Environmental Science & Resource Management	Chicana/o Studies	5th year Senior
D	Health Science		3rd year Junior
E	Biology	Chemistry	3rd year Junior
F	Biology	Chemistry	4th year Senior

Table 3: Summary of participants

Data-Collection Procedures

Prior to starting the research at hand, primary approval from the university's Institutional Review Board (IRB) was obtained along with the National Institutes of Health (NIH) Certificate of Completion (found in Appendix E). The NIH training is intended to protect subjects by preparing researchers to minimize risk factors. To further minimize risk, permission from the university's dean of students was sought before the flyer was distributed. A copy of the 'gatekeeper letter' that was sent to the dean of students can be found in Appendix C. The letter is based on an example provided in Creswell (2012). Once approval from the IRB was received, the data collection began. The first step was to post the flyers across campus via the university's Student Engagement and Applied Leadership Center.

Within two weeks of the flyers being posted around campus, 7 prospective participants, who met the search criteria, contacted me and initial appointments were scheduled. I met with each participant individually at a designated office location on campus. The initial meeting was to provide information and to answer questions about the study and the protocol to enable volunteers to make informed decisions about participation. Of the 7 prospective participants, 1

made no further contact and did not proceed. The 6 who wanted to continue were each guaranteed anonymity for the study and were assigned an alphabetical letter identity code on the day that they interviewed, ranging from A to F.

Once participants made known their interest to continue participation, I provided each an 'informed consent' form to sign prior to participation in the study, a copy of which is provided in Appendix D. Its format and content is based on an example provided in Creswell (2012). Interviews did not begin until a signed informed consent form was received, at which time I scheduled a second appointment with each student participant at the same designated location. Each participating student was interviewed individually and was subject to the same research prototype conditions. All interviews occurred in the same location and took place on different days, so as to further ensure anonymity amongst each other.

At the beginning of the second meeting, each participant was provided with a laptop and a link to a Qualtrics survey, which comprised of 10 questions and took less than 5 minutes to complete. The survey questions can be located in Appendix A. The survey data supplemented the primary one-on-one interviews by providing participants' background and demographic data. Following completion of the survey, I interviewed each respondent. Two audio recording devices were used to ensure that the interviews were captured for analysis; one was a handheld audio recorder, the second an iPhone voice memo application. I utilized an interview protocol, or list of questions, to aid in the organization and flow of the interview sessions. According to Creswell (2012), "An interview protocol is a form designed by the researcher that contains instructions for the process of the interview, the questions to be asked, and space to take notes of responses from the interviewee" (p. 225). These specific procedures were chosen for this qualitative study because narrative research aims to portray the lives of individuals by collecting

and telling their personal stories through chronicling their experiences (Creswell, 2012). While the interviews were being audio recorded, I listened and noted body language and any other psychosocial behavioral responses to the questions. Gilligan, Spencer, Weinberg, & Bertsch (2003) explained, "The listening guide is a method of psychological analysis that draws on voice, resonance, and relationship as ports of entry into the human psyche" (p. 157). Gilligan et al.'s (2003) listening guide supports my methodology choice and further supplements the grounded theory research design of the study. Grounded theory designs are primarily composed of systematic and qualitative procedures that researchers use to develop a broad explanation based on the views of participants, which help to explain a process, action, or interaction among people (Creswell, 2012).

During the one-on-one interview, I asked the same questions of each participant. These questions can be found in Appendix B. Participants were not provided the set of questions in advance of their scheduled interview date, however copies of the questions were provided at the start of the interview with the purpose of acting as a reference point and an *aide memoire* for the respondents. Participants were made aware that I would not impose a time limit for their responses and that the amount of information they chose to disclose would be determined by their own comfort level. The briefest interview lasted approximately 23 minutes, with the lengthiest lasting 1 hour and 20 minutes. The depth of answers also varied, some were very detailed while other questions received a sentence or two in explanation. I remained flexible on the structure of the one-on one interviews; the questions served as a guide but did not restrict the conversation of the interviewee. Some follow-up questions were used to maintain the conversation flow when needed and also served to probe for clarifying or additional information (Creswell, 2012).

Data Analysis

"Qualitative researchers analyze their data by reading it several times and conducting an analysis each time" (Creswell, 2012, p. 238). Once all of the data were collected, I sent the recorded audio files to a transcription service (Rev.com), who then sent the files back in written form. The interviews were transcribed to included pauses, um's, ah's, likes, etc. Keeping transcriptions in their natural state allow participants' voices to speak for themselves (Oliver, Serovic, & Mason, 2005). By keeping these pauses and filler words in the transcriptions, I was able to recognize certain cues such as hesitation, lack of comfort, and to consider participants' feelings as they contemplated and responded to the question being asked. I read through the transcriptions 3 to 4 times, took notes, and coded for reoccurring themes. On each reading, I developed a fuller understanding of the information the participants provided (Creswell, 2012), thereby forming a more accurate record of the conversations that took place. The Qualtrics survey reports were downloaded into spreadsheets and reviewed for commonalities and differences.

The subjective nature of qualitative research gives rise to the term 'interpretive research,' due to the researcher making a personal assessment of description or naming a theme that captures the major categories of data (Creswell, 2012). In order for emergent themes to be determined, the data were first coded.

Coding is the process of labeling transcribed text to form descriptions and identify themes in the data (Creswell, 2012). The initial review of each set of transcripts focused on highlighting keywords and phrases that were found in response to the questions that were asked of the participants. During subsequent reviews of the transcripts, I began to code keywords and phrases that emerged. To distinguish primary codes, I utilized a variety of colored highlighters classified

by a key for my own reference. This helped with the identification of emerging themes. Creswell (2012) explained themes as a cluster of similar codes combined to produce a principal idea from the data. They are a fundamental element in qualitative data analysis. I decided to code the transcripts by hand rather than use coding software because the experience would be more organic and keep me immersed in the process.

Limitations

Creswell (2012) described limitations as potential weaknesses with the study, identified by the researcher. As the researcher and designer of this study, I recognized that there are expected limitations. One limitation of this study is the small sample size of 6 participants in total. Therefore, the study's findings may not reflect or capture the experiences of all undergraduate women of color who major in STEM fields. Conducting further interviews may yield new, broader, and more representative information. The low number of students who expressed interest in participating in this study is indicative of the size of the university. The university has a total enrollment of almost 6,600 full-time equivalent students, and 25 majors, this poses another limitation for generalizability. The university's HSI designation is another possible constraint; the findings might not portray the experiences or viewpoints of a wider ethnic diversity of women who major in STEM at non-HSI campuses. The fact that the participants all came from the same Californian institution is another restriction. Findings of this study may differ from other studies conducted at college campuses outside the state of California. Lastly, the short time frame for the study was a limitation because the amount of data I was able to gather was curbed and is restricted entirely to undergraduate experiences in STEM as opposed to collecting data over an extended period allowing the tracking and cross referencing of data amongst the participants after graduation and into their professional careers in the field.

