Examining the Career Self-Management of Interdisciplinary Engineering Majors

by

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Dedication

I dedicate this dissertation to my loving mother, Dr. Jhancy Malay and my grandmother Suryavathi Malay, two women ahead of their time. I am forever grateful for your strength and unconditional support, which made it possible for me to pursue my dreams.

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Abstract

Interdisciplinary engineering programs such as Biomedical (BME), and Industrial engineering (IE) attract a diverse group of students compared to other engineering majors. However, students in BME programs report difficulties with career attainment. Engaging in career self-management (e.g., career exploration, job search, attending career fairs, etc.) can help students make informed decisions about their careers and has been shown to positively influence persistence, post-graduation career outcomes, and job satisfaction. While prior work documents the career exploration, career intentions, and career decision-making of engineering majors, research on career self-management (CSM) experiences of interdisciplinary engineering majors, such as BME and IE, is underexplored. Further, despite various efforts to diversify STEM fields, women of color are proportionally underrepresented in STEM occupations. Therefore, understanding the career self-management experiences of women of color in interdisciplinary engineering majors has important implications for addressing the need for diverse STEM talent and the difficulties in BME career attainment.

Using a multiple case study approach that included individual interviews and social network data from a name generator survey, this dissertation research explored the CSM experiences of twelve undergraduate women of color in BME and IE programs across the United States. Community Cultural Wealth (CCW) and the Career Self-Management Model of Social Cognitive Career Theory (SCCT-CSM) served as the theoretical lenses guiding the research. Findings revealed that engaging in CSM was emotionally taxing for participants. Community Cultural Wealth and various contextual/environmental factors identified shaped how participants engaged in CSM. Familial and Social Capital heavily influenced the CSM of participants, with peers and siblings serving as behavioral models who played a key role in participants' CSM. Implications for research and practice are discussed.

Chapter 1 Introduction

There is a labor market demand for engineering graduates with interdisciplinary skills and knowledge to address problems of the 21st century (Richter & Paretti, 2009). In response to these demands, there has been an increase in interdisciplinary offerings and programs to prepare graduates for work in industry (Brint et al., 2009; Jacob, 2015). In parallel with the rise in interdisciplinary program offerings, universities in recent times are facing growing pressures of preparing students for future jobs (Badoer et al., 2021; Pew Research Center, 2016). However, changes in the world of work and recruiting have placed the responsibility of managing career preparation on students (Adolphe, 2022). Individuals are increasingly expected to be more self-directed and exhibit adaptive behaviors in managing their careers (Hirschi, 2018). Students are competing for jobs in a marketplace which requires them to build professional networks and stand out to employers to secure employment (Badoer et al, 2021; Lent, 2018). Given these dynamics, understanding how students in interdisciplinary engineering majors engage in career self-management (CSM) to enter the workforce and how to support them through this process is crucial for improving interdisciplinary offerings and attracting students to these programs. In this dissertation research, I utilized a mixed methods case study approach to examine the career self-management experiences of women of color in interdisciplinary engineering programs to identify ways to support their career attainment and address their underrepresentation in the STEM workforce.

Defining Interdisciplinarity and Interdisciplinary Programs of Interest

Interdisciplinarity is a term that first appeared in the mid-1920s, and since then, scholars have extensively theorized and put forth various arguments for what counts as interdisciplinary work (Collin, 2009; Hausman, 1979; Klein, 1990; Lattuca, 2001, 2003). Scholars have also made efforts to distinguish interdisciplinary work from multidisciplinary and transdisciplinary work, with research indicating that the above terms are defined and understood differently by scholars and practitioners (Lattuca, 2003). Recent research in engineering education also highlights how

interdisciplinarity is differently interpreted and confused with multidisciplinarity by various faculty and administrators in engineering (Lattuca & Knight, 2010). The lack of consensus complicates the search for a shared definition of interdisciplinarity. However, one point of consensus seems to be that interdisciplinary work seeks to "integrate" knowledge, perspectives, and methods of different disciplines, and this integration is what separates interdisciplinarity from others (Klein & Newell, 1997). In line with this perspective, this proposed research focused on two programs, Biomedical (BME), and Industrial engineering (IE), because they integrate the knowledge and perspectives of both sub-disciplines within engineering and disciplines outside of engineering, such as biology and business, to address complex problems.

Lack of Research on the Career Management Experiences of Interdisciplinary Engineering Majors Hinders Their Participation in the STEM Workforce

Interdisciplinary engineering programs such as Biomedical (BME), and Industrial engineering (IE) attract a diverse group of students compared to other engineering majors (Brawner et al., 2012; Chesler et al., 2010; Pilotte et al., 2017). The broad disciplinary exposure of such programs has the potential to expose and direct students to multiple industries and career pathways post-graduation. In fact, research suggests that the variety of career opportunities available in IE could play a role in driving the recruitment and retention of women (Brawner et al., 2012; Rito et al., 2014; Shehab et al., 2005). Similarly, research indicates that BME students are interested in engineering and non-engineering careers (Patrick et al., 2021). However, research also indicates that students in BME programs experience difficulty finding employment and navigating the job market post-graduation (Berglund, 2015a; Nocera et al., 2018).

While there is extensive literature on the career intentions/plans, career decision making, and career pathways of engineering majors (Abhyankar et al., 2018; Andrews et al., 2023; Carrico et al., 2012; Gilmartin et al., 2018; Grau et al., 2016; Harris et al., 2017; Henderson et. al., 2018, 2022; Lichtenstein et al., 2009; Margolis & Kotys-Schwartz, 2009; National Academy of Engineering, 2018; Patrick et al., 2021; Rohde et al., 2020; Sheppard et al., 2014; Smith & Gayles, 2017; Winters et al., 2014; Winters, 2012), research focused on the career self-management (CSM) experiences of students' in interdisciplinary engineering majors like BME and IE is underexplored. With limited research on the CSM experiences of interdisciplinary engineering majors, we do not yet fully understand how they enter the workforce. Understanding the different factors and processes that enable career attainment for students in these fields, can

inform initiatives that support their transition into the STEM workforce. And, given that BME and IE attract a diverse group of students compared to other engineering majors, a limited understanding of the career attainment process of these students perpetuates existing inequities in the STEM workforce and hinders efforts to support the career goals of these students. These implications are further discussed below.

Supporting STEM Career Attainment of Minoritized Students is a Matter of National Interest and Social Justice

Supporting the transition of interdisciplinary engineering majors to the workforce aligns with national interests. Specifically, the entrance of students into the workforce increases the amount of talented human capital, which is particularly important for STEM fields where maintaining a critical mass and diversity of talented STEM individuals is crucial to supporting national competitiveness and innovation (National Science Board, 2010). Between 2024-34, STEM occupations are expected to grow by 8.1% (U.S. Bureau of Labor Statistics, 2025). Yet despite various efforts to diversify STEM fields, women and racially minoritized students are proportionally underrepresented in STEM occupations (National Science Board, 2019). Women and first-generation students in engineering are also found to be more likely to have only a single job offer available to them, significantly influencing their job selection decisions (Harris et al., 2017). Supporting the career aspirations of underrepresented students is therefore crucial to meeting STEM employment demands.

Furthermore, inclusion in engineering can serve to dismantle dominant ideologies of engineering innovation that reproduce injustice (Riley, 2018). For example, dominant ideologies of race and gender have historically resulted in innovations with built-in biases (e.g., male crash test dummies, pulse oximeters and facial recognition software with racial biases). Including the perspectives of individuals from different backgrounds and lived experiences can broaden the scope of engineering solutions and innovation to include the needs of the society at large (Diaz-Garcia et al., 2013; Hofstra et al., 2020). Lack of support for minoritized students to realize their STEM career aspirations reproduces existing inequalities (e.g., unequal representation in the STEM workforce and development of biased technology and products), and results in the loss of important perspectives for addressing society's challenges (Hofstra et al., 2020; Jamerson, 2022). Therefore, supporting STEM career aspirations and ensuring equitable access to engineering and

STEM careers overall for women and racially minoritized students is both a matter of social justice and national interest.

Lack of Career Support to Minoritized Students Contributes to Existing Economic Inequalities and Mental Health Concerns

On an individual level, many students and families view college education as a pathway to socioeconomic mobility (Adams & McBrayer, 2020; McArthur, 2011), a perception that is supported by wage differences between college students and high school graduates (Carnevale & Rose, 2015). Entering the workforce with a college degree can provide students with economic mobility (Haveman & Smeeding, 2006), especially when entering occupations in engineering, which are amongst the most highly paid compared to occupations in other fields (Carnevale et. al., 2015). Engineering degree attainment allows students to access a high salary (U.S. Bureau of Labor Statistics; Carnevale et. al., 2015). However, racially minoritized students who are inadequately supported in realizing their STEM career aspirations might not benefit from the economic mobility possible through STEM careers (Langdon et al., 2011).

Additionally, college students in general are known to experience high rates of psychological distress and it is essential to note that career indecision and concerns are linked to negative mental health outcomes (Hinkelman & Luzzo, 2007; Rottinghaus et al., 2009). In addition, emerging research indicates that first-generation and minoritized students in engineering are less likely to plan for engineering careers or graduate school due to the psychological cost associated with degree attainment (Henderson et al., 2022). Understanding the emotional and psychological dimensions of career self-management and supporting the career attainment of minoritized interdisciplinary engineering students therefore also has implications for addressing some of the mental health concerns facing college students.

Women of Color in STEM Have Unique Experiences and Needs That Warrant Further Examination

Engineering climates are often characterized as “chilly” and unwelcoming to women and students of color (Crawford & MacLeod, 1990; Cross & Paretti, 2020; Foor et al., 2007; McGee, 2016; McGee & Martin, 2011). Women of color (WOC) represent a subset of students who experience a “double bind” of race and gender marginalization in STEM spaces (Cross et al., 2017; Cross et al., 2018; Malcom & Malcom, 2011; Ong et al., 2011; Ong et al., 2020). Given

the unique positionality of women of color in STEM spaces, examining their experiences warrants further attention as research focused on only a single aspect of identity (e.g. race, gender or class) often fails to capture the experiences of people who face multiple marginalizations. And given the increasingly diverse landscape of higher education institutions in the United States, failing to attend to the distinct identities and needs of students further reinforces inequities that already exist in the college-to-workforce transition.

Researchers in recent times have noted how career development programming can serve to reinforce hegemonic practices (Perez et al., 2024) and have stressed the need for the development of culturally relevant career services and resources that integrate different aspects of students' identities (Means et al., 2016; Stebleton, 2007). Research using an assets-based perspective in particular can address the need for culturally relevant career development by highlighting the strengths and skills that students who face multiple marginalizations bring into different spaces. A nuanced and asset-based understanding of how women of color in STEM navigate the career self-management process can therefore inform the development of interventions and programming that are tailored to the distinct needs of these students.

Key Terminology

1. **Career Self-Management:** Refers to the career actions (e.g. career exploration, job search, networking) taken by students to obtain an internship or job. A more detailed description is provided in Chapter 2.
2. **Career Attainment:** Career attainment in the context of the present study refers to successfully obtaining an internship or a job in the engineering industry. A more detailed description is provided in Chapter 2.
3. **Cultural Wealth:** Cultural wealth is the various knowledge, skills, abilities and contacts that students of color possess and utilize (Yosso, 2005) in their career attainment. A more detailed explanation is provided in Chapter 3.

Research Questions

In this dissertation work, I examined how women of color in IE and BME move from their undergraduate degree programs into different careers by analyzing their social networks and experiences with career self-management. The study's overarching research questions are:

1. How do undergraduate women of color in BME and IE majors describe navigating career self-management?
2. What influences the career actions of undergraduate women of color in BME and IE majors?
3. How do undergraduate women of color in BME and IE majors leverage their cultural wealth to navigate career self-management?

To answer these research questions, I collected survey and interview data about the social networks and Career Self-Management (CSM) experiences of 12 undergraduate women of color in BME and IE majors across the United States. With each participant comprising a unit of analysis or case, I used reflexive thematic analysis to interpret the interview data and a multiple case study approach to identify the salient themes related to the research questions across the participants. An overview of the research can be found in Table 1 below.

Table 1. Logic model of dissertation research

Research Goals/Objectives	**Theoretical Frameworks**	**Research Questions**	**Research Methods**	**Broader Impacts/ Intellectual Merit**
1. Understand the experiences of undergraduate women of color with CSM 2. Understand the supports and barriers to the CSM of women of color 3. Identify the community cultural wealth leveraged by women of color for their CSM	SCCT-CSM and CCW informing research questions, survey and interview protocol development, and data analysis	**RQ1:** How do undergraduate women of color in BME and IOE majors describe navigating CSM? **RQ2:** What influences the career actions of undergraduate women of color in BME and IE majors? **RQ3**: How do undergraduate women of color	***Data Collection*** ● 12 women of color ● **Survey:** Social network and demographics information ● **Individual Interviews** ***Data Analysis:*** ● Descriptive summaries and participant profiles ● Reflexive	◗ Understand the career behaviors of women of color in interdisciplinary majors ◗ Understand the supports and barriers to the CSM of women of color ◗ Understand the career actions of students that contribute to positive post-

	in BME and IE majors leverage their cultural wealth to navigate CSM?	thematic analysis ● Within case and cross-case analysis	graduation outcomes ◗ Uncover inequities in access to opportunities and social networks

Intellectual Merit

By examining the career self-management experiences of women of color in BME and IE programs, we can identify the factors helping and impeding their career attainment. Using qualitative accounts to identify how social networks, outcome expectations, and various contextual/environmental factors shape the career attainment of women of color can uncover inequities in access to opportunities and resources. Finally, understanding how women of color leverage their cultural wealth in their career self-management can inform the development of asset-based and culturally relevant career supports as well as help engineering departments provide relevant and personalized career guidance to students.

Broader Impacts

Given the ability of programs like BME and IE to attract a diverse group of students compared to traditional engineering majors, understanding how students in these majors navigate career self-management to enter the workforce has significant implications for improving engineering education and career services as well as increasing the participation of underrepresented students in the STEM workforce. From a lens of national interests, increasing the diversity of talented STEM individuals in the workforce helps the nation remain competitive. Participation of underrepresented students in the STEM workforce can also serve to dismantle dominant ideologies that reproduce injustice. On an individual level, supporting the career attainment of underrepresented students in engineering will enable them to realize their career aspirations and benefit from the projected growth in STEM occupations. Finally, understanding the career experiences and needs of underrepresented students can help address some of their mental health concerns.

The following is the layout for this dissertation research (refer to Table 2). In Chapter 2, I review relevant research informing the dissertation study. In Chapter 3, I present the theoretical and conceptual models informing this work. Chapter 4 contains details of the research design and data collection and analysis plan. In Chapter 5, I present the findings related to the three research questions. In Chapter 6, I summarize the key findings, present various interpretations of the results, and situate them within the broader literature. I also discuss the limitations. Finally, in Chapter 7, I talk about the implications of this research and provide recommendations for engineering programs, educators, and career services professionals.

Table 2. Overview of dissertation chapters

Chapter	**Overview of Content**
Chapter 2: Literature Review	Reviews current and seminal works, including research on career self-management, career intentions and decision-making of engineering students, and women of color in engineering
Chapter 3: Theoretical Framework	Reviews the frameworks and relates how I plan to use them to inform this dissertation research
Chapter 4: Methods	Describes positionality, research design, participant recruitment, data collection and analysis procedures, pilot study, and ethical considerations, trustworthiness, and credibility
Chapter 5: Results	Presents findings related to research questions one (CSM experiences of women of color), two (factors influencing CSM), and three (CCW of women of color)
Chapter 6: Discussion	Presents summary of findings, possible interpretations and relevance of findings to existing literature, and limitations
Chapter 7: Conclusion, Implications, and Future Research	Presents implications for research and practice and suggests areas for future research

Chapter 2 Literature Review

The purpose of this literature review is to present the relevant conversations informing my research study. In this chapter, I first present the literature examining the underrepresentation of women and minoritized students in engineering. Next, I review the importance of understanding and supporting the career actions of engineering students. I then delve into the research on the career development of undergraduate engineering majors and the role of social capital in engineering students' decision-making. Lastly, to situate my research in the context of the career development of minoritized students, I examine the unique experiences and career development challenges of these students in engineering.