Conclusion

This chapter reviewed the methodological practices and procedures selected and implemented for this study, and presented the rationale for the selection made. Chapter Four will address the findings and results of the study, which may lead to answering the central question, what psychosocial factors impact undergraduate women of color majoring in STEM at a 4-year college institution? By answering this question, the findings can extend the existing understanding of the causes and solutions to the retention, attrition, and equity of access for higher education STEM students who are women of color.

Chapter Four

Findings

The purpose of this study is to understand the experiences of upper division undergraduate women of color currently majoring in STEM fields of study. Specifically, the possible effects psychosocial factors have on the experiences of these female college students. Chapter One describes the purpose of this research study and the ailments of having an inequitable representation of women and women of color in the STEM disciplines. Chapter Two provides a review of the literature to further strengthen and support the necessity and legitimacy of this study. Chapter Three explains the qualitative research design that guides this study and aids in the identification of themes that express the participants' voices. This chapter will present the findings from the Qualtrics survey data that were collected and the identification of 4 common themes (altruism, support, challenge, and opportunity) that were revealed by my analysis of the one-on-one interviews. The 4 themes support the conceptual framework of this particular study.

Qualtrics Survey Data

The Qualtrics survey data showed that 83% of the participants were aged between 18-22 years with 17% between the age range of 23-27 years. The academic standing of 50% of the participants is of junior standing students and 50% are senior standing. The ethnicities of the participants varied: one participant identified herself as Filipino-American, one as both Black and Mexican, one as Korean-American, one as Mexican-American, one as Latina, and one identified as Hispanic. It is important to note that question number 6 on the Qualtrics survey, which can be viewed in Appendix A, was an open-ended question, ethnicities were not pre-listed because I wanted participants to self-select the ethnicities with which they most identified without having to fit themselves into pre-constructed labels or categories. Fifty percent of the

participants were first generation college students, meaning they are the first in their families to attend college. All 6 participants reported being satisfied with their choice of major. The Qualtrics survey data supplemented the information provided by participants during the one-on-one interviews, and informed the subsequent analysis of themes that were derived and consequent findings collected.

Themes Arising from the One-On-One Interviews

Careful and systematic analysis and coding of the transcribed personal interviews revealed 4 prevalent themes that were common to each participants' description of their experiences as a student majoring in a STEM discipline: altruism, support, challenge, and opportunity.

Altruism. A recurring theme in the interviews of all 6 participants was that of altruism. Each explained in their own words that they chose their major not only to satisfy their own desires, but also out of concern for the wellbeing of others. This notion of pursuing a major because of the possibility to impact the lives of others was expressed in quite different ways with different hoped for outcomes: to create consumer products that are safe for the sick and promote awareness about the ingredients that can be harmful to one's health; to change failing systems that are in place; to become a professional who can support and give back to the family that provided for you; to be a role model for younger siblings; or to be a leader in the field who is trained in and enforces health law and regulations so as to keep vulnerable populations safe. Each of these reasons shared altruistic characteristics.

Participant A reinforced the idea of altruism when she explained in answer to the question: "What made you choose your major?"

> I chose my [biology] major because I was interested in cosmetic products and how they are made. Where do these products come from? What is in them? I also intended to get

> into Biology because I have a grandmother who was diagnosed with stage 4 breast cancer, so she uses all these products, and sometimes these products aren't as good for you when you are sick and you are [taking] different medications. She had to turn her whole diet around and use different products. So, it made me understand, okay, I'm in Biology and I know I can do something about it, so I thought of better quality products for cancer patients. I am still going about how to get these products together, like shampoo and conditioner [daily use products]. I was thinking of a bundle that could be sold, recommended through medical staff, or advertised through commercials because the rate of cancer has gone up and I think it would be very beneficial for them.

Participant A further explained that one day she would like to establish her own makeup and product line that would be geared towards the sick, that would be reasonably priced, but would also contain quality natural ingredients beneficial to one's health.

Participant C held altruistic ambitions when choosing to major in environmental science and resource management (ESRM). She connected with her early experiences of helping her mother garden in the mornings, and how not everybody has the opportunity to grow their own food.

> I took the [ESRM] 100 class, and I think just now, looking at all the science, it's weird because it kind of reminds me of my mom. I hated planting with her. I hated it. She would always wake us up and we'd always have to go gardening, but that was a sense of providing food for yourself, and I think that's what basically everybody should be able to do. I guess it kind of sucks because it goes into the justice aspect that some people do live in these places that they don't have access to that. [Those with little means] go to McDonald's where a salad costs $6 and a chicken costs $1. I think a lot of things pushed

> me to want to be in this field and want to learn more. I ultimately love the earth, I love everything. I love how people can put a name on something and that is what it does. Like, photosynthesis. You know? I find that amazing.

Participant C had clear aspirations for what she aimed to achieve by studying her major. She was enthusiastic to learn about the earth and how human actions can affect the environment, and how the environment affects human actions. She described her frustration with the cost of quality food and how that affects those with limited financial means in making healthy dietary choices. She was frustrated with the current political climate in the U.S. and the Administration's choices in regards to the Environmental Protection Agency (EPA) budget cuts. Participant C was very vocal about her love of the Earth and ambition to improve life on the planet:

> [In ESRM] we kind of forget about the people and, for me, [I like to ask] how we can help the environment and help the people? We can figure out how to work with our environments.

Participant B explained how she decided to major in biology because it was interesting to her, but it was also a compromise because her parents wanted her to become a doctor. She explained:

> All Latino parents expect you to be a doctor, a lawyer, something higher up and at first I was like, okay, maybe I'll just go [to school] and be a doctor, but then I felt there was just too much schooling. I just felt like that wasn't really for me, so I just thought biology sounds interesting and it's something I most definitely will find a job doing so my parents will still be like, "Okay, you're doing something with yourself, but also something that we like."

Participant B was satisfied at the compromise on a field of study that satisfied the importance of making her parents proud while at the same time choosing a major that was right for her.

Participant D conveyed the altruistic nature of her choice of major as she explained that health science matched her interest in leadership.

> I like doing a lot of leadership things. I wanted to learn more about [health] law. When I was [at a community college] doing a CNA [certified nursing assistant] program, I got too caught up with the patients and my mentor/teacher told me, "Maybe you should become an administrator instead" because I was concerned about a lot of the rules and regulations during that time.

Similarly, Participant D also portrayed altruistic intent in her explanation of why she is vocal in the classroom and asks most of her general questions during class, as opposed to asking privately after class or during an instructor's office hours:

> Because I know that's [talking with my professors during class] more effective because other students get to hear the questions I'm asking. Also, it sets that atmosphere where other students are going to ask questions after me.