Underrepresentation of Women and Minoritized Students in Engineering

Despite various efforts to broaden the participation of women and minoritized students, STEM fields and occupations have failed to attract these students in sufficient numbers (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; National Science Board, 2019). About a quarter of those working in science and engineering (S&E) occupations are women, and women who identify as Black, Asian American, Latina, and/or Native American are even further underrepresented (Ong et al., 2018; National Center for Science and Engineering Statistics, 2023). Past research points to a myriad of social factors that deter women and minoritized students from pursuing STEM careers, including cultural beliefs, racial and gender stereotypes, lack of role models, workplace dynamics, misalignment of values, and the "chilly climate" of male-dominated fields like science and engineering (Avolio et al., 2020; McGee, 2016; McGee & Martin 2011; Reuben et al., 2014; Seron et al., 2018; Smith & Gayles, 2017). Other research also points to individual motivational and social-psychological factors to explain differences in STEM persistence and career choices. These include factors such as interest, attitudes and beliefs, self-efficacy, professional identity, role congruence, professional role confidence, and not actual competence or performance (Buse et al., 2013; Cech et al., 2011; Lent et al., 2018; Patrick et al., 2021; Saucerman & Vasquez, 2014).

The "leaky pipeline" is a common metaphor used to describe the progressive attrition of individuals from STEM fields at various stages of education (Blickenstaff, 2005). However, the pipeline metaphor used to describe students' pathways into and out of STEM fields is outdated, as several authors have previously noted (Cannady et al., 2014; Skrentny & Lewis, 2022; Stevens et al., 2008). Some of these authors have presented the limitations of homogenizing and problematizing "leaking" by not examining the lived experiences of individuals in the pipeline. These authors have instead noted the need to acknowledge individual agency in career decision-making, highlighted the variations in individuals' paths to the STEM workforce, and the positive impact of the skills developed through interdisciplinary engineering education on the workforce at large (Cannady et al., 2014; Patrick et al., 2021; Skrentny & Lewis, 2022)

Therefore, while it is important to examine and address the social and individual factors that deter women of color from entering STEM fields and careers, I propose that it is also important to examine the processes through which women of color in BME and IE enter different career pathways. When students with STEM career intentions are not adequately supported, they might struggle to enter STEM career pathways and realize their STEM aspirations. The difficulties students face entering STEM career pathways further contribute to the underrepresentation of these students in STEM fields and exacerbates the inequities present in the STEM workforce. In the following sections, I present literature summarizing the importance of examining and supporting the career actions of engineering students. I also argue that examining how students enter different career pathways can help us understand how to better support the diverse career goals of women and minoritized students in engineering to increase their retention and participation in STEM careers.

Defining and Understanding Career Self-Management and Career Attainment

To understand how students enter different career pathways at the school-to-work transition point, it is important to examine the various career actions students take to enter the workforce. In this proposal, I use the terms "career actions" and "behaviors" interchangeably to refer to the career self-management (CSM) behaviors of individuals. While many definitions for career self-management exist in the vocational psychology literature (Greenhaus et al., 2010; Hirschi & Koen, 2021; King, 2004; Lent & Brown 2013), career self-management can be generally understood as behaviors or deliberate actions employed by individuals to manage and realize their career goals. These behaviors can include career exploration, goal setting, planning,

building networks, seeking opportunities and feedback, and continuous learning (King 2004; Parker & Collins, 2008). Similarly, career attainment or success is examined in the literature as both a subjective (fulfillment, satisfaction etc.) and objective metric (job title, prestige, salary etc.), encompassing the milestones associated with individual's professional paths (Abele et al., 2010). However, in the context of this study, career attainment solely refers to the objective metric of women of color successfully obtaining an internship or a job post-graduation.

Engaging in actions or behaviors like career exploration, networking, information gathering, participating in career fairs/job searches, and interviewing can assist students in making informed decisions about their career goals and pathways. In fact, prior work indicates that engaging in actions like networking and seeking opportunities such as internships, co-ops, and/or research can significantly impact the career outcomes of students. In the context of STEM fields, there's evidence to indicate that engagement in career planning activities could improve student persistence and retention (Cabell, 2021; Belser et al., 2017; Belser et al., 2018) by providing students with a better understanding of the opportunities available in their field. Some authors have also found STEM career planning courses and positive experiences of career counseling to have a positive influence on students' career search efficacy (Cabell & Gnilka, 2021). A recent study in engineering education on the perspectives of career services professionals also highlights the need for students to get involved with career development (Carrico et al., 2016).

Finally, proactive engagement in career behaviors is linked to the attainment of desired career outcomes and career success (Sturges et al., 2002; Sturges et al., 2005) which are further associated with life and career satisfaction (King, 2004). For example, in a study of first-year university students, career self-management was associated with life satisfaction (Praskova et al., 2015). Conversely, research also shows that lower job satisfaction is strongly associated with emotional burn-out, lower subjective physical health, and higher levels of anxiety and depression (Faragher et al., 2005). Promoting career self-management to assist in obtaining positive career outcomes therefore has implications for the mental and physical health of individuals. However, the specific career self-management experiences of engineering students are sparsely examined in the literature.

Career Intentions and Career Decision-Making of Engineering Students

Research in engineering education has primarily focused on the career intentions and career decision-making of engineering students. Prior work indicates that an engineering degree alone is not predictive of entering an engineering career (Lichtenstein et al., 2009). Instead, the post-graduation plans of engineering students are broad, and their career pathways are fluid, with people moving in and out of engineering careers. Research also finds that undergraduate engineering students are not committed to engineering careers, and only a subset of engineering students enter engineering occupations (Lichtenstein et al., 2009; Margolis & Kotys-Schwartz, 2009; Sheppard et al., 2014; Ro, 2011). Students tend to keep their options open and eventually pursue a variety of careers with an engineering degree (Sheppard et al., 2014).

Many factors, such as the specific engineering major, involvement in student organizations, internship experience, alignment of self and occupational knowledge, research experience, gender dynamics, and family, are known to affect the career choices of engineering students and graduates (Lichtenstein et al., 2009; Rohde et al., 2018; Smith & Gayles, 2017; Winters et al., 2014). Personal factors and attributes of individuals, such as personality, career values, self-efficacy beliefs, and outcome expectations have also been identified in relation to the post-graduation career choices of engineering students (Borrego et al, 2018; Margolis & Kotys-Schwartz, 2009; Patrick et al., 2021). When making decisions about their careers, engineering students are strongly swayed by a single experience, such as an internship, interactions with their faculty, and advice from their mentors (Lichtenstein et al., 2009). For interdisciplinary majors like BME students, career perceptions are found to be influenced by opportunities like undergraduate research, volunteering, attending alumni networking lunches, talking to professors, and attending department-level programming as well as programming by BME professional fraternities (Jamison et al., 2021). There's even literature indicating the positive outcomes associated with internship participation for engineering students (Bae et al., 2020; Massi et al., 2013; Powers et al., 2018). However, less is known about how students experience the process of procuring internships and jobs and who are the individuals supporting students during this process.

In examining the decision-making of engineering students, social capital is one factor that has received considerable attention in the literature. Prior work on engineering students demonstrates the influence of social capital on their decision to major in engineering, their

persistence, as well as on their career plans (Martin et al., 2013; Martin et. al., 2020; Skvoretz et al., 2020). While not specifically focused on the career outcomes of engineering students, a study on the social capital possessed by engineering students found that professors, advisors, family members, STEM-associated individuals, and many other alters in the social networks of engineering students provided various forms of social capital that helped students make decisions about their future careers (Martin et al., 2020). In the same study, family members of continuing-generation students are found to provide instrumental social capital in the form of engineering-specific information when selecting a college major, and families of first-generation college students are found to provide expressive social capital in the form of emotional support (Martin et al., 2020). Family, peers, and university and work-related individuals are found to influence students' career plans in engineering (Abhyankar et al., 2018). Students are also found to mobilize various forms of capital to support their professional development and make a successful transition from university to employment (Kovalchuk et al., 2017; Corple et al., 2019).

While existing research points to the influence of different individuals in students' decision-making, studies examining how social capital and support from various on-campus and off-campus resources influence the career actions of undergraduate engineering students are limited. For underrepresented and minoritized students in engineering, professional organizations such as the National Society of Black Engineers (NSBE) and the Society of Hispanic Engineers (SHPE) are known to provide various social capital that support the identity development, persistence, and success of these students (Daily et al., 2007; Martin et al., 2016; Revelo & Baber, 2018; Ross & McGrade, 2016; Smith et al., 2021). These organizations provide opportunities for professional development, access to role models, and support systems (Martin et al., 2016). However, the influence of social networks and social capital on the career behaviors of women and minoritized students in engineering is understudied. Therefore, while research exists on the myriads of factors influencing engineering students' career intentions and decisions, research on the process or the subsequent proactive behaviors students engage in to realize their career goals is limited. Translating career intentions to outcomes requires students to engage in actions such as performing job searches, attending career fairs, securing internships to gain professional experience, networking, etc. However, research on the proactive career actions of engineering students is sparse.

The limited research on the career actions of students suggests that engaging in career behaviors could be distressing to engineering students. For example, many students experience stress and anxiety when engaging in behaviors related to job selection and college-to-work transition (Harris et al., 2017), with some even expressing a lack of control over their early career pathways (Rohde et al., 2020). The job search process is very demanding for early career engineering students, with some students expressing ambivalence in engaging in job searches (Stiwne & Jungert, 2010). More work examining the career self-management of engineering students would allow us to draw stronger conclusions about the emotional experiences related to this process.

Two notable studies examining the career actions of engineering students and the role of individuals influencing the career plans of engineering students include research by Desing et al., (2024) and Abhyankar et al. (2018). Desing et al., (2024) used the Social Cognitive Career Theory Career Self-Management model (SCCT- CSM) to examine the contextual factors acting as supports and barriers to career attainment for biomedical, chemical, materials science, and mechanical engineering students at a large midwestern university. Based on data from multiple focus groups comprising 30 students in the second through fifth years of undergraduate study, the authors identified various contextual factors supporting and/or acting as barriers to students' career attainment processes. These factors include interpersonal relationships, institutional infrastructure, academics, social identity, and out-of-class experiences (Desing et al., 2024). In addition, the above contextual factors were found to be perceived as either a support or a barrier depending on the personality, demographics or identity of participants (Desing et al., 2024). Abhyankar et al. (2018) leveraged Eccles' Expectancy Value Theory to examine the influence of socializers on engineering students' career planning. Sixty-two junior and senior mechanical and chemical engineering students were interviewed about their post-graduation careers plans, the specifics of finding and obtaining jobs, and the influence of different people in these areas. In their study, family, peers, and university and work-related individuals were found to be the dominant socializers influencing students' job exploration, thinking about jobs, and pursuing further education (Abhyankar et al., 2018).

As Rohde et al., (2020) have previously noted, interdisciplinary engineering programs equip students with skills valued in many work contexts, more so than traditional engineering majors. Despite the benefits of such interdisciplinary education, students in BME report

difficulties in career attainment, graduate with fewer co-op and internship experiences, and experience lower hiring trends than other engineering majors (Linsenmeier & Saterbak, 2020; Nocera et al., 2018; Ortiz-Rosario et al., 2020). Biomedical engineering students also report competing with the more traditional engineering majors for jobs and feeling like a "jack of all trades" (Berglund, 2015b; Jamison et al., 2022). Interdisciplinary engineering programs also have distinct differences in the career plans of students. For example, compared to more established engineering majors, less than 40% of students in BME and IE have engineering-focused plans (Gilmartin et al., 2018). Despite these differences between engineering disciplines, students in traditional and interdisciplinary engineering programs are often compared to each other or grouped together in research. Given that interdisciplinary programs like BME and IE have distinct differences (e.g., career plans/pathways) compared to traditional engineering programs (Gilmartin et al., 2018; Linsenmeier & Saterbak, 2020), the experiences of students in these majors warrants further research. Specifically, research examining how the social networks of students in these majors influence their career management and entrance into different career pathways is needed. In the next section, I present the literature on the unique experiences and career development challenges of underrepresented students in engineering and argue for examining how these students enter different career pathways.

Career Development Experiences of Underrepresented Students in Engineering

The literature suggests that the transition to the workforce is a taxing endeavor for engineering undergraduate students, disproportionately affecting first-generation and minoritized students. For example, first-generation and minoritized students in engineering are found to be less likely to plan for careers or prepare for graduate school in engineering due to the psychological cost associated with degree attainment (Henderson et al., 2022). Furthermore, minoritized students, like women and first-generation students, are more likely to have only a single job offer available to them, significantly influencing their job selection decisions (Harris et al., 2017). Existing research points to the need to further understand the psychological and emotional dimensions of transition to the workforce for engineering majors. In addition, research shows us that STEM climates are competitive and unwelcoming (Hurtado et al., 2011; Cheryan et al., 2017) and that women of color in STEM face a "double bind" of race and gender marginalization (Cross et al., 2017; Malcolm & Malcolm, 2011; Ong et al., 2011). Under these circumstances, the experiences related to the career attainment process for women of color

warrant further examination. And while positive internship experiences are highly influential, research also shows internship participation is unequal, with URM students, low-income students, and first-generation students less likely to have internship experiences (Atwood et al., 2021). Understanding how women of color navigate career self-management could help address some of the inequities in internship participation.

This dissertation builds on the research by Desing et al., (2024) and Abhyankar et al. (2018) in multiple ways. First, this research focuses on interdisciplinary engineering programs, specifically students in BME and IE whose experiences are minimally examined in the literature compared to more traditional engineering majors. Next, in addition to gaining a deeper understanding of the role of social networks in career self-management, this research examined the influence of outcome expectations on career actions and seeks to explore the emotional dimension of career self-management. Finally, this research centers the perspectives of women of color and takes an asset-based approach to understanding their career management experiences. By sampling students with both positive and negative experiences with finding internships, this research also makes it possible to understand potential sources of inequities in the career attainment process.

Chapter 3 Theoretical and Conceptual Models

I leveraged the Social Cognitive Career Theory Career Self-Management Model (SCCT-CSM) by Lent and Brown (2013), and Community Cultural Wealth (CCW) by Yosso (2005) to ground this research. In the following sections, I provide an overview of these frameworks, their recent applications, and conclude by specifying how they were used to help me achieve my research objectives.

Career Self-Management Model of Social Cognitive Career Theory

The Career Self-Management (CSM) model by Lent and Brown (2013) is an extension of the choice-content model of Social Cognitive Career Theory (SCCT) originally proposed by Lent, Brown, and Hackett (1994). A basic premise of the SCCT-CSM model rests on the assumption that people are able to assert agency to direct some of their career development. The model then focuses on the specific mechanisms or adaptive career behaviors through which people achieve their goals. Therefore, in this model, adaptive career behaviors are broadly defined as "behaviors that people employ to help direct their own career (and educational) development" (Lent & Brown, 2013, p. 559). Similar to SCCT, the adaptive career behaviors conceptualized in the SCCT-CSM model are influenced by self-efficacy expectations, goals, outcome expectations, and environmental factors or supports and barriers (Figure 1). However, unlike the original SCCT models, which predict interest and entry into different fields, the SCCT-CSM model focuses on the underlying factors and processes through which individuals achieve their objectives. In particular, the SCCT-CSM model is primarily concerned with understanding the micro-level processes of how and under what conditions individuals engage in adaptive behaviors such as planning, goal-setting, career exploration, decision-making, job searching, and identity management, to name a few, to direct their career development (Lent & Brown, 2013).

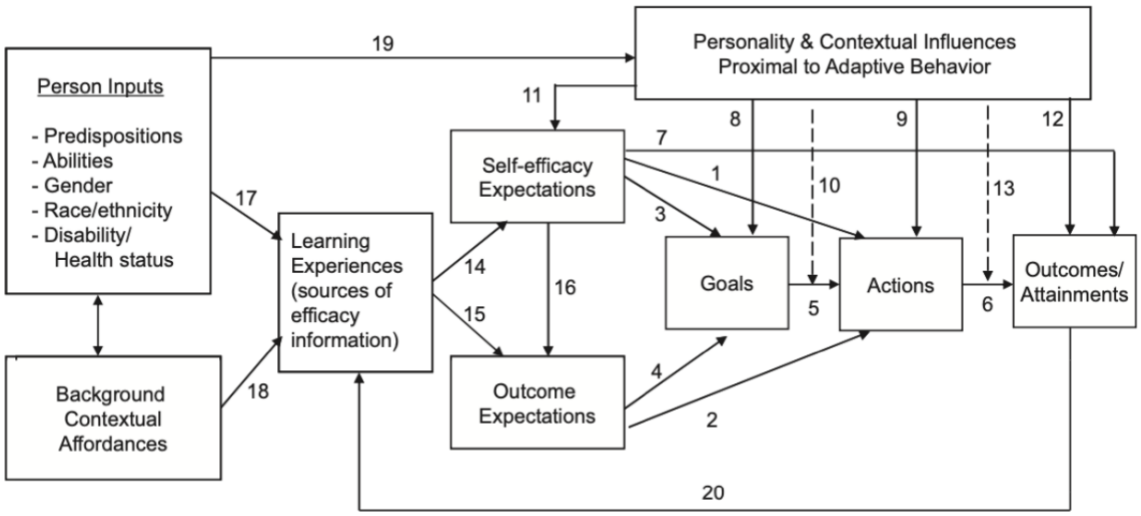


Figure 1. Model of SCCT Career Self-Management as depicted in Lent and Brown (2013)

In the SCCT-CSM model, self-efficacy expectations, outcome expectations, goals, as well as personality and contextual factors are all modeled to affect adaptive career behaviors. These factors are conceptualized to directly influence adaptive career behaviors through pathways one, two, five, and nine in Figure one. Self-efficacy and outcome expectations also indirectly impact adaptive career actions through their influence on goals (pathways three and four). Similarly, outcomes (e.g., career exploration, networking, career attainment), person inputs (e.g., race, gender), and background contextual affordances (e.g., socioeconomic resources) indirectly influence adaptive behaviors through their influence on learning experiences (pathways 17, 18, and 20) which form the sources of information for efficacy. In this model, it is important to note that adaptive behaviors are modeled as instrumental but not the ultimate determinant of outcomes (pathway 6). The relationship between goals and actions (pathway 5), as well as between actions and outcomes (pathway 6), is mediated by contextual and personality factors (pathways 10 and 13). In other words, personality factors (e.g., neuroticism), the presence of contextual or environmental supports (e.g., social or financial support), and barriers (e.g., lack of access to certain resources and information), enable or limit the exercise of agency by individuals.

The SCCT-CSM model therefore provides a guide to understand how individuals from different backgrounds might direct their agency in the presence of various contextual factors to achieve their goals (Lent & Brown, 2013). The framework also predicts relationships between

the different factors in the model leading to adaptive career actions and career outcomes. Given that this dissertation work was focused on understanding the various factors influencing the career actions and, ultimately, the career attainment of interdisciplinary majors, the SCCT-CSM model was an appropriate framework to guide this research. Furthermore, the SCCT-CSM model has previously been applied to study career exploration, career decision-making, and job search outcomes in college students (Lent et al., 2016, 2017; Lim, 2014). More recently, it has also been used to examine the career exploration of Native American students with STEM goals (Turner et al., 2022), factors contributing to the consistency in the career goals and decisions of engineering graduates (Winters, 2012), and the supports and barrier to career attainment of engineering majors (Desing et al., 2024).

Community Cultural Wealth

In addition to the SCCT-CSM, I leveraged the Community Cultural Wealth Framework (Yosso, 2005) to understand the influence of person inputs and social networks on the career actions of women of color in interdisciplinary engineering majors. Community Cultural Wealth by Yosso (2005) is an asset-based framework that focuses on understanding and describing the cultural knowledge, skills, and abilities that communities of color possess as a result of their lived experiences and histories. The community cultural wealth framework utilizes a critical race theory approach to challenge the traditional Bordieuan interpretations of cultural capital and provides an alternative to this interpretation by adopting an asset-based view. According to Bourdieu, knowledge of the white upper and middle classes is considered valuable by society, and cultural capital is the cultural knowledge, skills, and abilities inherited by these privileged groups. Social mobility in a hierarchical society is made possible by acquiring cultural capital, either through one's family and/or through formal schooling. In this way, social and cultural reproduction occurs in society through the acquisition of cultural capital, and dominant groups are able to maintain power by limiting access to the cultural capital required for social mobility.

While this interpretation provides a structural explanation for the hierarchical reproduction of society, Yosso (2005) asserts that this interpretation exposes the culture of the white, middle class as the standard. And in doing so, the traditional interpretation of cultural capital situates some communities as culturally wealthy and other communities as culturally poor. Yosso (2005) further argues that the valuation of white, middle-class culture and the devaluation of the knowledge of people of color is another manifestation of contemporary racism

in the structures, practices, and discourses of our society. In order to challenge the traditional, racialized, deficit-informed assumption of cultural capital, Yosso (2005) calls for centering of the voices and knowledge of people of color. To do this, she draws from Chicana/o studies and from various theoretical models such as the Internal Colonial model, Marxism, Chicana and Black feminisms, and cultural nationalism. In addition, she situates the history and the evolution of Critical Race Theory (CRT) as a valid lens that would enable her to examine race and racism embedded in educational structures and discourses and by extension challenge the traditional interpretation of cultural capital (Yosso, 2005).

Utilizing the lens of CRT, Yosso asks the question, "are there forms of cultural capital that marginalized groups bring to the table that traditional cultural capital theory does not recognize or value?" (Yosso, 2005, p. 77). Yosso defines culture as the dynamic "behaviors and values learned, shared, and exhibited by a group of people" (Yosso, 2005, p. 75). Further, Yosso (2005) critiques capital to be a narrow range of assets and characteristics and proposes wealth, which is all the accumulated assets and resources of an individual, as the alternative. Yosso defines Community Cultural Wealth as "an array of knowledge, skills, abilities and contacts possessed and utilized by Communities of Color to survive and resist macro and micro-forms of oppression" (Yosso, 2005, p. 77). Beginning with the perspective that communities of color are places with multiple strengths, the model highlights at least six forms of capital that communities of color nurture: 1) *Aspirational capital, 2) Linguistic capital, 3) Familial capital, 4) Social capital, 5) Navigational capital,* and *6) Resistant capital* (Yosso, 2005). An illustration of the model can be seen below in Figure 2.

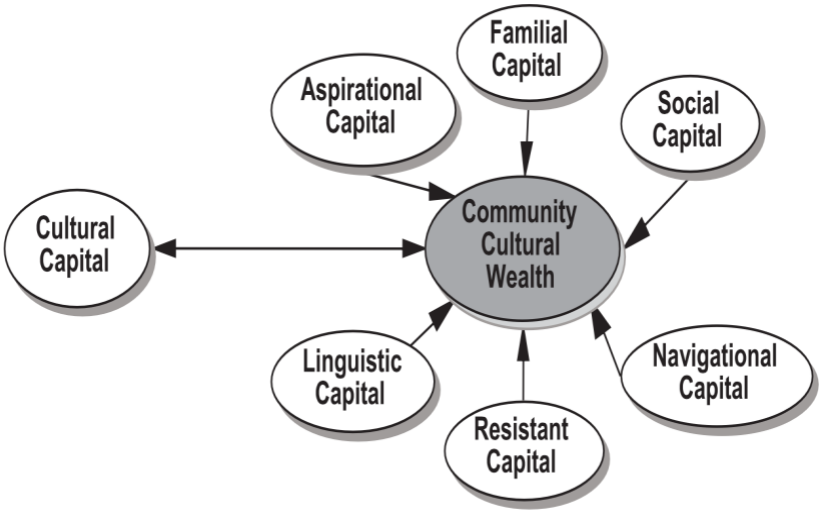


Figure 2. Model of Community Cultural Wealth as depicted in Yosso (2005)

Aspirational capital is the resiliency exhibited by communities of color "to maintain hopes and dreams for the future, even in the face of real and perceived barriers" (Yosso, 2005, p. 77). *Linguistic capital* refers to all the skills acquired through communicating experiences in more than one language and/or style (Yosso, 2005). Yosso draws from research in bilingual education to assert that students of color possess multiple communication skills. She highlights the skills acquired through translating for adults and the traditions of storytelling prevalent in many cultures to include memorization, attention to detail, the ability to communicate via art, music, or poetry, and various other social tools of vocabulary as well as 'real-world' literacy skills. *Familial capital* is the "cultural knowledge nurtured among familia (kin) that carry a sense of community history, memory, and cultural intuition" (Yosso, 2005, p. 79). Here the concept of *familia* or kin extends beyond the traditional understanding of family to include 'extended family' and kinship ties nurtured in community. These ties teach a commitment to community well-being and model lessons of caring, coping, and providing to inform "emotional, moral, educational and occupational consciousness" (Yosso, 2005, p. 79).

Social capital is the networks of people and community resources that can provide "instrumental and emotional support to navigate through society's institutions" (Yosso, 2005, p. 79). This refers to the ways in which communities of color share with one another their social contacts and community resources to attain education, legal justice, employment, and health care while giving back the information and resources gained to their social networks. *Navigational capital* is the skill of maneuvering through social institutions that were historically not created

with communities of color in mind. (Yosso, 2005). This form of capital acknowledges the individual agency in navigating various spaces, including schools, health care, and the job market, while tapping into the social networks that facilitate this navigation. *Resistant capital* is the "knowledges and skills fostered through oppositional behavior that challenges inequality" (Yosso, 2005, p. 80). This form of capital equips communities of color with cultural knowledge, skills, and motivation to challenge the status quo and transform oppressive structures. Finally, Yosso (2005) highlights that culture is dynamic, the various forms of capital outlined above are not static, nor are they mutually exclusive. Instead, they overlap and build on one another to form the collective wealth that communities of color possess.

The framework provides a critical lens to examine the ways in which marginalized students continue to persist and thrive in educational institutions despite the structural barriers that they may face. It also provides clear contextual variables that institutional agents can begin to value and nurture to support historically excluded students. By centering the knowledge and skills of those at the margins and expanding the concept of cultural capital, this framework makes predictions on how the field of education can be transformed into a space where historically excluded students can persist and thrive. In this dissertation work, I used Yosso's framework to understand how women of color in BME and IE programs used different forms of cultural wealth to navigate the career self-management process. Cultural wealth is seen as the innate knowledge, skills, and abilities that communities of color possess (Yosso, 2005). Therefore, I operationalized *Aspirational, Familial, Navigational, and Resistant* capital as person inputs and *Social* capital as a contextual influence in the SCCT-CSM model (Lent & Brown, 2013). *Social* capital is operationalized as a contextual influence and not a person input because unlike the other forms of cultural wealth which are more skill and knowledge based, social capital comprises the network of people and resources assisting students with navigating various situations and institutions. As such social capital can function as a direct contextual support when students are navigating career self-management. An integrated version of the frameworks is represented in the Figure 3 below.

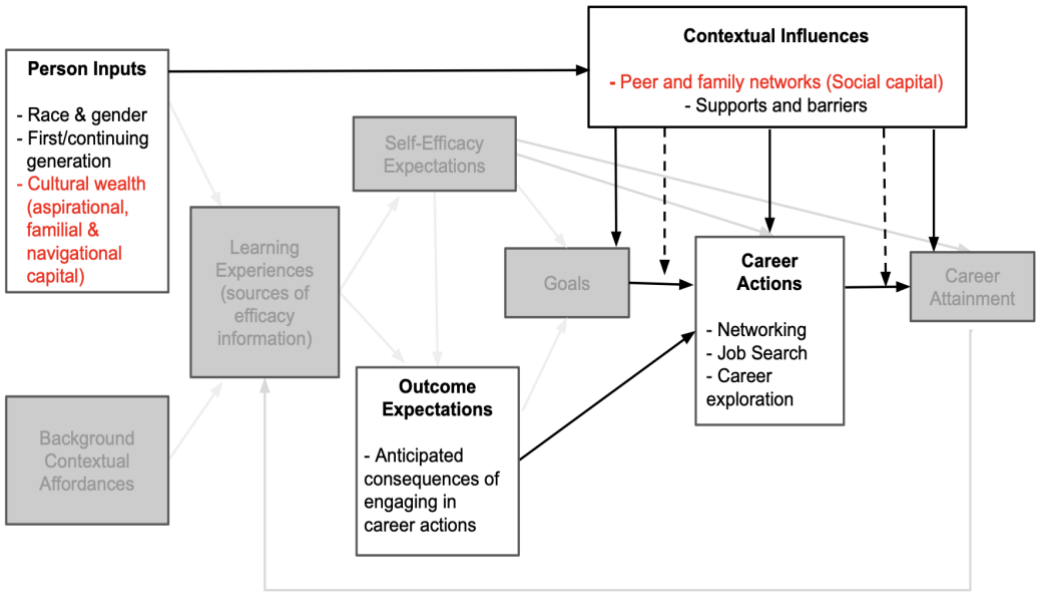


Figure 3. Model of SCCT-CSM from Lent and Brown (2013) adapted to include Yosso's (2005) Cultural Wealth (in red)

Application of Frameworks in the Study

The SCCT-CSM and CCW frameworks informed my research questions, interview protocol development, and data analysis plans. I operationalized *Aspirational, Familia, Navigational, Resistant* capital as person inputs and *Social* capital as a contextual influence in the SCCT-CSM framework. Accordingly, the interview protocol consisted of questions aimed at understanding the careers actions, outcome expectations, and environmental/contextual influences informing the CSM of women of color. In addition, the protocol also consisted of questions that prompted students to reflect on how they leveraged their CCW to navigate career attainment and the range of emotional experiences they experienced that are associated with engaging in CSM.

Chapter 4 Research Methods

This chapter outlines the methodological approach used to examine the career actions, cultural wealth, social networks, and emotions of undergraduate women of color in BME and IE programs. The research questions guiding this work are:

1. How do undergraduate women of color in BME and IE majors describe navigating career self-management (CSM)?
2. What influences the career actions of undergraduate women of color in BME and IE majors?
3. How do undergraduate women of color in BME and IE majors leverage their community cultural wealth (CCW) to navigate career self-management (CSM)?

To explore these questions, I used a multiple case study approach grounded in SCCT-CSM and CCW frameworks. This research consisted of a pilot study (details at the end of the chapter.) and a post-study. The pilot study was undertaken in the Fall of 2023 to assess and refine the scope and the data collection protocols for the larger dissertation post-study. In the following sections, I first discuss my positionality and how it informed this dissertation research, followed by an overview of the research design of the post-study. Next, I include details of the recruitment, data collection, and data analysis procedures. Finally, I provide details of the pilot study and address issues of trustworthiness and credibility of the data collected.

Positionality

I reject objectivity in research and care about understanding how individuals interpret their experiences to create their realities. Further, my worldview has been shaped by my social identities and lived experiences as a South Asian woman and an international student navigating the United States' higher education system. My lived experiences have made me aware of how access to opportunities and the realities of different individuals are shaped by various power relations. Therefore, in line with critical constructivist paradigms, I understand and interpret an

individual's meaning-making by both acknowledging the subjectivities of individuals and the existence of various systems of oppression. I am specifically motivated to understand how agency and opportunity structures interact to shape the realities of individuals.

This research was motivated by my experiences as a biomedical engineering student. I arrived at this work with an intimate understanding of the complexities present in the career attainment process. As an undergraduate student in biomedical engineering, I had career aspirations of entering the engineering industry. However, as an international student, I was unfamiliar with navigating the United States' higher education system and the career attainment process. In addition, my experiences of feeling isolated and excluded from the dominant cultures of my undergraduate and graduate engineering programs further contributed to my understanding of how access to crucial resources and social networks within engineering can impact the career attainment process. My negative experiences with career attainment in engineering have sensitized me to the barriers that might be present in the career attainment process. My background has also sensitized me to understand how people holding similar/shared positionalities might make meaning of their career attainment process.