When asked about her thoughts on the representation of women of color in STEM, Participant D explained:

> As a student, this is a question that we don't think about, but if we do think about it, it's interesting… Yes, it is true that there's more men in STEM, but I think that's with everything else, as well, even in the workforce. Everything, a majority was always men. Now that technology and science is increasing, and it is very important for the future, it is important for women to step up because even with the testing that is being done, it's all men. Not a lot of women are there to be there and obviously men and women are

> different; our bodies, biologically, physiologically, everything is different. Even the medicines we have, it's catered more towards men, and that could be dangerous to women. So, the more we have women representing STEM, it would be fair. No, it would be better, generally, even with educating the next generation. We can then separate those two, men and women, because you can't just have science devoted to one thing.

At the end of her interview, Participant D wanted to add:

> I think it is important [to say], I think we kind of use individuals of color from other countries to do these technical things [for us] in America. Like, when we're using computer technology or science, we are just depending on others, but I think we need to start from us [early on in] the education system from Pre-K to 12. We need to teach our future generations to be able to do STEM for themselves and not to depend on others. I get really excited when it comes to science and now that I am in health science and we are talking about statistics, this is why I think it is so perfect to come here and talk about it with you. Health science opens your mind to these things, like why we need to do certain things to make it a better place… I didn't always think about the future. I didn't think about anything. I just thought, I need to figure out the problem and find a solution. Now that I am in health science, I am understanding that STEM is important.

Throughout the interview, Participant D explained many reasons for her desire to be in involved in health administration and to become a leader in the field as a way to benefit and impact the lives of others.

The theme of altruism was introduced during my interview with Participant F when she answered my question, "Did you ever feel like giving up or changing majors?'

> … I'm very privileged to be surrounded by a lot of supportive people who see the value in changing your mind, and trying to reorient your life so that you are at the center of it all. So, whenever I felt like giving up, even now, I think of my family. I'm very family oriented. I have two younger brothers, and they're both autistic, and I want to put them through college, and I just want to do all these things for them and be the person that I wish I had when I was growing up. Then, for my family too because my dad and mom, they're always like, "We worked really hard to emigrate from the Philippines, and we left our families to make our own, and to make a living." At a younger age, I didn't think much of it. I was like, well whatever. But then now, I'm an adult, and I understand it completely. The struggles don't equate, but there was struggle nonetheless. So, I think my personal struggle is to be able to take these challenges and be okay with them, and to conquer them as best as I can and be driven by the idea that this… My decisions don't only affect me, but they affect the people that I care about. I have been told that I'm really selfless in that way. I don't think of it as a selfless act, but anyway, I just think it's an obligation because my family came here. They changed their lives completely to make a family, to make me, make my brothers, and what do I do? What could I do to repay that? I can't. The best that I can possibly do is get my education and show them they didn't come here for nothing, and that they raised me right... With that in mind, that's kind of my own personal mantra, to be able to think, "This isn't just for me."

At the end of the interview with Participant F concluded:

> It's important to really be there for one another, and to be kind and to be considerate of what others are going through. Once we're able to understand each other on that basic level, then I think that's when we can start making a difference. There can be some

> movement forward in this whole push for equality because I always just think that if I can do it, you can do it too, but it's more like, we can do it together as long as we're there for each other.

Participant F's sense of altruism was highlighted throughout her interview. She was aware of her family needs and kept those in perspective with her own. She was committed to the notion that in order to be successful in STEM, students need to support one another.

Altruism also surfaced in my interview with Participant E when I asked her: "Did you ever feel like giving up or changing majors?'

> I'd like to say that I got past the giving up, but that's not true. With every bad grade, it's like, "Why am I here? Why am I trying to do something that's just so difficult?" But what I do to remind myself is that I see my degree as not totally belonging to me. It's going to have my name on it, but at the end of the day, the people I help along in the future, it belongs to everyone there. I work better when I realize I'm not just doing things for myself. I'm doing it for the benefit of humanity in a sense.

I responded with a follow-up question, "Helping others is what motivates you to persist through challenges?" She replied, "Yes. Yes. And the other people I inspire along the way." She had many aspirations to help others and made it clear that was a primary motivator for her to accomplish her academic goals.

Regardless of the stories they told and the explanations they provided, all 6 participants introduced themes of altruism and selflessness and how these traits were personally important and fundamental to the decisions they had made about the academic pathways they had chosen. In the one-on-one interviews there was overlap in the sense of responsibility the participants assumed for others as well as self, and the tensions that may occur.

Support. Another theme that arose when analyzing the set of one-on-one interviews with participants was that of support. 100% of the participants mentioned the theme of support when talking about their academic journey in STEM. In discussing support that was received or perceived, participants mentioned the role played by: parents, family members, faculty and faculty mentors in their college careers; K-12 STEM experiences; clubs; and peers. This notion of having a strong support system emerged in each interview and in some cases, was a reoccurring theme throughout the interview process. Support can come in a variety of forms but to the individual receiving it or the individual in need of it, it steered the direction of her success.

Participant B discussed how she has a supportive family, started working at a Learning Resources Center (LRC) close to where she lives and regularly utilizes the STEM Center at the university which helps to keep her focused on and feel supported in her studies:

> I've got a very supportive family since the start… I go to the STEM Center a lot. It's a nice environment to just even study there. Then the LRC, I just started working there. Everyone's really friendly and they seem like they want to help you. Since the STEM Center has it all, like Latinos too, I've noticed that… Which is also very motivating too.

Participant B felt that the support she received from these resource centers and having peers that she could relate to, helped her to stay focused in her studies.

Participant A focused on the support she receives from her family in her response to question number 3: "Do you feel like you had support from your family pursuing the major you chose?"

> I do feel like I have a lot of support and I got support from my family coming into college and also when I was younger, but more so I think I have more support now that I'm in college. Just because I'm the first person in my family to… I'm the oldest, so I feel like I

> have a bit more pressure, and I also want to do this for myself. I want to pursue higher education, but my parents have always pushed me to do whatever makes me happy and whatever is best for me in my long-term future.

Participant A further explained how the support she receives from family also puts pressure to finish:

> Sometimes I feel like I don't have the support just because [my parents] also have a life and I have a life, so my life isn't going to be revolved around them and they're not going to be revolved around me all the time. But, I really do feel like I'm supported at home. Families aren't perfect, but I really do feel like I'm supported and, one day, I think for my parents I can turn around and do the same thing that they are secured and that they're living comfortable. Right now, it's just a little push for me to finish.

Participant C discussed the support that came from her K-12 experience and clubs in which she was a member. She also addressed the disconnect she feels from her family in regards to her studies and how that makes her feel:

> I remember in 6th grade we had an overnight type of science camp opportunity. I think it was $100 or something. All of my friends were going, so I wanted to. I talked to my teacher and she told me there was a fee to attend. She gave me the option to fundraise, so a group of us did and we got to go.