I argue that my experiences with career attainment in engineering offer me a unique lens to understand how individuals might experience the career attainment process. However, I also acknowledge that my experiences and my relation to different identities might unconsciously shape what I see and interpret as the participants' experiences. To avoid misinterpretation of participants' realities, I engaged in the process of journaling throughout the process of data collection and analysis. Specifically, I reflected on my presumptions about individuals, and their career attainment experiences and how my positionality might have shaped my interpretation of the participants' experiences. Further, I acknowledge that different participants might have responded or behaved differently with respect to my position as an outsider or an insider of their community (e.g., similar or dissimilar social identities). Therefore, to establish trust and rapport with the participants, I briefly explained my motivations and intentions for the study at the beginning of the interviews with the participants. Finally, I used orienting questions set forth by Secules et al., (2019) to guide my reflection on how my beliefs, background, and training might have influenced this research.

Research Design: Multiple Case Study Approach

This research utilized a multiple case study approach (Yin, 2018) to gain an in-depth understanding of the career self- management experiences of women of color in interdisciplinary engineering programs. Case study approaches often use a combination of methods, such as interviews, surveys, observations, document analysis, etc., to arrive at an in-depth understanding of the phenomenon of interest (Crowe et. al., 2011). In case study approaches, the unit of analysis is a "case," which is a bounded entity or system of interest. The multiple case study approach involves a detailed examination of multiple cases of interest to generate rich and detailed data that provides an understanding of a phenomenon in its entirety. A multiple case study approach also makes it possible to observe similarities and differences across cases using a cross-case analysis, thus enabling theory building. For case studies, it is also important to form boundaries around the case by defining the system of interest using a set of criteria (Yin, 2018). These criteria allow the researcher to clearly define the unit of analysis and distinguish it from other cases. The individual participant comprises the unit of analysis or "case" for this multiple case study research. The selection criteria used to select the individual cases are discussed in the participant recruitment and data analysis sections below.

For my data sources, I utilized a survey instrument and individual semi-structured interviews to develop an in-depth understanding of how women of color in interdisciplinary engineering programs leverage CCW and navigate CSM to achieve their intended career outcomes. In the following sections, I outline my participant recruitment, data collection, and data analysis plans. I provide further details about each of the sources of data (name generator survey and semi-structured interviews) in the data collection section.

Participant Recruitment

The participants for this study were recruited using purposeful (Creswell & Poth, 2016) and snowball sampling (Merriam, 2009). Specifically, I used my social networks (e.g., academic advisors, faculty members, graduate and undergraduate students, administrators) to distribute an email requesting participation in this research. I asked people to forward a recruitment email to their contacts in various BME and IE programs and student chapters of the Society of Women Engineers (SWE), the National Society of Black Engineers (NSBE), and the Society of Hispanic Professional Engineers (SHPE) at 4-year engineering institutions in the United States. The email template I shared contained a brief study description and a PDF attachment of the informed

consent form (Appendix A). The email template also emphasized that participation is optional. Participants who were interested in the study could begin their participation using a Qualtrics link provided in the email. In addition, at the end of the Qualtrics survey, I asked participants to optionally forward a request for participation to anyone interested in the study.

To be included in the study, the participants had to meet several criteria, which they were screened for using the survey data. They must: self-identify as a woman of color, be at least a third-year student enrolled in an undergraduate BME or IE program in the United States, and have industry career intentions post-graduation. I focused on students who were at least in their third year as they were likely to have some experience with career behaviors such as career exploration, networking, seeking out internships/jobs, and navigating career fairs. The selection criteria described above are included in Table 3 below.

Table 3. Participation selection criteria for semi-structured interviews

Selection Criteria
Self-identify as a woman of color
Is an undergraduate student
Is at least in their third year
Is enrolled in an undergraduate biomedical or industrial engineering program
Has intentions to enter industry careers post-graduation

Data Collection

Data for this study came from two primary sources: a name-generator survey and individual interviews. Students who opted to participate in the study first completed a name-generator survey on Qualtrics and then participated in an approximately 75-minute one-on-one semi-structured follow-up interview over Zoom software. The Qualtrics survey began with the informed consent process, followed by a brief description of the motivation and goal of the study. The participants were then directed to the name-generator survey.

Survey: Name Generator Instrument

Name generators are tools commonly used in social network analysis to study the structure and dynamics of relationships by collecting information on the social networks and relationships of particular individuals or groups (Burt et al., 2012; Marin & Hampton, 2007). Name generator instruments are used to collect various information on individual-level networks,

also known as ego networks. This information includes collecting data on network characteristics such as network size, tie strength, composition, and homophily (Campbell & Lee, 1991; Marin, 2004). Network size refers to the *number of individuals (alters)* in a person's network. Network tie strength measures the *strength and nature of the relationships (ties)* in a network. Network composition provides information on the *attributes of the alters*, such as their occupations and demographic information. Finally, network homophily provides information on *the tendency of individuals to form connections* with people who are similar to them (McPherson et al., 2001). These characteristics can help us understand the dynamics of an individual's social environment, such as the level of their social connectedness, the diversity and homogeneity of their social connections, and the implications this might have on their access to various information, resources, and opportunities (Ramos et al., 2024). Therefore, by collecting network data using a name generator instrument, we can make inferences about the social capital of various individuals, where social capital in this study refers to the network of people who provide emotional and instrumental support to women of color (Yosso, 2005).

In this dissertation research, I used a name-generator survey to gather information about the participants and the various individuals in the participants' ego network. After walking the participants through the informed consent process, the name-generator survey first collected the demographic and background information of the participants. This included their race and ethnic identification, gender identification, generational status, international student status, year in college/university, previous internship/co-op experience, career plans after graduation, involvement in engineering-related student organizations, and frequency of use of career services and academic advising.

The next set of survey questions asked the participants to identify up to five people (alters) who had supported them when they engaged in each of the following activities: *1) exploring career interests, 2) searching and obtaining internships/jobs/research/co-op experiences, and 3) networking and preparing for career fairs.* For each activity, participants indicated if the alters they mentioned were the same or different from those mentioned for the previous activities. Therefore, the possible number of unique alters that participants could indicate in the survey ranged from zero to 15. A full list of the survey questions can be found in Appendix B.

To understand the network characteristics of the people influencing and supporting the career actions of women of color, the Qualtrics survey also collected demographic and background information of the alters mentioned by the participants. For each alter the participants mentioned, the survey asked them to provide information about the gender, racial and ethnic identification, and the general occupation/field of the alter. Finally, the survey questions also asked the participants about the nature (ex: parent/guardian, sibling, peer, mentor etc) and strength (on a scale of one to six) of their relationship, and the frequency of contact with the alters mentioned. The list of possible occupations and relationship types that participants could assign to the alters is indicated in Table 4 below. The above information from the survey allowed me to describe the network characteristics of each participant in the study, such as their network size, strength, and composition. At the end of the name generator survey, the participants were asked to provide their email and mailing address to receive compensation for the survey. The participants were also optionally asked to forward a recruitment message to others who might be interested in the study.

Table 4. Sample name-generator survey question collecting alter relationship and occupation information

Think of up to five people who have helped you in exploring career interests. For each person:	
List their relationship to you:	List their occupation:
a. Parent/Guardian b. Sibling c. Other Family Member d. Peer e. Partner/Significant Other f. College/Uni Faculty g. College/Uni Staff h. Mentor i. Other, please specify:	a. Academic Professional b. Currently Not Working c. Engineering Industry Professional d. Non-engineering Industry Professional e. Self-employed f. Stay-at-home Caretaker g. Student h. Do not know

For the one-on-one interviews, I periodically reviewed the survey responses and invited select students via email to participate in a follow-up interview based on their responses to the questions about previous internship/co-experience and post-graduation career plans. Specifically, I only considered participants who indicated an interest in industry career plans post-graduation

as this research focuses on understanding the career planning experiences of women of color with industry intentions. Additionally, I also strived to recruit an equal number of participants from BME and IE majors, participants with and without previous internship/co-op experiences, and a racially diverse sample of participants for the cross-case comparison and analysis. I initially aimed to recruit 20-25 interview participants who fit the criteria described above, but I stopped data collection after multiple recruitment efforts yielded no additional survey responses. All participants were compensated with a $20 Amazon gift card for completing the survey portion of the study.

The data collected using the name-generator survey served three purposes: 1) It was used to understand the participants' social networks, 2) recruit participants for follow-up interviews, and 3) gather detailed information about participants' social network during the interviews. Specifically, during the semi-structured interviews, I referred to the individuals mentioned in the survey and asked participants how the people in their social network supported them with various career actions (see semi-structured interview section for more information). Therefore, the survey helped identify key individuals in participants' social network, and the follow-up questions in the interviews provided information about the types of support provided by different individuals.

Semi-structured Interviews

The primary data source for the study included semi-structured interviews with 12 women of color currently enrolled in undergraduate BME or IE programs across the United States. I chose a semi-structured interview format to gather data because of the flexibility it offers. In a semi-structured interview format, researchers have a predetermined set of questions to guide the data collection, but the questions can be framed and organized in different ways based on the conversational flow between the interviewer and the participant (Creswell & Poth, 2016). This flexibility allows the researcher to maintain the flow of conversation and ask follow-up questions to dig deeper into the participants' experiences while staying on track with the topic.

I invited a subset of the survey participants via email to participate in an interview. The email included a copy of the informed consent and a custom link to a poll for participants to provide their availability for the interview. Once the participants filled out their availability, I followed up with an interview time and date and the Zoom information. Before each interview, I

briefly reviewed the participant's survey responses and took notes about the individuals whom the participant identified as "supports" in the survey. Additionally, based on the information in the survey, I also created egocentric sociograms of the participants' social networks to guide some interview data collection (Hogan et al., 2007). Sociograms are visual representations of social relations in a group and an egocentric sociogram is a visual representation of the individuals in an ego networks. In an egocentric sociogram, the individuals in the participant's social network are represented as circles, also called vertexes, and the relationship between individuals is represented using lines, also called edges. More information about how I created the sociograms is included in the survey data analysis section. I began the interviews by sharing details about myself and my interest in this study to build rapport with the participants. I asked the participants for their consent to audio and video record before proceeding with the questions in the protocol.

I initially developed the interview protocol guided by previous literature and constructs related to the SCCT-CSM theoretical framework, such as career actions (CA), outcome expectations (OE), and immediate contextual/environmental factors (EF). Therefore, the initial interview protocol was designed to prompt the student to describe their experiences with various career actions in addition to prompting them to reflect on how their immediate environmental context (EF), outcome expectations (OE), and emotional experiences (EE) shaped their career actions (CA). I revised the initial protocol questions based on expert feedback and pilot study data. More information about how I refined the interview protocol based on expert feedback and the pilot study is presented at the end of this chapter

The final interview protocol consisted of four sections. The first section was intended to build rapport with the participants and collect their background information, such as major and year in college, post-graduation career goals, and how the participants developed an interest in their particular major and career goals. These questions provided me with contextual information about the participants and their engineering programs. The second section consisted of questions meant to uncover the career actions (CA) taken by participants related to their career goals. Some questions in this section included: "1) What are some specific actions/steps you have taken so far, such as networking, seeking career guidance, attending career fairs, etc., to make progress toward your career goals? and 2) What has been your experience with searching and applying for any previous internship or job-related opportunities?" In addition to the above questions, I also

screen-shared a sociogram of the participant's social network and asked them to verify the information as well as talk about how each of the individuals mentioned supported them with different career actions. For example, after sharing the sociogram, I asked the participants, "In the survey, you mentioned that [peers/family/mentor] helped you with [searching and applying for internships/networking/career exploration]. Can you tell me more about how they supported you?"

The questions in the third section asked the participants to reflect on how different factors in their immediate environment (EF) might have shaped their CSM. Example questions in this section include: "1) What, if any, challenges have you faced while finding and applying to internships and jobs or navigating the career resources available to you? 2) What, if any, particular resources do you think played a significant role in helping you make progress towards your career goals?" The last set of questions in section four aimed to capture students' outcome expectations (OE) and emotional experiences (EE) associated with CSM. To gather information on emotions, throughout the interview, I asked participants follow-up questions about their feelings using prompts such as "How did you feel [doing/about]? Why did you feel that way?" Further, I also asked participants direct questions such as "Describe the range of emotions that come up for you when you think about making plans for your career." "How do you feel overall about engaging in the process of finding and securing internships or jobs?" "How do you feel about your chances of securing a job that aligns with your interests after graduation?"

To help participants respond to the direct questions about emotions in section 4, I screen shared a document consisting of hand-drawn female characters expressing 14 different emotions and asked participants to pick one or more characters that expressed how they felt. These characters are part of a measurement instrument called Premo which was developed for users to self-report their emotions in a variety of situations (Laurans & Desmet, 2017). Premo consists of a male and female character expressing 14 different emotions, seven positive and seven negative, and the female version of the characters is included below (Fig.4). In addition to asking participants to pick characters, I also asked them to rank the characters they picked, describe the emotion displayed by the characters they picked in their own words, and explain why they felt those emotions. The participants' responses allowed me to visualize the dominant emotions experienced by participants within and across all the cases when they engaged in different aspects of CSM.

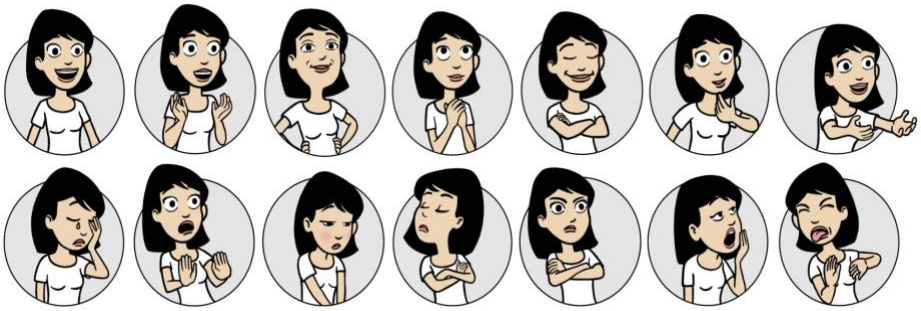


Figure 4. Female version of Premo expressing fourteen different emotions

(left to right: joy, admiration, pride, hope, satisfaction, fascination, desire, sadness, fear, shame, contempt, anger, boredom, disgust) **(**Fourteen of Premo expressions **by** Pieter Desmet **is licensed under** CC BY-NC-ND 4.0**).**

Finally, to understand how CCW might have influenced participants' experiences with CSM, I also asked them questions about how their family, culture, and upbringing prepared them for making progress towards their career goals and dealing with career related challenges. I ended the interview by asking the participants to share any other relevant information not already covered in the interview. Examples of interview questions and the corresponding constructs they are based on can be found in Table 5 below, and the full interview protocol can be found in Appendix C.

Table 5. Sample interview questions

Construct	**Example Questions**
Background	Can you tell me about how you got interested in engineering? What are you hoping to do after graduation?
Career Actions (CA)	What are some specific actions you have taken so far, such as networking, seeking career guidance, attending career fairs, etc., to make progress toward your career goals? Please be as detailed as possible.
Environmental Factors (EF)	What, if any, challenges have you faced while finding and applying to internships and jobs or navigating the career resources available to you? How did you choose to deal with the challenges? What, if any, particular resources do you think played a significant role in helping you make progress towards your career goals?

Community Cultural Wealth (CCW)	In what ways do you feel like your family, culture, and/or upbringing prepared you for the steps you might have to take to make progress toward your career goals?
Outcome Expectations (OE) and Emotional Experiences (EE)	Describe the range of emotions that come up for you when you think about making plans for your career. How do you feel overall about engaging in the process of finding and securing internships or jobs? How do you feel about your chances of securing a job that aligns with your interests after graduation?