When I asked Participant C about support she had received from her family while pursuing her chosen major (question 3), her response was:

> Not really because I think my family, every time I try to explain, I have this language barrier with my parents. I do know Spanish, but saying the major is very, and what it actually does, it's hard. My parents would always tell me like, "Oh, well if I went to

> school, I'd be a criminal justice or FBI agent," or my dad was like, "I would be an engineer." It's kind of like, even in the hard sciences or whatever, my major is still seen as not that "sciency."

For Participant C, her strong involvement in clubs and relationships with friends bolstered feelings of being supported and motivated when she felt like giving up after twice receiving a D in a chemistry course:

> It was very disheartening. It made me think of myself less. I just felt dumb, like why don't you get it? Not even dumb, like maybe you could've done it, but you didn't do it. You didn't do the homework, you didn't do this, you could've tried harder. That really just got me down. I don't know what exactly motivated me to stay. I think maybe it was my friends. Maybe it was… I was in the Green Generation Club, so I knew everybody there. I never told anyone in the club about my failing chemistry, but I remember hearing from a lot of people in the club that chemistry was hard for them, so that kind of made me feel better. Green Generation was the first club that I got into. I saw so many different faces, so many backgrounds, so many everything, and we all had one thing in common, we loved the earth. I loved talking to all of them, and they were so outgoing. I think if I turn my back on environmental science, I feel like I would've turned my back on that, so maybe that's kind of how I stayed.

Participant E considered that she received mixed support from her parents because of her choice of major:

> My father is a computer software engineer. Numbers are his thing. Growing up, he always emphasized the importance behind math. When I told him I was initially becoming a nursing major, he's like, "That's good. You are going to find a job right

> afterwards." Then I told him about biology. He was like, "Whoa, that's a whole other world. What are you doing here?" My dad has always been, "Whoa. I don't know that much about it, therefore I'm kind of iffy." But, my mom was totally for it. She is totally backing me up 100%. She doesn't understand the stress that goes behind it, but she's totally down and supporting me in any way she possibly can.

Participant E went on to explicate how she did not feel supported by treatment she received as a woman of color in the STEM field:

> Being a woman of color, since I am Black and Mexican, I am not taken seriously whether it be from certain professors on campus or my peers. Even when I go to conferences and talk to professionals, I find that when I tell them I'm seeking to pursue a career in the whole science field as a researcher, I get a lot of second takes, or like, "Really? What are you doing? Why do you want to do this?" I get a lot of, "You know, it's a lot of hard work." It's just like, well, you all don't even know me, but okay. One of my lab partners who I've had for the past 2 years, he's a white male, so it's like when both of us have questions, if I ask the same question to a certain professor, it's kind of like, "Well, why don't you know this?" Whereas if he asks it, then it's like, "Oh, it's just this, this, this." It's kind of like, okay, different treatment.

In discussing her attendance at a STEM conference, Participant F saw that it had helped her feel supported.

> I went to a conference my junior year and this conference is STEM oriented. The mission of the conference is to diversify STEM and try to encourage underrepresented minorities to pursue higher education. There, I was exposed to so many different career

> opportunities and I met a lot of different people and networked in the way I've never really networked here. I came back, I felt supported, motivated, and energized.

Her family has always supported Participant F's goals in higher education and this removed pressure from her.

> It's not even because they're involved in medicine, but it's like… They never pressured me to do anything I didn't want to do. If I wanted to major in art, they'd let me major in art. If I wanted to major in math, they'd let me major in math. It wasn't even a thing that I needed permission to do, it was like, "If you want to do that, then you get to do it, and whatever you want to pursue after your undergrad, that's your prerogative."

However, Participant F encountered adverse treatment also.

> I am aware of the controversy, and the issue of being a woman of color in STEM, because there's a very large amount of misrepresentation, and there's lack of equality. I have experience, there's one that popped out the most to me, I think it was at a network event here, and I wanted to talk to somebody, but there was a man, and they were talking, and I stood there for a while not really being noticed. I didn't think it was because I was a woman, and I didn't think it was because I was a woman of color. I thought it was because I was short, and then I was like, "I am short. I'm 4'11"." I don't have the size and the aesthetics. Obviously, there's this type of superficial reality to looking at somebody and be like, "Okay, maybe I want to talk to them more than whatever."

Participant F continued:

> Now that I'm talking about it, it's been a while since I've talked about it. I'm just thinking, "Oh, I wonder why I wasn't spoken to?" But I kept thinking like, "Oh, maybe it's because I'm short. Maybe because I haven't really, I don't have the physical demeanor

> I guess to allow somebody to see me," I suppose. But with that, I think aside from that, I've never experienced explicit negative treatment, because of being a woman, for being a woman of color, but I have seen it with my friends. At the conference that I told you about, it's a yearly conference, so I went to it last year. I have a couple of friends who wanted to pursue careers with NASA, and they stood at the booth ... NASA and the NSA, it was interesting seeing the dynamic, because at NASA they were very welcoming, very welcoming of the women and they're like, "Yeah, we need more biologists. We need more chemists. We need you to add diversity to this whole organization association." Then, next door, was NSA. There was a man there who was sitting with one of our ... He was standing, and there was one male friend, and then one female friend. Then, I saw ... Oh my gosh, just thinking about is making me, ugh. But, this guy he was like, "Oh," so he looked at the guy and said, "You look like a math major. I think you're short for the NSA," and totally disregarded me and my other friend.

Reminiscing on this experience, caused Participant F to remember frustrations that she tried to bury away.

Family support during her early years was critical for Participant D.

> My dad didn't really give me many toys, but if he did, I remember he would always tell me… He would give me an actual keyboard, and he would say, "In the future, this is going to be your future, so learn how to use it." So, I was only like 5 years old, and for 2 years I would learn how to do the ABC's on the keyboard and trying to type as fast as I can. So anything with the computer or science, I just loved it. My brother majored in bio and chemical engineering, so we would always talk about science together and that gave me moral support.

Participant D also spoke to how she received support from participating in Kumon during her K-12 years.

> Kumon is… It's not part of school or anything, but basically, they take anybody that's interested in learning math, reading, and English. So, you are supported in self-learning. That helped me lot.

Half of the participants specifically described faculty support that they had received during their STEM education and how it affected their experiences. Whether it was participating in undergraduate research with a faculty member or attending regular office hours, Participants F, E, and C all described how those connections or lack thereof made them feel supported throughout their studies.

> Participant F:
>
> I have a really strong relationship with faculty within my major. I visit my professors weekly, and sometimes I feel like I have to tone it down because they might be like, "Oh man, she's here again." But, yeah, I visit them often and I do talk to them. I think opening up that way, I remind myself that they're people too, and I know that they enjoy hearing feedback from students of how well they are doing or maybe they need some type of critique. It's almost like therapy to talk to a professor who understands what you're going through because they're teaching the class you are struggling with. Otherwise, you wouldn't be there. They don't want to hear that you're perfect and that you're doing extremely well in the class. They want to hear struggle and then help you find a path to overcome those struggles and endure it.

Participant E:

When it comes to seeking help and asking questions, I am very hesitant because I had this experience my sophomore year in my first general chemistry class. The professor was just extremely rude. Within the first 5 weeks of the semester, I went to his office hours. I got a grade on a test that I wasn't happy with. I scheduled a visit and sat down with him. By the end of the session, actually throughout the whole session, he was acting really weird. I'd ask him questions and he's like, "I don't know. You're supposed to know this. You're a student." I specifically sent an email saying, "I am hesitant on these questions. Can you please just reassure me that I'm approaching this the right way?" By the end of the session, he basically said based on the questions I was asking, I should stop attending class because I'm going to fail the course. There was no need to really show up to class anymore if I was him. He laughed in my face when he said that. I was like, "Okay, that was lovely." I passed the class with a C. Not the best, but I still passed it. That [experience] really affected the way I approached my future STEM professors because I started to second-guess myself, whether the questions I was asking are right or wrong.

Participant C:

Well, ___, was always awesome, but she's really busy most of the time, so I don't really get to see her that much, but I did have the opportunity to go to Costa Rica with her for the class I was taking. I think that was when I really told her that she helped me embed myself into my major. Seeing her and hearing her talk about her interest and passion, really helped me figure out how I want to be as a person, and maybe, hopefully a professor one day. Just her as a woman in STEM, I think really helped me.

Also, one half of the participants discussed their frustrations around the issue that historically women of color in STEM have not been supported and that they had to learn the success stories of women of color through Hollywood movies, specifically referencing the film *Hidden Figures*. Participants B, C, and E each mentioned that they had never heard about the women in *Hidden Figures* until they watched the movie and how frustrating that had been for them. Question number 11 in the one-on-one interview protocol asks: "What are your thoughts on the representation of women in STEM, more specifically, women of color in STEM?" Participants B, C, and E responded:

Participant B:

Admirable. I just admire them. They seem so strong and tough. I just saw *Hidden Figures*. They just seem so strong and tough; very confident. I see them as very confident. I feel like they didn't get much support. I don't know, just personally I feel like any woman of color just probably doesn't get as much support as other races. Just women in general too, so it's like color plus being a woman.

Participant C:

I feel like I don't hear that much about them. I don't know if you went, but there was a *Hidden Figures* showing [at the neighborhood theater]. Having that representation of women that have done it, [right now] maybe it's not really that much advertised or shown that much in the media, or in our history books, is important. I feel like that should have been in our history books. They did everything by hand. That was crazy. I want to see more women in STEM, and I don't want it to be forcibly put on them, but I think that there is a way that we can get people interested in it. I know ___ ___ college has a GE requirement that incudes computer science and so everyone is required to take a

computer science course and with that they found that people really like computer science.

Participant E:

We're not appreciated. When you are growing up, you're in K-12, you're learning about the first man that walked on the moon. We don't learn about the woman who actually hand-wrote the code to get him to the moon. You don't learn about the women that influenced major accomplishments in STEM. For me, personally, the way I have to find out about women of color in STEM is through Hollywood, and movies, and all of that. It seems as though it's a scavenger hunt. When you do find a woman in STEM, you're just blown away. That should not be something. We're just not taken seriously. Just like the fact that we're the backbone of not only STEM, but a lot of different things we have now. Yeah.

The theme of support was one which recurred throughout all 6 interviews and was expressed though related ways.

Challenge. The third theme that arose through transcription analysis was that of challenge. All participants in this study recounted how they enjoyed overcoming challenges, specifically challenges within their majors, and how that drove them to persist and succeed in their academic careers. While the experiences of challenge varied amongst the 6 participants, there was a clear parallel in how each person was motivated to overcome those challenges in order to meet their goals.

Participant C outlined how academics started to challenge her and how that made her feel.

Going to middle school and high school, I think it just started getting harder and I don't know why. Chemistry is never a good subject for me. I'm still in chemistry right now

> and I'm still struggling, but I still get happy when I get the answer right, and I love that. I ended up just not doing great in [CHEM 121], and whether it was because of the housing situation or whatever, maybe I can defend myself, but ultimately, I got a D. You need a C or better to pass to CHEM 122, so I decided the next semester to take it over again. Same thing. Maybe it's not me. Maybe it's chemistry, maybe it's me. Ended up getting a D again. That really… I think made me second guess myself and saying if I can't even get this class, why am I even in this major because it is science related, and you should be getting this already. I went to the academic advisor, and in a way, I kind of took it as you should change your major. It was very disheartening. It made me think of myself as less. I just felt dumb, like why don't you get it? Not even dumb, like maybe you could've done it, but you didn't do it. You didn't do the homework, you didn't do this, you could've tried harder. That really just got me down. I don't know what actually motivated me to stay. I think maybe it was my friends.

The struggle Participant F faced was how to be a successful role model for her younger brothers, and how her quest to make her parents proud helped her overcome the challenges.

> I failed two classes twice, and… Well, I didn't fail; I got a D, which is still technically not passing. My self-confidence was very low because I was unmotivated and I didn't find the right people to supplement me in productivity, which is really bad because I think that shows that I haven't developed a complete sense of independence. I don't feel like I need people to be productive, but I find myself most productive when I am around people… I see that I am critical of myself and I think it's the way that I've been raised because even though I have had a really large support system, a very strong support system, there would be other people who would criticize me. I would take those

criticisms and amplify them. That habit has definitely carried throughout my life, but I can see it more easily now and I devalue them as necessary.

For Participant E, her struggle is with the challenges that are experienced within her major, and she often compares her success with that of her peers.

> When I make a mistake, I notice that my peers haven't made the same sort of mistake. That's when I'm hard on myself and start to think I can't really do this. It's neutral. Sometimes I'll be like, yes; I've got this. Overly confident. Then, other times, I'm just like, nope; don't have it.

Participant A described how she deals with challenge and the actions she takes to prioritize her schedule.

> I can't really dwell on failing. I have to keep going and try to figure out what I did wrong. In a classroom environment I'm motivated to do my work right then and there, but when I'm at home, sometimes I feel like I have my family, so my priority changes. Well, between work and school, I have to work, but I mean school comes first. When I am at home I do feel like I procrastinate a little bit more than I would at school. I know I can do it if I put my mind to it because I've had experiences where I didn't do my work at one point because I got anxiety and so that pushed everything back, so I did fail a class before. That was all because I would procrastinate and let things get to me, where I just pushed off the important things that I was supposed to follow through with. I know I can do it, but I know at that time I was lazy and I know that it's not me and I know I could have done a lot better. No one's going to do my work for me, so I had to push through it the next time around and I ended up retaking that class and I put my mind to it and I studied and I changed my habits and I went from a D to a B. Failing is a part of life and

> if you get it the first time, great, but if you don't, get back up and the second time around you'll do it bigger and better.