Following a semi-structured interview format, I used the questions in the protocol as a guide during my conversation with the participants. I used follow-up prompts such as "tell me more" "can you expand on that," and "why do you think so" to probe more detailed descriptions of the participants' experiences. During the interview, I also took notes digitally to capture any contextual details or first impressions that stood out. Immediately after each interview, I created analytical memos of my overall thoughts related to what I learned from each of the participants (Lareau, 2021). After the interviews, I compensated the participants with a $35 gift card.

Data Analysis

The unit of analysis for this dissertation research is the individual participant. I first analyzed the survey and interview data for each participant separately before integrating them during the interpretation phase for the cross-case analysis. The survey data helped me understand the social network characteristics of participants while the qualitative data contextualized the social networks of participants and allowed me to understand how participants leveraged their networks and engaged in career self-management more broadly. Integrating the survey and interview data for each participant allowed me to generate a comprehensive profile for each case before engaging in cross case analysis.

Survey Data Analysis

For the survey data, I first downloaded the responses from Qualtrics into an Excel spreadsheet for analysis. I then assigned pseudonyms for all the participants using a random name generator and replaced their names with the pseudonyms. Next, for the 12 participants who completed both the survey and interview portions of the study, I created descriptive summaries

of their social network by identifying the number of unique individuals mentioned in the survey and summarizing the demographic and occupation information of the alters. As a reminder, participants were asked to identify individuals who supported them with their CSM in three specific areas: *1) exploring career interests, 2) searching and obtaining internships/jobs/research/co-op experiences, and 3) networking and preparing for career fairs.* Therefore, in addition to identifying all the alters in a participant's social network, I also grouped them into three categories (career interests, job search, networking and career fairs) based on how participants identified them as providing support related to their CSM. I used tables to organize the descriptive summaries of the participants' social networks. An example of this is presented in Table 6.

In addition to the descriptive summaries, I visualized the social relations of each participant using an egocentric sociogram. As a reminder, in an egocentric sociogram, the individuals in the participant's social network are represented as circles, also called vertexes, and the relationship between individuals is represented using lines, also called edges. After manually generating sociograms for each participant in PowerPoint, I overlayed the individual sociograms over the occupation fields of the individuals mentioned in the survey. An example of this visualization is included in Figure 5, where the star represents the participant, and the circles represent the individuals in the participant's social network.

Table 6. Descriptive summaries of participants' social networks (Example)

Name	**Alter**	**Gender**	**Race**	**Relationship**	**Supported With**	**Occupation**
Participant 1	Alter 1	Woman	Black	Parent	Job search	Eng Industry
	Alter 2	Man	Black	Sibling	Career int, job search	Student
	Alter 3	Woman	Asian	Parent	Networking	Caretaker
	Alter 4	Woman	White	Mentor	Career int, networking	Self-employed
	Alter 5	Woman	Asian	Faculty	Career int	Academia
	Alter 6	Man	Latino	Peer	Job search, networking	Student
	Alter 7	Non-binary	White	Partner	Career int, networking, job search	Eng Industry
Participant 2	Alter 1	Man	Asian	Peer	Career int, job search	Student
	Alter 2	Man	White	Mentor	Job search	N/Eng Industry
	Alter 3	Woman	Black	Faculty	Networking	Academia
	Alter 4	Woman	White	Parent	Networking	Eng Industry
	Alter 5	Woman	White	Parent	Career int	Self-employed

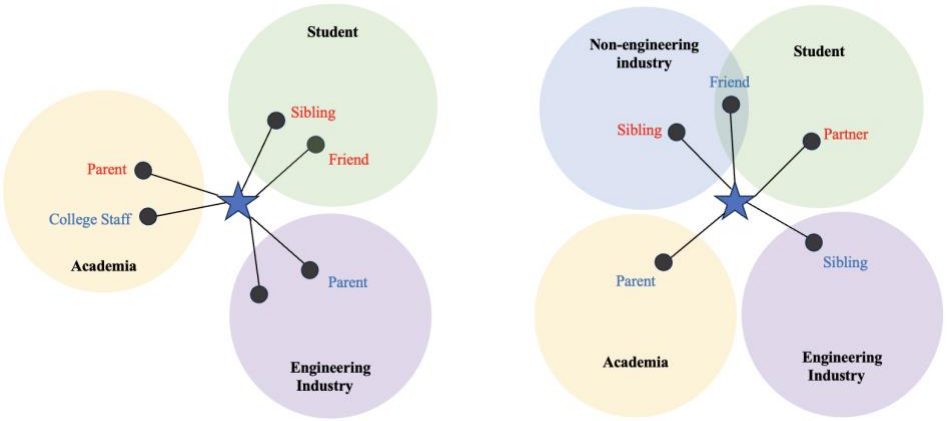


Figure 5. Example sociograms of participants' social networks.

The star represents the participant (ego), and the circles represent the people in the participant's social network (alters)

As previously mentioned in the data collection section, I used the egocentric sociograms during individual interviews to verify the social network information of participants' and learn more about the support provided by the different individuals in their social networks. Specifically, during each interview, I was able to verify the relationship type (ex: peer, mentor etc.), strength of the relationship (scale of 1-6), and race and gender information of each of the alters in the participants' social networks. I was also able to verify and update the occupation information (ex: faculty, engineering industry, student etc.) of the alters based on participants' descriptions of the alters occupations. Therefore, at the end of each interview, I reviewed and updated the descriptive summary table and egocentric sociogram of each participant based on the information they shared with me during the interview.

In addition to creating descriptive summaries and egocentric sociograms, I calculated network characteristics such as network size and homophily for each participant. Network size was determined by identifying the number of unique individuals mentioned by each participant. Network homophily, which is the propensity of participants to form relationships with individuals similar/dissimilar to them based on specific attributes (e.g, race, gender, occupation, etc.), was measured using the EI index shown below (Krackhardt & Stern, 1988; Everett & Borgatti, 2012).

$$EI = \frac{(External - Internal)}{(External + Internal)}$$

External here refers to the number of ties with individuals who have different characteristics from the participant, and internal refers to the number of ties with individuals who have the same characteristics as the participant. For example, a social network that consists of individuals who are all of a different gender than the participant will have an EI index of one (complete gender heterophily), and a network that consists of individuals who are all of the same gender as the participant will have an EI index of negative one (complete gender homophily). After calculating the above network characteristics for each participant, I looked for patterns within each participant's social network, paying attention to whether different types of networks (small or large, heterogeneous or homogeneous, etc.) and individuals (peers, family, faculty, etc.) were associated with providing support related to specific aspects of CSM (career exploration, job search, and networking and career fairs). I later integrated the social network information of each participant with their interview data to generate comprehensive profiles for the cross-case analysis.

Semi-structured Interview Data Analysis

Prior to any qualitative data analysis, I developed a list of a priori codes based on the research questions and the SCCT-CSM (Lent & Brown, 2013) and CCW (Yosso, 2005) frameworks which I later applied to the interview transcripts to identify patterns within each interview. First, the automatic transcription service provided by Zoom was used to transcribe the interviews. After downloading the Zoom-generated transcripts, I replaced all the names in the transcripts with pseudonyms and cross-referenced the transcripts with the Zoom recordings to check for any discrepancies. After cleaning the data, I coded and analyzed the interview transcripts one at a time by engaging in the process of reflexive thematic analysis (Braun & Clarke, 2006). I first read through a transcript to familiarize myself with the data and took notes digitally to capture my thoughts. After familiarizing myself with a transcript, I used a deductive coding approach where I applied theory driven a priori codes to the transcript and looked for patterns of meaning within each of the coded data. I repeated this process one at a time for all the transcripts. The list of a priori codes and the definitions used to guide the deductive analysis is included in Table 7.

Table 7. Theory driven a priori codes and the definitions used to guide the deductive analysis

Associated Framework/ Constructs	Code	Description
SCCT-CSM	Career Action (CA)	Participants discuss the different steps or actions they engage in to achieve their industry career goals
SCCT-CSM	Career Support (CS)	Participants discuss the different factors or resources that are supports to their career actions, goals, or outcomes
SCCT-CSM	Career Barrier (CB)	Participants discuss the different factors or resources that are barriers to their career actions, goals, or outcomes
CCW	Aspirational Capital (As-C)	Participants discuss maintaining motivation, hopes, and/or dreams towards their industry goals despite obstacles or setbacks
CCW	Linguistic Capital (Li-C)	Participants discuss language skills or competencies developed through navigating different contexts that are supporting them with their career self-management
CCW	Familial Capital (Fa-C)	Participants discuss the influence of family/community history, values, support, and wisdom on their career actions, goals, or outcomes
CCW	Social Capital (So-C)	Participants discuss leveraging or activating their social network for support related to their career actions, goals, or outcomes
CCW	Navigational Capital (Na-C)	Participants discuss the strategies they use to navigate career attainment systems and processes not designed for students with diverse experiences
CCW	Resistance Capital (Re-C)	Participants discuss skills and knowledge developed through engaging in oppositional behaviors
Emotions	Positive Affect (A-P)	Participants discuss the positive emotions and feelings associated with their career self-management
Emotions	Negative Affect (A-N)	Participants discuss the negative emotions and feelings associated with their career self-management

After coding and analyzing individual interviews, I integrated the social network information from the survey and the themes identified in the interview of each participant into a comprehensive case profile for cross-case analysis. The case profile of each participant included the descriptive summary and key characteristics information of their social network, the qualitative themes from the individual interview, and contextual information from the survey and interview data.

Cross Case Analysis

Drawing from Miles and Huberman (1994) and Bae (2022), I developed a cross-case matrix where each row represented a participant, and each column represented different key themes and variables from the case profiles of participants to facilitate cross-case analysis. I used the cross-case matrix to systematically compare different participants' social networks and experiences to identify overarching themes relating to the research questions. Specifically, across all the cases, I identified the salient experiences, emotions, environmental factors, and forms of cultural wealth associated with CSM for women of color. Throughout the process of data analysis, I maintained a journal reflecting on how my positionality was influencing my interpretation of the participants' experiences.

Pilot Study Informing Dissertation Work

This dissertation study began in the Summer of 2024 and was informed by a pilot study that took place in the Fall of 2023. The pilot study was undertaken to define the scope and refine the data collection protocols for the dissertation study. The pilot study consisted of two participants who took part in both the survey and the interview portion of this research. For the pilot, I identified two subject experts and emailed them a request to participate in the study. The recruitment email contained a Qualtrics link which directed the participants to the name-generator survey. The survey began with the informed consent process and collected the social network information of the participants using a name generator survey. Participants were also asked to consent to continue with the interview portion of the study and were compensated $20 for completing the survey. I scheduled individual interviews with the participants over email and conducted the interviews over Zoom software. The participants were compensated $35 for participating in the pilot interview. The pilot study revealed some technical issues with the name generator survey which were addressed following the pilot interviews. During the pilot

interviews, I took notes about which questions elicited confusion or detailed responses from the participants. The pilot served to improve the flow and clarity of the proposed dissertation study.

In addition to the pilot study, I sought feedback from three peer engineering education researchers on the survey and interview protocols. Specifically, the researchers were asked to examine the survey and interview questions and provide suggestions to improve the clarity of the questions. After engaging in a conversation about my goals for the survey and interview data, the researchers provided me with feedback to improve the phrasing and clarity of questions. They also made suggestions for possible questions to include in the survey and interview protocol. For example, I added options "stay-at-home caretaker" and "currently not working" to the name generator survey questions which ask for the occupation of alters in the participants' social network. Similarly, one of the earlier questions in the survey was changed from "Do you regularly meet with your academic advisor?" to "How often do you meet your academic advisor?" For the interview protocol, I received feedback to incorporate more probing questions when interviewing the participants about their career self-management experiences. I also received feedback to include follow-up prompts and give examples of specific career actions in my interview questions to elicit direct responses from the participants. The suggestions provided by the researchers were incorporated to refine my final data collection protocols along with feedback from committee members.

Ethical Considerations

I have taken multiple steps to protect the participants of the study. First, I obtained approval from the University of Michigan Institutional Review Board (IRB) before collecting any pilot or dissertation data and adequately compensated all participants for completing the survey and the interviews. At each step of the data collection process, I asked the participants for their consent and let them know that participation is entirely voluntary. I also let the participants know that they are not required to answer any questions that they do not want to answer. To protect participant identity, each participant in the study was assigned a pseudonym. In addition, any other names identified in the interviews were also replaced with a pseudonym to reduce the chances of identifying participants or the people in their social network.

All the data collected from the participants was stored on password-protected systems, accounts, or web-based storage provided by the University of Michigan. Only research team members were given access to the data collected from the participants. All audio and video

recordings were initially stored in the Zoom cloud storage and were deleted after checking the Zoom-generated transcription for accuracy. The original online survey data was also deleted after downloading and storing it in password-protected accounts and systems with all the names replaced. At any point, I will immediately destroy any data if a participant requests it. Otherwise, all remaining data will be deleted seven years after the participants have stopped participating in the study.

Trustworthiness, Credibility, and Generalizability

I employed multiple strategies to address threats to credibility and trustworthiness of the data collected. One of the first validity procedures I employed was to pilot my survey and interview protocols and gather feedback from experts. This process helped me to check for communicative and procedural validity by refining my protocols and addressing issues related to data collection. In addition, throughout the data collection and analysis process, I maintained a journal reflecting on my positionality and how it might have influenced my interpretation of the participants' experiences. Finally, to generate overarching themes addressing the research questions, I engaged in triangulation by using multiple sources of data (e.g., memos, survey responses, and semi-structured interviews) to inform the findings (Creswell & Poth, 2016; Lincoln & Guba, 1986). I also engaged in peer debriefing (Lincoln & Guba, 1986) by discussing my codebook and interpretations of the data with other engineering education and higher education scholars. A key feature of the multiple case study approach used in this research is to develop an understanding of the phenomena of interest in depth (Yin, 2018) over making broad claims about the experiences of students with CSM. Therefore, the findings generated from this research are not intended to be widely generalizable. However, the insights generated from this work may be relevant in specific situations that share similarities with the contexts and characteristics of the cases examined in this research.

Chapter 5 Findings

In this chapter, I first describe the participants in the study and then present findings on the career actions, contextual/environmental factors, community cultural wealth (CCW), and emotions associated with CSM of women of color to address each of the three research questions. The participants in my study include twelve undergraduate women of color from five different universities across the United States. The universities include a large public research university in the south (SU), a large public research university on the west coast (WU), two large public research universities in the Midwest (MU1 and MU2), and a large public research university on the east coast (EU). All the women were in the third or fourth year of their majors with nine of the twelve women in Biomedical Engineering (BME) programs and the rest in Industrial Engineering (IE) programs. Six of the women self-identified as South Asian, three women self-identified as Black, two women self-identified as East Asian, and one woman self-identified as Biracial (Asian and Hispanic/Latina). Additionally, one of the participants self-identified as an international student and two of the participants self-identified as first-generation students (i.e. a student whose parents did not complete a four-year college degree) in the survey. While I did not explicitly ask participants about their socioeconomic status, two of the participants talked about coming from low-income backgrounds during the interviews. The network size, which is the number of unique alters or individuals in participants' social networks supporting their CSM, ranged from four to 13. The participants' network size, demographic, and background information are summarized in Table 8 below. In the next three sections, I present the findings related to each of the three research questions.