Participant D recognizes that her persistence is what helps her to overcome perceived challenges within her major.

> If I didn't get something that my professor wanted the students to get, I would keep going, try to figure it out, and it just kind of kills me sometimes that I don't get something. I'm persistent, like I wouldn't give up on it. I would keep going. Because I do love my major, and I know how important my major is, I know that even in school it's limiting, the education you're given. There's more and I know that my professors know more than what they are teaching, so I ask questions, I go to them, and I like to actually challenge them too.

Self-doubt was a challenge that Participant B had to cope with as she grappled with inner thoughts of her inability to succeed in STEM.

> Last year, before even declaring my biology major, [switching majors] was in the back of my mind. I would be like, "Oh, maybe sociology is better for me, maybe psychology, something that isn't much like a hard science," because I don't know, I just felt like I didn't feel smart enough. Then noticing my other friends, they were doing biology and they were struggling, but they still stuck with it, so then I was like if they can do it so can I. Just seeing them, I guess that's where I get most of my motivation is just from seeing other students. I'm just like, I can do this. After I finally declared my major as biology, I haven't really had that feeling of wanting to change my major. I feel like if I wasn't doing biology, I wouldn't be happy in my other classes.

Each participant described the personal challenges she faced throughout her course of studies and emphasized the desire to overcome those felt challenges and the empowerment that came from overcoming them.

Opportunity. The fourth theme that evolved from analyzing the transcripts of the one-on-one interviews was that of opportunity. The majority, 67%, of the participants discussed how they chose their major and persisted to overcome the challenges they experienced, spurred on because of the opportunities they would enjoy once they graduated with a STEM degree.

Participant F believed that her STEM major will help her find a job once she graduates with her degree.

> I have experience in both biology and chemistry. I think that makes me very marketable, but in terms of the way of thinking, and critical thinking, people think biology is authorization, but I think it's more of an understanding of the contents. I see biology as a vehicle to applied chemistry and how we understand biological systems. Before I decided to major in biology, I thought I could become a technical writer because I like writing and reading, but my goals were always steered towards STEM. Then, after a while, I asked myself what would be lucrative? Where can I find myself being exposed to more opportunities for internships, and jobs?

The decision to major in biology and minor in chemistry was a strategic choice for Participant F. She wanted to make sure that her STEM education was enhanced by two studies, also ensuring that she had a comprehensive understanding of how one subject influences another, so that when she graduates she will be a competitive applicant in the job market.

Participant C spoke of 3 influential factors: working on a capstone project with a fellow student, seeking advice from graduate students, and the opportunity to assist professors with

research. These factors helped her to choose her major and realize her choice in major, and made her realize that her choice would bring job security.

> Research really helped me. I was happy. I was fortunate enough to help ___ with her capstone my sophomore year and after that I loved it. That really helped me. That helped me stay in the ESRM major because I know that there is a job or research opportunities that I can do when I graduate.

Participant C conveyed her passion about her studies and the opportunities she would have to play a part in improving the environment once she graduates:

> ESRM is very earth based, very geomorphology, the changing of this or coastal management, but I think we kind of forget about the people and how we can help the environment and help the people because ultimately for ESRM, it's like, "No, take the people away. Overpopulation. People suck." Which, yeah, sadly we do, but we also are awesome. We can figure out how to work with our environments. That's my mentality, and I think for ESRM, it's just very broad, very, kind of abiotic.

Her love of science determined Participant A's choice of major, also she was encouraged by opportunities she would have to make a difference in the world. She explained why she switched her major from chemistry to biology.

> I've always enjoyed science because it's very interesting to me and it feels like a whole other world and there's a lot you can do with science and I think it just caught my attention because I was good at it… It wasn't always easy for me, but I was good at it. I just really enjoy it and I know I can do something big with science once I graduate. When I started at the University, I was a chemistry major and I ended up changing my major to biology because I felt like biology was more broad of a science and I wanted to

> learn about both the inside and outside of the body. Chemistry is more, it's just saying one aspect of the body and the environment. So, I thought of biology because I know that I would be more knowledgeable for me career and I would know a little bit more than just knowing about chemistry.

The decision to switch from a chemistry major to a biology major with a chemistry minor was also strategic on Participant A's part; she was thinking about her impending career and what would support her future goals.

Participant B chose her major because she recognized the subject was broad and would present a wider scope of job opportunities after she graduates.

> I decided to pursue biology because I just thought it was really broad, so whatever I wanted to do after college I could probably still have a good playing field. STEM can seem so restricted to certain things, but it's pretty much everywhere. It doesn't matter where you go; you're secured for life pretty much. STEM is going to make up the future.

The rationale presented by Participant B for why she chose her major epitomizes how each of these young women thought about career and other future possibilities before finalizing her choice of major, and the realization that STEM subjects provide a potential wide array of opportunities for those who go into the various fields.

Conclusion

The 6 participants in this study willingly provided insights into their personal and academic lives that many do not get to hear. Their unique stories provide an understanding of how they got to be where they are, and how they managed to prosper in their academic studies despite challenge, adversity, and the effect of realization that they are a minority in the field of STEM education. Analyzing the data revealed by the transcriptions and subsequently identifying

the themes made evident by the process, led me to reflect on connections to the Transition Theory proposed by Schlossberg (1984) and Moral Development as theorized by Gilligan (1981), both of which are discussed in the next chapter.

Chapter Five

Discussion and Conclusions

The previous chapter provides detailed accounts of the experiences of 6 undergraduate women of color currently majoring in STEM fields of study. Analysis of the data gathered through one-on-one interviews with the participants revealed 4 reoccurring themes: altruism, support, challenge, and opportunity. Each theme was disclosed and described through the voices of the participants. This chapter summarizes the theoretical framework and helped guide this study and conceptualize the findings in chapter 4. Limitations of this study will be discussed and I will propose possible areas for future research.

Theoretical Frameworks

Grounded Theory (Glaser & Strauss, 1967), Moral Development Theory (Gilligan, 1982/1993), and Transition Theory (Schlossberg, 1984) are three theoretical lenses that helped guide this study. Glaser and Strauss' approach to generating theory shaped how I explored the possible outcomes for this study; it widened my focus when collecting the data and conducting a thorough analysis. Through the 4 themes that surfaced, I discovered that mattering matters. This idea of mattering was evident first in the theme of altruism, it then appeared in each of the other 3 themes. A sense of mattering is important, especially when you are a student. Being a woman of color in STEM matters and the women who participated in this study made that clear when telling their stories. Each woman explained in their own way how they wanted to impact others and make a difference in the world; they wanted to matter.

Schlossberg (1989) wrote, "The polar themes of marginality and mattering connect all of us – rich and poor, young and old, male and female. Are we part of things; do we belong; are we central or marginal? Do we make a difference; do others care about us and make us feel we

matter" (p. 1)? While these are common questions that people ask of themselves, each participant touched on principles of mattering throughout their interviews, which is relevant according to Schlossberg's Transition Theory. The 6 women experienced a significant transition in their lives when they declared their major in one of the STEM fields of study. Goodman, Schlossberg, and Anderson (2006) define transition as, "Any event, or non-event, that results in changed relationships, routines, assumptions, and roles" (p. 33). Schlossberg (1984) explained that adaptation was determined by the interaction of three variables: the individual's perception of the transition, characteristics pertaining to the pre and post transition environments, and the personal characteristics of the individual experiencing the transition. Goodman et al. described four factors that influence one's ability to cope with transition, which were coined the 4 S's: situation, self, support, and strategies. The authors explained that an individual's level of effectiveness to cope with transition depends on his/her resources in these areas. The 6 participants all had a strong sense of self and support systems in place that helped them transition through some of the challenges they faced while pursuing their STEM degrees.

The research findings of Gilligan (1982), described in *In a Different Voice*, focused on the moral development of women. The findings contradicted previous models of human growth which did not appear to match women's experience. The 6 women in this study each referenced aspects of care and justice in their one-on-one interviews; the importance of wanting to make an impact on the world and mattering to others spanned the interviews, which connects to Gilligan's Theory of Women's Moral Development. Evans, Forney, Guido, Patton, and Renn (2010) stated, "The different voice [Gilligan] delineated is distinguished not only by gender but by the themes of care and justice" (p. 111). Gilligan's extensive research on women's development demonstrated that women use care and responsibility as their moral compass (Evans et al., 2010).

The women in this study all portrayed a sense of responsibility to others, whether that was direct family members or humankind in general, these women all had a selfless moral compass that embodied their thoughtful personalities.

Findings and Discussion

This exploratory study started with no hypothesis or expectations about the lived or perceived experiences of the participants. I did not want to make assumptions or limit the themes that would emerge from the data collected. I wanted the participants' voices and their stories to be the focus. I recognized that each participant would contribute to my findings in different ways. It was these underlying principles that led me to be guided by Grounded Theory as proposed by Glaser and Strauss (1967), who contended "Grounded theory can help to forestall the opportunistic use of theories that have dubious fit and working capacity" (p. 4). The authors go on to reason that researchers conducting in highly empirical studies have conclusions that tend to offer "tacked-on" explanations taken from logically deduced theory in which they account for or interpret findings from which they draw general sociological meanings. The intent of this study was to generate explanations and theory in a general manner from the data as suggested by Glaser and Strauss. Following this model, I did not hypothesize what the findings would be, nor commit to an extant theory, or theories. I used the three theoretical lenses as a means to guide me through data collection, coding, and subsequent analysis of the findings to correlate the identified themes.

The four notable themes that emerged from the data analysis were thought provoking and informative. The themes of altruism, support, challenge, and opportunity brought to light many aspects of the participants' selfless personalities and motivation to succeed and make a difference in the lives of others. Reviewing the transcriptions revealed that only 1out of the 6

participants, described that she was treated adversely within her STEM major because of her gender and ethnicity. None of the other participants had similar experiences of being treated differently from their peers due to gender and/or ethnicity. Most participants perceived their peers and the campus community as accepting and treating them equally, and they attributed that feeling of comfort to the diversity of the community in which they live and go to school, as well as the campus' HSI designation. Each participant spoke of their strong support systems, whether that was family, peers, friends, or faculty, as helping them overcome challenge, hardship, and/or stress.

A noteworthy factor that arose through the interview process was that of deflection. One participant (F) explained how a recruiter overlooked her at a networking event while those standing next to her were addressed before she was, and the experience left her feeling slighted and disregarded. What was surprising was that she attributed the lack of attention to her height, explaining that she is 4'11;" it wasn't until the interview that she recast the encounter, questioning the recruiter's motive in ignoring her, and questioning the possibility of her gender and/or ethnicity as a contributing factor to the treatment she received. This notion of deflection as a means to justify adverse treatment is not uncommon when 'stereotype threat' is experienced. According to Block, Koch, Liberman, Merriweather, and Roberson (2011):

> Women and people of color are still underrepresented in many occupational roles. Being in a situation where one is underrepresented, and thus in the demographic minority, has been shown to be a factor leading to the experience of stereotype threat – the expectation that one will be judged or perceived on the basis of social identity group membership rather than actual performance and potential. (p. 570)

Often, those that experience unfavorable treatment by others find solace in trying to explain away the negative behavior by attributing it to something that justifies the person's wrongdoing. Research focusing on this psychological coping mechanism has made connections to stereotype threat and its source of stress. Inzlicht and Kang (2010) explained:

> At the most basic level, stereotype threat is a source of stress and could be viewed within the broader framework of stress and coping models. According to a number of theoretical perspectives on coping with stigma, stereotype and social identity threat, once appraised, could result in a number of physiological, emotional, cognitive, and behavioral reactions that are distinguished along the lines of voluntary and involuntary responses. (p. 468)

The 6 participants in this study shared their stories which, while unique, were connected through the 4 identified themes. Together, their stories, illustrated the selfless and hardworking nature of the participants. Although there is no quick fix solution to the underrepresentation of women of color in STEM, when asked what advise they would give to young women of color considering the pursuit of a STEM degree, the participants explained that more pathways, support, and opportunities made available for young women and women of color in the K-12 education system would help encourage and inspire those to follow their aspirations. The women all mentioned that their recommendation to women and women of color considering pursuing a STEM degree, the participants explained that more pathways, support, and opportunities made available for young women and women of color in the K-12 education system would help encourage and inspire others to pursue their academic goals. They each raised the idea of never giving up, that failure is a part of learning, and that they wouldn't be

where they are now if it wasn't for staying strong and never giving up. Participant A closed her interview encouraging:

> Give it all you have and even if you fail, there's always room for better potential and better results at the end. I don't think someone should be judged by their gender. I think anyone is capable of pursuing something they put their mind to.

Limitations

Despite careful planning, I was aware of the limitations to this study. The first limitation was that all participants came from the same university, which has an HSI designation. This may have narrowed the scope of data collected and the themes subsequently identified. Secondly, all participants responded to a flyer asking students to volunteer their time for this study, yet the 6 participants majored in few of the wide range of STEM fields of study. Consequently, the voices of women of color in other STEM fields of study were not heard. Time for the collection of data and subsequent analysis of findings was limited, allowing for only one face-to-face interview with each participant.