Table 8. Participants' demographics, background, and network size.
Here, internship experience (Internship Exp) indicates experience in industry acquired as an undergraduate student. SU – Southern University; EU – East Coast University, WU – West Coast University; MU1 – Midwest University 1; MU2 – Midwest University 2

Pseudonym	Major	Race	University	Internship Exp	Network size
Maryam*	3rd year BME	South Asian	SU	No	6
Amira	4th year BME	Black	SU	Yes	13

Manvi	3rd year BME	South Asian	SU	No	6
Sarah	3rd year BME	South Asian	SU	Yes	11
Mei**	3rd year BME	East Asian	SU	Yes	10
Neha	3rd year BME	South Asian	SU	Yes	8
Layla	3rd year BME	Black	EU	No	4
Summer	4th year BME	Black	EU	Yes	8
Stephanie	4th year BME	Biracial	WU	No	12
Emma*	4th year IE	East Asian	MU1	Yes	5
Samira	3rd year IE	South Asian	MU2	Yes	11
Maya	4th year IE	South Asian	MU1	Yes	11

* Indicates self-identification as a first-generation student in the survey
** Indicates self-identification as an international student in the survey

RQ1: How Do Undergraduate Women of Color in BME and IE Majors Describe Navigating Career Self-Management

To understand participants' experiences with career self-management, I analyzed the interview data coded using the career actions (CA), negative affect (A-N), and positive affect (A-P) a priori codes within and across the participants. I specifically looked for the career behaviors, emotions, and experiences that were common across participants. In addition to analyzing all instances of positive and negative affect a priori codes, I identified the Premo characters that at least half the participants in my study selected as best representing their emotions when engaging in different behaviors such as job search, making career plans, and navigating career resources. The Premo characters supplemented the analysis of affect related a priori codes and helped me better visualize participants' emotional experiences. In the sections below, I present the findings related to the career behaviors of participants' followed by the emotional experiences they associated with their CSM.

Career Behaviors and Experiences of Women of Color

To obtain jobs and internships, almost all participants described engaging in traditional proactive career behaviors such as attending career fairs, seeking support from institutional resources, and utilizing LinkedIn, Handshake, or university specific job sites. For example, Neha, a 3rd year BME student, said, "*I'd get the resume done and I'd go get it checked out by someone at the career center. And I'd go to the career fair and talk to as many people as I could and then apply online. So sometimes I got some responses back, sometimes I didn't.*" Maryam,

another 3rd year BME student, also said that she went to the "*all major career fair in the spring"* and *"met with a few advisors for BME.*" Similarly, Summer, a 4th year BME student, said, "*I update[d] my LinkedIn the beginning of college. I was told by the career center to do that. And then I just applied through the LinkedIn platforms to most of my jobs. And then also I did attend career fairs at our school.*"

Participants' narratives also included mass applying to different jobs with varying degrees of success. Sarah described that she had "*definitely cold applied to a lot of different jobs*" and "*got a response from three companies out of 50 applications*" which she found "*really unmotivating*." Manvi said she "*applied to 30 to 35 companies*" and "*got interviews for two to three*" while Maryam and Mei, both 3rd year BME students, mentioned, "*apply[ing] to a bunch [of internships]*" and "*just apply[ing] everywhere [for jobs].*" Samira, a 3rd year IE major, also described that to land her first internship the summer of her freshman year she had applied to "*around a hundred applications"* as she would apply to *"maybe 10-ish a week"* starting the second month of school.

In addition to utilizing traditional career supports and platforms described above, a few participants talked about utilizing online social platforms, such as Reddit and Instagram, for personalized career advice and tips. For example, Amira shared how she had spent hours on Reddit learning about other people's experiences with career attainment. She also talked about utilizing the resources on Redditt to format her resume as described in the excerpt below,

> When I first started applying…***I always spent so much time scrolling through just people's experiences. Like I would look at that for like if I was interviewing with a well-known company. I would look up, okay, engineering, this company, reddit interview questions. I would just be all over that*** cause, I was like, okay, these people are anonymous. They have no reason to not reveal interview questions… ***And then they had a resume template on Reddit as well for engineering students, so I pretty much rewrote my whole resume to fit that. And they were like, okay, this is what you, it was super detailed like it was kind of insane.*** My friends are pretty meticulous, but this was like, actually insane. They're like, you have to use this type of dash line for your dates. You have to bold this, but you can't bold this. ***I spent hours on that website.***

Another participant Neha also felt that people on Reddit are very authentic and paint a realistic picture of the career attainment process unlike career centers and other resources where the advice can be disconnected from reality. However, Neha also described how Reddit can be a dual edged sword, saying that,

> ***Reddit is good for the interview process***. Reddit and Glassdoor, they're really good for what should you expect once you get your foot through the door because it helps me tailor my answers to figure out what people want, what people like. ***Reddit is a dual edge sword, though, because people there can be way more hopeless than you are, and that makes you nine times more depressed than you originally would be, because they're even more depressed. But it is a very helpful resource, because people are very real on there, like in a lot of career center stuff and like basic Google searches, people are overly optimistic. You know, they're like, it'll work out if you try, just keep trying. And sometimes you don't want to hear that, sometimes you want to hear the reality.*** So, it's a good resource for that.

Similar to Amira and Neha, Manvi expressed that Reddit can be a good resource for learning about other people's experiences and the interview process. Manvi specifically talked about only utilizing Reddit when she needed hyper-specific advice that she can't find anywhere else. However, she provided an example of being led astray by advice on Reddit as shared in the excerpt below,

> There was this one company that I really wanted to work at, and I got [a] final round for that company. But, it was my own mistake. I got really really sick the day before the interview, and I was bedridden all day, I just didn't have enough energy to prepare. And then, ***I went on Reddit, and I was like, how hard is this interview? And everybody was like, oh, it's really simple, you just talk about yourself. So then I was like, okay, that's easy, I can take the time to rest and instead of cancelling my interview, I just took it, which I regret now, because my interview did not go as the other Reddit interviews went***. They asked me a lot of technical questions, and I just hadn't prepared because I was feeling so sick.

Overall, an analysis of the participants' career actions indicated that they engaged in a range of proactive career behaviors typically expected to lead to internships and jobs. However, engaging in proactive career behaviors alone was insufficient for many to secure industry positions. Participants experienced various barriers and gaps in institutional support (described in findings of RQ2) and relied heavily on their social capital and even online social networks such as Reddit to persist in their CSM. Some of the participants' career behaviors such as mass applying to opportunities and relying on online social networks also suggested that participants might have lacked access to traditionally valued forms of capital such as relevant industry contacts for their career attainment, causing them to employ a broad job search strategy. In the following section, I present an analysis of the participants' social capital and how it influenced their CSM.

Career Self-Management as A Socially Supported Process

In examining the career behaviors and experiences of participants, CSM emerged as a socially supported process i.e., many described relying heavily on their social networks for emotional, navigational, and instrumental support related to their CSM. Therefore, findings related to social capital of participants are presented in combination with the findings of RQ1 in this section. The size and composition of the participants' social networks are summarized in Table 9 below.

Table 9. Size and composition of the participants' social networks.
Here, Engineering Alters is the number of alters in a participant's social network that are currently in the engineering field.

Pseudonym	Major	Network size	Women/ Racially Minoritized Alters	Engineering Alters
Maryam*	3rd year BME	6	6	-
Amira	4th year BME	13	13	6
Manvi	3rd year BME	6	6	1
Sarah	3rd year BME	11	10	1
Mei**	3rd year BME	10	8	3
Neha	3rd year BME	8	7	2
Layla	3rd year BME	4	4	-
Summer	4th year BME	8	8	2
Stephanie	4th year BME	12	10	-
Emma*	4th year IE	5	5	1
Samira	3rd year IE	11	9	3
Maya	4th year IE	11	9	1

* Indicates self-identification as a first-generation student in the survey
** Indicates self-identification as an international student in the survey

From the survey and interview data, I identified the key individuals that at least half the participants mentioned as supporting them with three specific areas of CSM: *1) exploring career interests, 2) job search, and 3) networking and career fairs*. Specifically, participants mentioned parents, mentors, peers, and faculty as the key individuals supporting them with navigating their career interests (Table 10).

Table 10. List of the types of alters participants indicated as supporting them with navigating their career interests.
"X" represents the presence of at least one alter with the respective relationship type in the participant's social network.

	Types of Alters Supporting Navigating Career Interests								
	Parent	Sibling	Partner	Peer	Mentor	Faculty	Staff	Other Fam	Other
Maryam		X	X	**X**		**X**			
Amira	**X**			**X**	**X***			X*	
Manvi	**X***		X		**X**				
Sarah	**X***			**X**	**X**				
Mei	**X**	X*		**X**	**X***	**X**			
Neha	**X***	X*		**X**	**X**	**X**			
Layla	**X**								
Summer	**X**			**X***	**X**	**X**			
Stephanie	**X**				**X**	**X**			
Emma	**X**			**X**	**X***				
Samira				**X***	**X**	**X**			
Maya	**X**	X		**X**	**X***	**X**			
Total	**10**	4	2	**9**	**10**	**7**	0	1	0

* Indicates an alter currently in the engineering field

Interview data further revealed that the individuals described above provided emotional and navigational support to participants exploring their career interests. For example, Manvi talked about how her parents were always looking out for opportunities for her and "*a lot of what they do is helping [her] talk through things.*" Similarly, Sarah, whose dad is in the engineering field and whose mom is in the medical field, said *"I was able to draw inspiration from both [parents] and kind of figure out what I wanted to go into."* Neha also talked about her parents supporting her with career exploration. She specifically mentioned that her parents did not

restrict her to traditional Indian career paths and emphasized following her passion, allowing her to try new things and go after what she wanted as described in the excerpt below,

> ***My parents have been very big on letting me explore my interests. Again that's a little bit different than what most Indian kids experience*** because they were the ones like my mom was like don't become a doctor unless you're a hundred percent sure. And because she's a teacher, I always grew up wanting to be a teacher, so already looking into those like non traditional Indian career paths. ***And they've always been very supportive of me trying new things, and you know, going after what I wanted.***

With regard to peers, Emma shared that talking to her peers "*who's in it with me right now*" about why they're applying to different positions helped her think more broadly about her career interests. She shared, "*hearing their thoughts or their point of views on why they're applying to their jobs or certain companies, and learning what they're interested in helped me open up my mind on things that I need to look for when I'm applying."* Similarly, Samira mentioned multiple close peers from her fraternity who inspired her to be more serious about her own career goals and pursue work that excited her. She described watching her friend turn down a "*really established, guaranteed return offer company*" and accept an offer from a smaller company with no guaranteed return offer, which she said "*made me realize I should be thinking a lot about what I really like, how I want to work and where I want to work*" Amira also mentioned having "*a lot of career discussions*" with her friend, who is a PhD student, about whether she should consider an undergraduate lab or go straight into industry. She further talked about having "*heart to heart conversations*" with friends she made during her internship about what she's expecting out of engineering and how she can succeed. She described that the friends she made during her internship were senior to her and provided her advice on how to be successful in the engineering workforce which she found very helpful, as seen in the excerpt below,

> My friends were approaching the end of college. So ***talking to these people who are about to graduate or who just graduated was really helpful.*** They're like, okay, are you sure that you want to do this? Is this something that you're willing to dedicate your time towards like, you know, ***they would list out the things that I needed to be successful as, like an engineer.***

In addition to family and peers, mentors, who included graduate students and engineering and non-engineering industry professionals, also helped participants identify career interests. For example, Neha shared that her mentor, who is a graduate student in her research lab, *"was great at helping me figure out if I wanted to do research or industry and kind of giving me*

opportunities and places to look for that." She further mentioned that she was generally supported in figuring out her career interests by "*talking to people and hearing what their opinions were and their advice.*" Similarly, Manvi talked about joining a research lab and receiving support from her PhD student mentor with figuring out her career goals. Mei said that her mentors were "*really good at helping [her] identify what [she's] interested in,*" and Sarah described finding her internship mentor's perspective on "*the things that she would do differently*" helpful. Emma also shared how her mentor who is in the engineering field gave her very specific advice on navigating her career such as "*getting manufacturing experience [early], if that's something [she] want[ed] to do, or potential career path in which [she] can go down."* Similarly, Amria talked about having *"a lot of talks"* with her aunt, an industrial engineer, who served as a mentor. She described having conversations such as, *"How do I go about this? What is engineering like? What am I doing?"* when she first started in engineering.

Finally, with regards to faculty support, Summer, a Black woman, shared forming connections with two Black woman faculty on campus who pushed her to think about her options. One of the faculty, who was involved in a program to inspire successful engineers that Summer is a part of, talked to her *"about the pathways she could get involved in."* Another faculty, who Summer described as a diversity leader on campus, pushed her to think about her long-terms goals as seen in the excerpt below,

> She's just like a diversity leader on campus. But she's the one that goes to my church, and she kind of pushed me to think more about the long term of my career goals. And ***she also talked about the research route, to think about something not just I guess taking classes or education wise, because I know I want to get out of school. But just to think about how I want to apply my schooling to the future***, and what projects I might want to work on.

Similarly, Stephanie also described seeking support from her faculty for exploring career interests. She mentioned that of the faculty she listed, *"two out of three faculty have been in industry already"* which she described was very helpful for learning their perspective on "*how you can make it in BME in whichever path you decide to take*" Finally, Samira shared that her academic advisor made her think about applying for internship by asking her about it every time they met, which she said *"kept [her] on track with not giving up on applying to stuff and making sure that [she] was putting [herself] out there."* Overall, parents, peers, mentors, and faculty provided navigational and emotional support to participants to help them explore their career interests. Peers served as behavioral models, with participants drawing from peers' thoughts and

experiences to shape their career thinking. Alters such as graduate students and parents were able to provide general support to participants, whereas alters with exposure to the engineering industry, such as Emma's internship mentor, Amira's aunt, and the faculty Stephanie referenced, were able to provide more specific guidance and information on potential career paths.

For searching and obtaining internships and jobs, at least half the participants cited parents again as a top source of support followed by faculty and peers as shown in Table 11.

Table 11. List of the types of alters participants indicated as supporting them with searching and obtaining internships and jobs.
"X" represents the presence of at least one alter with the relationship type in the participant's social network.

Types of Alters Supporting Searching and Obtaining Internships and Jobs

	Parent	Sibling	Partner	Peer	Mentor	Faculty	Staff	Other Fam	Other
Maryam		X	X			**X**			
Amira	**X**			**X***				X*	
Manvi	**X***				X				
Sarah	**X***	X		**X**					
Mei	**X**	X*		**X**		**X**	X		
Neha	**X***	X*			X	**X**			
Layla	**X**								
Summer	**X**			**X***	X	**X**			
Stephanie						**X**			X
Emma				**X**					
Samira				**X***		**X**	X		
Maya	**X**	X				**X**		X	
Total	**8**	5	1	**6**	3	**7**	2	2	1

* Indicates an alter currently in the engineering field

Parental and peer support included advice on how to navigate the job search process as well as more instrumental support such as sourcing relevant opportunities and providing resume help to the participants. Sarah described consulting her parents who are in the medical and engineering fields about how to get her foot in the door "*even if [their experience] is not the same as today*." She said, "*It was so helpful to kind of understand what different steps that they might take or have taken to get into the industry.*" Similarly, she shared that observing her peers who are navigating the current career landscape with her provided her with valuable information about her strategy. She said, *"It was kind of helpful to see steps that they were taking that worked for them and wasn't really working for me, or things that I was not doing."* Her parents, peers, and siblings also kept an eye out for her and directed her to opportunities. She explained that since the success rate of applying to jobs and internships is low, having her parents and peers, who are familiar with her interests, direct her to opportunities allowed her to cast a wider net and share the load of finding relevant opportunities with her network as described in the excerpt below,

> ***It was kind of helpful to have more eyes out on the job market that could potentially point me in the direction of a couple of applications, or even different companies that maybe more pertain to BME and things that I wanted to go into.*** So it was helpful to have a larger circle of people that were maybe looking out and maybe spotting things that I had missed.

Similarly, Maya shared that her parents provided her with emotional and instrumental support by *"always just been there for [her], always listening"* and by sharing "*flyers and LinkedIn posts"* when they heard of *"anywhere that's hiring."* Neha also talked about the key role her dad, who is in the computer science industry and has experience interviewing candidates, played in her job search. She shared that he gave her specific advice on tailoring her resume and talking to people. She explained, "*The biggest thing is having people look out for you a little bit and give you those opportunities because I wouldn't have found so much of the stuff that I was interested in if I hadn't had someone in my corner looking out for me."* Similarly, Emma shared that she and her friends kept an eye out for internships for each other and her friends acted as an information source for preparing for interviews. She shared, "*if they apply to the same company that I applied, I'll be like, okay, what type of interview questions were you asked? How do I prepare?*" Amira also described her mom providing her instrumental support by connecting her to relevant contacts in their family network. She specifically talked about how their family friend was able

to connect Amira with a recruiter for a second interview at a company she was interested in. She shared,

> I had an interview with [company] a couple of weeks ago, and so I told my mom about it. She was like, oh! What's this company? And then, ***so this is a family friend, I guess, and she works there, and she knew the hiring manager, and was able to set up another interview with them, so that was like some good help and support I've received.***

Additionally, Amira relied heavily on her peers of all ages for help with her resume. She said she consulted her friends "*who had gotten their master's in engineering, who have worked in the industry for years*" and "*friends who just graduated*" and *some "still in school*" to look at her resume and "*tell [her] anything that's wrong.*"

In addition to parents and peers, Maya and Samira shared examples of how faculty members supported their job search. Maya shared how two faculty members, who are her bosses at the leadership institute that she is a part of, were *"always sending [her] anything that's hiring" and "always offering to write [her] recommendations for any jobs or any experiences that [she] wanted to apply to."* Similarly, Samira talked about her professor from her minor who *"sent out newsletters to do with internships and stuff"* and with whom she *"talked previously about different sustainability oriented internships."* Overall, the alters supporting job and internship search provided participants with instrumental support by sourcing various opportunities for them, providing resume support, and sometimes connecting participants to relevant networks. Participants also received navigational support from alters in the form of advice on how to navigate applying to jobs and by observing peer behaviors.

For networking and navigating career fairs, almost all participants indicated peers as the key individuals providing them with emotional, navigational, and instrumental support (Table 12).

Table 12. List of the types of alters participants indicated as supporting them with networking and navigating career fairs.
"X" represents the presence of at least one alter with the relationship type in the participant's social network.

	Types of Alters Supporting Networking and Career Fairs								
	Parent	Sibling	Partner	Peer	Mentor	Faculty	Staff	Other Fam	Other
Maryam		X	X	**X**					

Amira				**X***		X			
Manvi			X	**X**					
Sarah	X*	X		**X**			X		
Mei			X*	**X**			X		
Neha	X*	X*		**X**	X				
Layla						X			
Summer				**X***		X			
Stephanie				**X**					
Emma				**X**					
Samira				**X***	X	X			
Maya	X	X			X*		X		
Total	3	4	3	**10**	3	4	3	0	0

* Indicates an alter currently in the engineering field

Participants shared multiple examples of the support provided by peers for networking and navigating career fairs. Stephanie described that she gets *"scared with that many people"* at career fairs, so she went with a group of friends that she's met and stuck with since freshman year. She also mentioned that she and her peers *"compared what [they] learned from each recruiter."* Manvi talked about working together with her roommates to refine her resume which she attributed as *"the only reason [she] was able to get some of the final round interviews."* She described her roommate, who's held different jobs, as being "*really good with resume stuff"* and *"really good at describing things in a way that companies like."* Mei also shared that her friends "*help look through my resume,*" and that they all "*walked to the career fairs together,*" and "*lined up at the lines together.*" She described her peer support as *"a lot of in the moment, and they're together kind of support."*

Similar to Mei, Emma shared how she and her friends use a divide and conquer approach at career fairs to find out information about different companies and the opportunities available with them. She explained how this strategy allowed her and her friends to navigate career fairs more effectively as seen in the excerpt below,

> ***We very much divide and conquer. Okay, you go to the company that you're most interested in, and usually we have similar interests and they might prefer one company***

> ***over the other so then they go, and then they find out the information.*** If it's mostly like, apply online, they'll just tell me that. Or if it's like, hey, it's really important, you go talk to them because they're doing interviews tonight and like being able to go do that. But a lot of the times the career fair is always like, hey, apply online, and we'll get back to you. So not all of us have to wait in line or like, oh, did you see that company is here, I didn't know that they were here, you should go talk to them, or cool opportunities like that. ***So just sharing each other's interest, and what's currently going on at the Career fair is really helpful.***

Sarah also talked about the benefits of navigating career fairs with her friend in BME who has been going through the job recruitment process with Sarah. She explained how her friend was able to visit the in-person career fairs and relay information back to Sarah about whether companies were interested or not. Sarah explained, "*it's important to have those few resources to tag team and figure out what would work for you guys and you know, be the most efficient use of your time and resources."*

Amira shared examples of how her peers in the National Society of Black Engineers (NSBE), an affinity-based student organization aimed at supporting Black students in engineering, helped her prepare for her first in-person career fair. She explained that even though she was not close to her NSBE peers, "*they were very helpful*" and gave her very specific advice on preparing and navigating the career fair such as she described in the excerpt below,

> [NSBE peers] were very helpful, and like, hey, go ahead, go to these companies. ***This is how you do your elevator pitch. This is how you should conduct yourself in front of, like this is how you should talk to people, these are the questions you should ask.*** I was able to get an interview during the career fair so before they were kind of giving me quick little interview prep.

As evidenced in the narratives above, the shared experience of going through the career attainment process positioned peers, who included a range of individuals from acquaintances to close friends, to play a key role in participants' narratives. Peers supported participants with networking and career fairs by providing resume, navigational, and emotional support, which allowed participants to more effectively explore opportunities and manage the workload associated with career attainment.

Overall, participants' descriptions of their social networks indicates that many of the alters were women and/or racially minoritized individuals (i.e. Asian, Black, Hispanic/Latino). Of the alters mentioned, peers were able to provide diverse forms of support for all aspects of CSM while parents and faculty primarily played a role in helping participants navigate career interests and job opportunities. Further, mentors, faculty, and some of the parents and peers who

were in the engineering industry or had previous industry experience were able to provide more specific navigational and instrumental support to participants compared to the general support participants often received from their non-engineering alters. Finally, participants differed in the access they had to traditional forms of valued capital such as engineering industry alters leading to disparate support for CSM.

Emotions Associated with Career Self-Management

Many participants attributed negative emotions such as frustration, sadness, anxiety, overwhelm, and stress to their CSM experiences. For example, Manvi, Neha, Sarah, and Maya described feeling "*frustrated*" with the job search process. Manvi explained that some of her frustration stemmed from not finding relevant opportunities, even at BME companies, or not fully understanding what companies do and which jobs she would qualify for. She explained,

> "***At times I was really frustrated because I would want to apply for a company so bad, but they would just not have an intern position that I could do.*** It would be like a CS or a business internship position, even though it's a BME company. So at times, it was frustrating. ***But it was also confusing, because, what should I apply for? What does this company exactly do?*** Cause you're marketing your products, which I understand. But what do you guys do specifically, are you selling these products? Are you making these products? I think it was a lot of that."

Sarah explained that a big challenge she faced was mass applying and not getting any response from many companies, even if she completely fit the job description. She said, "*you could be applying to as many companies as you can and not really get a response from many unless you have a specific connection to a recruiter, or someone within that company, which can be really frustrating.*" Sarah further shared that applying to jobs and internships "*feels like grasping at straws and like your efforts are not really going anywhere*" which can be "*a little unmotivating.*" However, she also expressed that she had not found a better way.

Similar to Manvi and Sarah, Neha expressed frustration with the overall job search process and said, *"you gotta do what you gotta do. It's frustrating, and it's tiring, and you feel a little hopeless.*" She further elaborated that *"the frustration motivates her to keep trying and keep persisting"* because her previous opportunities came when she least expected them and she believes that you have to try and *"knock on as many doors as possible."* Maya, who is an IE major on the other hand, shared feeling frustrated and hopeless receiving a lot of rejections when she applied to internships as a sophomore, impacting her confidence in her abilities. She expressed that *"A lot of companies didn't want sophomores and so that was very, very frustrating*

and I felt hopeless a lot of times. I was like, I'm never going to get a job. I don't even know how to do anything that they're asking me to do."

Other participants like Amira and Neha attributed emotions such as despair and a sense of sadness to their CSM experiences. For example, Amira, who is looking for jobs locally, shared that the job search experience is *"exhausting, sometimes demoralizing."* because of the limited options in her area. She described feeling helpless and said, *"your search runs out and they're like, we don't have any more jobs in this area. And it's like, what do I do."* She also described a feeling of *"lingering despair at all times"* because of the state of the job market and hearing her peers' experiences with obtaining jobs in the BME field. She shared how hearing about her friends' efforts to unsuccessfully get a job impacted her and explained,

> ***Hearing some of my friends be like, I applied to 150 jobs, and I customized my resume for each one, and I only heard back from 2, or hearing some of my friends who did really well here, got like near a 4.0, and they're like, it took me 3 months to get a job. And I'm like. you're kidding right? You're, that's a joke. You're being silly.*** And just hearing other Bme students are like I want to go get my master's, because, I didn't feel like I could get the job I wanted with my undergrad degree. ***So hearing all those things. I'm like despair, despair, despair.***

Similar to Amira, Neha talked about her major being ill suited for her career goals and shared how her job prospects and experiences with the job search process made her feel pessimistic. She explained that while everyone is supportive, *"there's only so much they can do, and it's very much just, go apply, try, try, and it gets a little bit difficult to just keep persisting and keep applying."* She further elaborated on how comparing her experience to her peers on campus impacted her and said,

> ***It gets a little bit draining, because you're on a campus with a lot of really accomplished people that are also getting things that they want, and then you see yourself getting turned away just by virtue of your major,*** even though you know you might have some like the same skills that someone else has.

While the above examples represent emotional responses to obstacles and disappointments, participants like Maryam, Layla, Emma, Mei, Sarah, Maya, and Manvi also talked about the emotions tied to the pressures and uncertainty associated with CSM and entering the job market. For example, Maryam and Layla talked about experiencing anxiety when engaging in different career behaviors like applying to jobs and attending career fairs. Maryam described feeling very nervous, with her anxiety *"being through the roof,"* for her first career

fair, which she attributed to not having any prior experience talking to companies and to her discomfort with marketing herself to employers. She explained,

> ***I mean initially, I was very nervous, like my anxiety was through the roof like at that point, because I was like, oh my god! Talking to actual companies! I've never done that. How do I do that?*** But after practicing a bunch of times with my sibling and partner it gave me a clear vision. ***And it's also personality wise, I'm not really the type to put myself out there right? So it` was a bit out of my comfort zone like, I actually have to sell myself, it's not just everybody asked me questions and I answered them. I actually have to be the one to initiate.*** So, it was definitely out of my comfort zone, but I feel like it's something that I'm becoming more and more comfortable with.

With the support of her sibling and partner, Maryam described being able to overcome her anxiety and get comfortable with career fairs. Layla, similarly, talked about her anxiety being a significant barrier to engaging with career resources and the job search. She described feeling nervous about not finding a job in rehabilitation engineering and said, "*honestly, when it comes to job searching I don't know what to expect, and that, honestly, is what kills me, and my anxiety in not knowing.*" She also attributed her emotions to her personality and her low outcome expectations to engaging in career behaviors and explained,

> ***I feel like the biggest challenge is honestly myself and my anxiety. I don't like discovering things that are new, like I will choose the most hardest route to not have to do anything new. And so I feel like that's my biggest challenge, because I'm so afraid of what will go, like what will happen.*** Oh, I done wasted an hour of trying to apply to things, and I never got the job. Why am I going to the career center and I still won't get this internship, like ***I done put in all this effort, and I still didn't get this job, and I could have spent it towards studying or doing my homework. So then, it's just like it's my anxiety.*** Now I'm overthinking and I'm like, dude, is it even worth doing this?

Maya, an IE major, also talked about feeling overwhelmed and scared in the beginning because of the ambiguity associated with CSM, which led to some avoidant behavior. She explained, *"At first, it was something that was so overwhelming and I kept trying to push it off. I was like, this is so scary, I don't even want to start it, I'll do it tomorrow. And so my initial feeling was, I don't even know what this is, it's such an ambiguous thing to me."* Emma, another IE major, talked about feeling nervous when engaging in job search. She expressed that applying to internships, interviewing, and meeting people is "*very nerve wracking*" as "*making a first impression really makes or breaks things.*" But she described that she managed her emotions by reminding herself of her previous experiences with successfully applying to internships and the abundance of opportunities available, as described in the excerpt below,

> When I go about applying for internships, I always, I'm really nervous. But I always like to put in perspective, all I can do is be myself. ***And they don't pick me, whether that's my fault or their fault, it doesn't really matter, there's more companies***, and I know that honestly the more that I do it going from freshman year to full year, ***I always know it works out.***

Similarly, Mei shared that applying to jobs was *"so overwhelming"* and a *"very dark era"* of her life. She explained the *"dark era"* as the stress and uncertainty associated with disclosing her international student status to employers and not knowing which jobs to apply to. She said,

> It's just really stressful, like going into it. ***As an international student, I'm like, what the hell do I even put on this like, when should I drop it in the interview, hey, by the way, I'm an international student. I didn't know which jobs to apply. So I applied to a bunch***. I applied all the way from software to construction engineering, to biotech and like making vaccines to manufacturing hardware, to even biomedical engineer roles at HP like making printers. I don't know how they'd even use a BME person, but it matched like whatever I was looking for, so I applied. Obviously I didn't hear back, but just applying everywhere.

Finally, Sarah and Manvi talked about the pressure and uncertainty associated with post-graduation. Sarah shared, *"It's very daunting and a little bit scary, if I might say, going into industry or even going up to graduation and needing to have a plan afterwards."* She further said that the pressures of post-graduation can be "*a little bit unmotivating, even if that's counterproductive.*" Similarly, Manvi also described feeling anxious and stressed about finding a job as she approaches graduation as shared in the excerpt below,

> I'm a lot more anxious this year about finding a job cause ***I feel a lot more pressure because I'm almost about to enter the job market. So I really need to get some experience and figure out what I exactly wanna do, you know?*** So I think I'm feeling anxious about that and stress.

In addition to the emotions described above, participants also shared experiencing positive emotions such as hope and happiness related to their CSM. For example, when talking about what's ahead, Maryam shared feeling a bit scared of not having a job offer close to graduation, but she also described feeling hopeful that an internship offer might turn into a full-time position. She said, *"I'm kind of hopeful in the same sense. Let's say I do land an internship for next summer, then I feel like I would be very hopeful in turning that internship into a full time job offer after I graduate."* Similarly, Amira shared how some days she was *"very hopeful"* and *"more optimistic"* when she got an interview offer. Maya also talked about feeling *"a little bit more hopeful"* once she moved through her discomfort with engaging in job search and

"start[ed] to get offers" and *"started to build [her] network."* which in turn motivated her to *"reach out, get more opportunities, and try more things."* She shared, *"I definitely started out scary, didn't know what was going on, figured out what it was, realized I really didn't like the process of it, and then worked my way until I was happy with my results."* Manvi also shared feeling *"a lot more hope this year than [she] did last year"* as a result of gaining more experience from classes and research in addition to *"have[ing] a game plan this year."* Layla shared how hope influences her career actions and motivations by describing a situation where she engaged in job search after her friend provided her with some hope as described in the excerpt below,

> ***When my friend sent me stuff, she gave me hope because one of the reasons I don't apply is because I don't have the GPA for it***. That's one of the reasons I don't apply. But she gave me hope, oh, there are some companies that aren't asking for a GPA. You just gotta send in this this and this, and she sent me the name of the company. ***So now you gave me hope. Okay, now I can apply. That fueled me to do whatever. So really, I've really run off of hope. If I don't have hope, I have nothing.***

Participants' narratives provided examples of how emotions like hope influenced their motivations and career actions. Participants experienced hope when engaging in different career behaviors yielded some results, such as hearing back from recruiters or getting an interview or internship offer. Feeling hopeful in turn motivated participants to persist in their CSM.

RQ2: What influences the career actions of undergraduate women of color in BME and IE majors?