Recommendations

Future research on women of color in STEM would be advanced by collecting data from participants who come from campuses that differ by ethnic majority, either predominately White, historically Black (HBCU's), HSI, and those with no specific demographic designation. Furthermore, if the campuses were selected from multiple states rather than campuses from the same state it would further diversity the findings, making the results more generalizable. Imminent research in this area would benefit from hearing the voices of women majoring in some of the other STEM fields of study such as math, chemistry, physics, and engineering so as to compare voices across the STEM spectrum. A longitudinal study that tracked the personal

and professional experiences of women of color in STEM fields, with data gathered through a series of interviews throughout their educational and career journeys, would reveal the impact of psychosocial factors and their influences on women of color in STEM over time and how their professional careers evolve during the process.

Ultimately, more K-12 schools and college campuses need to address the need of implementing inclusive STEM support programs as a way to better reach students of all ages, genders and colors in an effort to help bridge an opportunity for them to explore math and science at an early age with confidence in their abilities and desires, so as to advance in these subjects and possibly pursue a career in the field. It will then be imperative that colleges and universities work closely with K-12 school when creating support programs and pipelines to ensure seamlessness for students to supplement their interests in STEM and succeed in higher education.

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Appendix A

Qualtrics Survey Questions

1. What is your first and last name?

   *For researcher identification purposes (in case multiple volunteers have the same first name).

2. What is your age range?

☐ 18-22 yrs ☐ 23-27 yrs ☐ 28 yrs or above

3. What academic level are you? (Junior or Senior)
4. Were you a transfer student?
5. What is your major?
6. What race/ethnicity do you most identify with?
7. Are you a first generation college student?
8. If not, has anyone in your family earned a college degree? If so, what type of degree and in what subject matter?
9. Are you satisfied with your choice in major?
10. Is your current major your initial major of choice?

Appendix B

Interview Questions

1. What made you chose your major?
2. Were you always interested in STEM? From what age were you interested in STEM?
3. Do you feel like you had support from your family pursing the major you chose?
4. Being a woman of color in STEM, do you feel like you noticed any differences in your treatment verse the treatment received by your peers? This could be treatment in the classroom, outside the classroom, at events, from faculty/staff/students.
5. Do you feel that your K-12 educational experience prepared you for an academic carrier in STEM? Explain.
6. Did you ever feel like giving up or changing majors? If so, what made you motivated to persist?
7. How would you describe your levels of self-confidence in your major using a scale of 1-5 (1 being the lowest and 5 being the highest)? What about self-efficacy within your STEM major? Did you always feel that way?
8. What 3 words would you use to best describe yourself as a student? Please explain.
9. How would you describe your relationship with the faculty within your major? Do you feel comfortable seeking help or asking questions?
10. Within your STEM courses and education, have you felt that there are an adequate amount of mentors for you to look up to and learn from professionally? Explain.
11. What are your thoughts on the representation of women in STEM? And more specifically, women of color in STEM?

12. What advise do you have for other women of color considering pursuing an academic career in STEM?

Appendix C

Gate Keeper Letter

Dear _____,

My name is Fara Ravan and I am a graduate student at CSU Channel Islands. I am writing to you to for permission to conduct a research study on your campus. The purpose of this study is to tell the stories of undergraduate women of color pursuing a degree in a STEM field of study and what mechanisms, internal and external, aided them in staying motivated and succeeding as an underrepresented population. I am interested in conducting my research at _____ because I feel a strong connection to the University. _____ is a multicultural campus that prides itself on diversity and I would love to be able to tell the success stories of some of the upper division junior and/or senior students' experiences persisting in a major where they are the minority. If approved, I plan to post flyers across campus in order to select student volunteers to participate and, if needed, I will work with the coordinator of LSAMP (Louis Stokes Alliance for Minority Participation) on campus in order to obtain a snowball sampling of participants needed for this study. The director of LSAMP will also receive a gatekeeper letter. The study will initiate in the spring of 2017. All participants will receive informed consent forms to sign.

Once consent forms have been collected, the research will begin in which I will be meeting with the 5-7 participants to interview them separately. Our interviews will be conducted in a quiet and private location on campus; most likely in a reserved conference room. An electronic survey will also be administered to each participant via Qualtrics. All data and surveys will remain anonymous. The results will be reported and analyzed within my thesis. Student participation will be voluntary and they will be free to drop out of the study at any time. Thank you for your time and consideration. I look forward to hearing from you.

Sincerely,

_____

Fara Ravan
fara.ravan@csuci.edu

Appendix D

Informed Consent Form

Thesis Title: "Undergraduate Women of Color Majoring in STEM Fields: Sharing their Stories"

The following information is provided to help you decide whether you wish to participate in the present study. You should be aware that you are free to decide not to participate or to withdraw at any time without affecting your relationship with the School of Education, the University, or myself. To participate in this study, you must be at least 18 years old and of junior or senior standing.

The purpose of this study is to tell the stories of undergraduate women of color pursuing a degree in a STEM field of study and what mechanisms, internal and external, aided them in staying motivated and succeeding as an underrepresented population.

Data will be collected via an initial electronic Qualtrics survey and one private one-on-one interview with myself. The interview will last approximately 35 minutes and will be audio recorded while I take notes. The survey data and the interview will be the only data collected. I will contact you for a member check, in which you will be given the opportunity to review my analysis of our interview and confirm its validity. Your interview and survey results will be kept confidential throughout the study.

Do not hesitate to ask questions about the study before participating or during the study. I would be happy to share the findings with you after the research is completed. Your name will not be associated with the research findings in any way.

For this study, it is expected that participants may experience minimal risks as they participate. People react differently to stimuli, and it is possible that some may react negatively to the survey and/or interview questions. If participants experience any discomfort, they should be told that they can terminate the process at any time and that they have access to Fara Ravan and Faculty Advisor (Dr. Merilyn Buchanan) should any issues arise. The expected benefit associated with your participation is the impact that your experience of overcoming adversity in education will have on educators and other students like yourself.

If you have any questions about this study, you may contact Fara Ravan at: (xxx) xxx-xxxx or fara.ravan@csuci.edu and Dr. Merilyn Buchanan at: (xxx) xxx-xxxx or merilyn.buchanan@csuci.edu. For questions or issues regarding your rights as a subject, please

feel free to contact the Institutional Review Board (IRB) at (xxx) xxx-xxxx or via email at irb@csuci.edu.

Please sign this consent form. You are signing it with full knowledge of the nature and purpose of the procedures. A copy of this form will be provided for you to keep.

☐ By selecting this box, I agree for the interview to be audio recorded.

☐ By selecting this box, I do not agree for the interview to be audio recorded.

_____ _____

Signature Date

Appendix E

NIH Certificate

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Fara Ravan** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 05/08/2016.

Certification Number: 2070798.

Appendix F

Flyer for Participation

Research Participant Opportunity for Female STEM Students of Color

- Are you a junior or senior standing student majoring in a STEM discipline?
- Would you be willing to contribute to a Master's research study by telling your story as a female of color majoring in a STEM field of study?
- Can you spare approximately 45 minutes of your time?

For more details

Please contact Fara Ravan,
MA in Education candidate, at fara.ravan@csuci.edu