To identify the various contextual/environmental factors influencing the career actions of women of color, I analyzed the instances of career support (C-S) and career barrier (C-B) a prior codes within and across all participants' interviews. I specifically looked for the common supports and barriers participants attributed to their CSM and generated themes from the cross-case analysis. Several factors influencing the CSM of participants emerged from the analysis which are discussed in the sections below.

Mixed Experiences with Traditional Recruiting Events

Participants described attending different types of career fairs, such as all major fairs, BME specific fairs, virtual fairs, and career fairs organized by affinity group organizations like National Society of Black Engineers (NSBE) and Society of Women Engineers (SWE). However, many participants described both all majors and BME specific career fairs as

ineffective avenues for finding internships and jobs for BME majors, which in turn shaped their engagement with these resources. For example, Neha, a 3rd year BME student, described that "*The all major career fair is definitely less helpful for BME majors because most companies don't take BME majors, even though you are engineering. [The more broad companies] are very specifically looking for mechanical, electrical, chemical."* She further shared that while BME specific career fairs are tailored to BME majors, students face intense competition in these spaces because of the limited number of positions available, as seen in the excerpt below:

> So most BME companies actually come for the BME career fair so it's really helpful because you know that they're there for you. Only downside is the fact that ***we have tons of BME majors that are all applying for the same positions. So it's like, yes, it's great they're all in one place, and they're all looking for you. But there's like a million of us. Well, that's being dramatic, there's about 500 people there trying to get those one or two spots***."

Sarah, a 3rd year BME student, expressed her sentiment towards the BME specific career fairs that they do not "*feel very productive or helpful*" as oftentimes the recruiters "*are not as interested in hiring, or have just showed up for the event, or, pack up after a couple of hours or are not really available, or don't reach out after career fairs.*" Maryam, another 3rd year BME student, shared that while she could not make it to the BME specific fair because of a conflict in schedule she had *"heard from some friends that did go [to the BME specific career fair] that it wasn't that helpful for them because it was all just the same generic advice that each company would give them. So it felt very repetitive and not helpful in any sense."* Summer, a 4th year BME major, echoed Maryam's perceptions and shared her unfruitful experiences with attending career fairs. She mentioned that "*when the recruiters were talking to us…it seemed like they already knew what kind of applicants they wanted already before even talking to them. So they said, to just email them or just apply online. But, I never hear anything back*." She also described feeling intimidated with the crowd sizes as "*the whole school is attending the career fair, and you're just being put against them in line*." Because of the long lines she shared being able to attend only four booths in a two-hour time frame. Stephanie, a 4th year BME, also said that career fairs "*kind of scared her*" because of the long, crowded lines. She described that the recruiters she spoke to told her *" I'm not going to take your resume, I can't take 100 resumes. But if you send me an email, I would rather prefer that and we can have a coffee chat."* Stephanie further shared that her experiences made her realize she would rather skip "*fighting a hundred people"* and just cold email recruiters.

Similar to the participants above, Amira, a 4th year BME major, expressed an overall disillusionment with career fairs because of getting repeatedly turned down by recruiters as seen in the excerpt below,

> "I've been to other career fairs. I've been to a couple. I have not had a positive experience except for my first [virtual] one I'd say. Like, ***I hate the long queue times, I hate having to dress up. I hate that. You stand in line, and they're like, well, we're not hiring for your major, or they like, pick apart your resume, or they're like, Oh, well, we want people who are graduating. Well, we want 4th years. But we mean people who are graduating this semester, not that semester. I hate it***"

Amira further shared how her experiences with career fairs and with NSBE recruiting events shaped her decision to not attend the NSBE National Conference despite her mom nudging her to go to the conference. She said,

> "***I guess recruiters come [to NSBE] from different companies, and this will happen every week, and it's never a company I can work for. They'll have Shell, and what am I gonna do at Shell, you know? Or they'll have NVIDIA, and I'm like, that's cool. So I feel like it's very limited for me***. I remember, it's kind of funny. So they have the National Conference every year, and it falls on Spring Break and my birthday also falls in that same week. And I was like, I'm not doing this. I'm going to go celebrate my birthday. And I remember my mom calling me while I was on vacation. She's like, why didn't you sign up for that NSBE conference? Why aren't you there? I see on Twitter people are at the NSBE Conference. ***Why aren't you at that NSBE Conference, and I'm like, why would I go?***"

Layla, a 3rd year BME student, also echoed Amira's experience with career fairs and NSBE. She shared that while NSBE had helpful resources for resumes and LinkedIn, the recruiting focused events were not useful for BME majors. She expressed that recruiters are "*here for the computer science and the mechanical engineers. So what am I going to find as a BME major?*" After finding different career fairs unhelpful for obtaining internships and jobs, Layla described disengaging with them and turning to the opportunities she might find on campus instead, as described in the excerpt below,

> ***I realized the regular career fairs have nothing for biomedical engineers***. Even in the engineering section, if you go to a chemical company, they're looking for chemical engineers. If you go to a mechanical company they're looking for mechanical engineers. And ***even when I went to the biomedical engineering career fair, they wanted upperclassmen. So it was a lose-lose situation regardless, like nobody actually wanted me***, and even by upperclassmen I mean people who are about to graduate. I understand why I'm going and like you go for the practice, to get your name out there. ***But it's like you're not going to get me the experience that I actually need, which really means I just really need to stick to whatever I can find on campus.***

Emma, an IE major, shared the other participants' dislike for career fairs. She explained that not everyone can skip classes and spend 2 hours in line to talk to recruiters. She also felt that" *it's harder to stand out"* to recruiters as they see many people in a day, She said, *"it's very hard to gauge which company and why they are here cause you don't really know until you wait in line for an hour and then get up to there and then you're like, my days' wasted."*

While most BME participants described their career fair experiences as unhelpful for obtaining internships or jobs, Samira and Sarah expressed that attending these events allowed them to learn more about different companies and the opportunities available to them. Samira, who is an IE major, shared that she really liked career fairs because of the "*exposure to a ton of companies at once."* She said that career fairs are "*really effective because they're really just directly looking for interns there*" and explained,

> ***You could kind of connect in a way more humane way than just throwing your application into a portal***. ***I really hate the void***. So it's nice to feel like they're taking your resume like they're actually gonna look at it. So it's more motivating to me to try with my elevator pitch and the way I present myself.

Sarah also expressed that BME virtual career fairs provided exposure to "*a wider variety of companies, without having to attend in person*." She further shared that these fairs provided students with contact information for companies which she said, *"can be somewhat helpful."*

Similar to Sarah, some of the participants described better outcomes from attending virtual career fairs and other career events. For example, Amira, who attended an HBCU as an electrical engineering major before transferring to SU as a BME major, described securing an internship through a virtual career fair event. She attributed securing the internship to attending a virtual career fair event and getting one-on-one time with a recruiter. She said,

> We had a virtual career fair, and ***I was signing up for random interest meetings where you could just sign up to hear about a company, so I signed up for all these different companies,*** but I also signed up for one for [company name] and ***the recruiter was like, hey, there's not that many people here, I'll give you an interview if you want***."

She also attributed attaining the internship to targeted recruitment efforts at her HBCU to place students in internships and co-ops, which reduced the barrier to entry. She explained that her HBCU was "*really trying to get people to do co-ops and things of that nature,*" and so the *"recruiters who were coming were like, we understand the situation, we know that we want more people from the school."* Mei also described landing an interview with a BME company through a career fair related event. Specifically, she described her experience connecting with a recruiter

through a resume review event prior to the career fair, which later led to an interview. She explained,

> ***Before I talked to one of the recruiters at the career fair, BME had a resume review thing with a bunch of SU alum.*** And basically, you submit your resume, and they look at it and they give feedback. So, I submitted my resume to this guy who worked at [company], and then ***he looked at my resume, had a little facetime session, and he said, okay, yeah, make all these changes and come find me at the career fair. So that's what I did. I talked to him at the career fair again***. He was like, really pleasant guy, really nice conversation, and after that I got an interview with [company].

Finally, Sarah shared her experience networking with a guest lecturer from industry which helped her get her foot in the door by landing an internship as described in the excerpt below,

> We had guest lectures that would come in so after the lectures, they always say that they're open for questions or ready to answer any questions, and I would go up and talk to them, and oftentimes it was during the recruitment process, and they would always, you know, they can put in a good word or you know, open some doors for you. So ***I actually emailed one of the guest lecturers, and she was able to kind of provide me with that connection***.

Overall, the findings related to participants' experiences with traditional recruiting events indicate that many of the women of color in this study, especially in BME, found in-person career fairs unhelpful for connecting with employers and job opportunities, suggesting a dearth of clear career opportunities for some interdisciplinary majors, challenging the perception that the skills developed in interdisciplinary engineering programs are valued in many work contexts. Instead, career events such as informational sessions, resume reviews, and alumni-connection opportunities, which provided students access to industry professionals in smaller settings, better supported participants CSM. Further, while almost none of the participants specifically referenced their identity in relation to their career fair experiences, Maya, a South Asian woman and a 4th year student in IE, talked about being hyperaware of her identity when navigating career fairs. She shared,

> I'm walking up to the career fair trying to strike up a conversation with this person, but ***I know that I have a disadvantage with, like the white guy in line behind me. And so I feel like that was definitely something that was extremely apparent throughout the whole process, like relating to my identity***, and I felt like also could have been a big setback in the process.

Similarly, as described above, Summer, a Black woman in BME, also expressed noticing disinterest from recruiters at on-campus fairs and shared, "*it [seemed] like they [recruiters] already knew what kind of applicants they wanted already before even talking to them."* While

Summer did not attribute her observation to her identity, she later shared that despite not having many BME specific opportunities at the NSBE career fair, "*it [was] more personable just speaking to someone that is catered towards me,*" and that she felt *"more comfortable talking to them."* Further, in contrast to her experiences at SU, Amira also attributed her success obtaining an internship while at an HBCU to the HBCU's targeted recruiting efforts, as seen in the section above. Therefore, the findings also suggest that the recruiter disinterest noted by many of the participants might be rooted in not only a bias against certain interdisciplinary majors, but also gendered and racialized preferences and biases

Gaps in Support by Institutional Resources and Affinity Based Organizations for Interdisciplinary Majors

Participants' narratives illuminated potential gaps in institutional and affinity-based sources of support. Institutional resources such as advisors, departmental programs, and campus career centers were experienced as generic and unhelpful by some participants. For example, Maryam talked about seeking detailed guidance on gaining relevant experience in BME from her advisor who directed her to resources on campus she was already aware of. She attributed the generic advice from her advisors to their lack of experience in industry, as seen in the excerpt below:

> "For career advice, I mainly would go to another advisor who's been a BME advisor for 20 plus years. So he was really sweet, but he also wasn't super knowledgeable about industry because ***he got his PhD and just started teaching. So he never went into industry or explored anything outside of teaching or advising. So it was also kinda like, oh, well, this is why I got generic advice, I guess***."

She further shared that while the BME faculty she reached out to were generally supportive of her career aspirations, they advised her to pursue a master's to make herself competitive for industry positions. She described receiving advice such as "*PhDs are for when you want to teach. Master's, this is if you want to get into industry.*" One of her professors with experience creating a medical device also told her, "*you need a master's if you wanna make it big or even sometimes even get in, especially with the job market now, just to make yourself stand out from your competition."* As a result of her experiences with the faculty and advisors in her department, Maryam expressed disappointment and shared she might consider a master's at

some point. She also explained that she "*decided to just consult with family friends and see how they did it.*"

In fact, similar to Maryam, participants shared challenges with finding BME specific career support and personalized career advice. For example, Amira talked about how while her social network provided her with a lot of resume support, she experienced difficulties finding "*specific advice on how to really tailor her resume*" for BME positions because "*most of [her] friends are CS or mechanical or electrical*" Similarly, Neha talked about how while she appreciates the resources provided by the career center at SU, she felt that the support can be basic and not personalized, as seen in the example excerpt below,

> "***But I mean, in some cases, I don't really find it helpful because there's only so many things that they could do when you go to them with your resume and at some point they can't help make it any better because they don't know everything that you've done. They don't know how to tailor it, so it's just like I've heard all the advice before. So now, in my 4th year, those sorts of things don't feel super helpful***… But overall, I mean overall, it's been a positive experience with them, and I do appreciate that they provide as much support as they do and they send us emails like every single day about different things, you know."

Neha described that she was "*very lucky*" to have her dad and sister to answer basic questions about resumes and talked about leaning on her social network for more personalized support given that they know more about her experiences. She said, "*If I'm like I don't know what to put on my resume, my sister can always be like, well you did that, put that on there, and your mentor, your friends, they can do that sort of more personalized tailoring versus the career center can only really give you pretty generic help."* Emma, an IE major, also shared her perspective on career advising and why she finds it generally unhelpful. She explained that career services *"just provide me a lot of options, and I already know my options, and them providing me more options doesn't really help."* She further shared that decisions surrounding jobs and potential companies to consider are ultimately up to her because career advisors are not going to tell her what to do. Therefore, career services providing her with more options is not what she needs, and hence why she does not "*really utilize those resources."* Maya, an IE major, also shared that while the career center "*was definitely helpful as a freshman*," she found the resources provided by them less helpful in her later years when she needed more specific help. She explained, "*once I had my resume reviewed, I'd done my mock interviews and things like that, I kind of needed a little bit more specific help to what I wanted. And so I feel the career center wasn't as useful in that way.*"

Finally, Stephanie, a BME major, described her negative experience seeking resume help from career service, which impacted her confidence in seeking support from them. She shared,

> ***I did once for my resume, and they reviewed it. But then it turns out they were students too***, so I don't blame them that they didn't give perfect answers, but it was funny, because I had a format, and then I sent it to them. ***And they're like, can you change this and this. I'm like, yeah, absolutely. So I changed it and changed it and then I sent it to one of the industry professionals that I contacted. And they're like, what is this format? Like why did you do this? And they changed it back to my original format.***

Other participants like Summer shared their experiences with unsuccessfully reaching out to their departments for support. Summer expressed that she asked to be connected with a Black alumnus through a BME mentoring program for freshmen in her department. However, she shared that the department could not find anybody for her and instead connected her to a student in the graduate program who was unresponsive. This experience led Summer to seek support from the Black faculty advisor in her department, as she described in the excerpt below,

> "We actually had a biomedical mentoring, I think they had sent out an email or something my freshman year, and ***I had specifically asked for a Black alumni. But then they said they didn't find anybody, and I'm like, I know there are Black alumni that graduated under this department, but I guess maybe none of them signed up to be a mentor.*** They did find somebody like in the grad program so they gave me her email but she didn't even respond to me. ***So then I was like, well, I guess you know there is nobody. So that's why I geared towards the [Black faculty] advisor in our department instead***."

Summer's experience with unsuccessfully reaching out to her department highlights how traditional institutional supports failed to support her CSM, pushing her to rely on her cultural wealth. Finally, participants' narratives also revealed potential gaps in career support by affinity-based organizations such as NSBE and programs tailored for first generation students. For example, while the three Black women participants (Amira, Layla, and Summer) in the study described the career development resources provided by NSBE, such as career fair prep and resume support, as helpful, they also acknowledged that the recruiting events were tailored to more traditional engineering majors, as shared in the section above. Similarly, Emma, a first-generation student in IE, shared her experience with a program for first generation engineering students and said,

> [program for 1st generation engineers] do provide a lot of resources, but honestly, ***if anything, it provided more of a community as opposed to resources to find jobs and whatnot. Like they do a lot of company outreach, but I don't really utilize them, because I feel like a lot of the companies are very tailored to bigger companies like***

> ***Google or CS specific.*** So a lot of the resources that I've been able to find, it's just through my own research and the willingness to go learn it.

As seen in the excerpts above, participants often experienced gaps in support for career attainment by institutional resources and affinity-based organizations, which forced students to become self-reliant to achieve their career aspirations. Specifically, participants described experiences such as receiving generic and unhelpful advice, finding recruitment events tailored to more traditional engineering majors, and a lack of support tailored to their identities and needs. As a result, participants engaged career services minimally and turned to their social networks for detailed guidance and personalized career support.

Influence of The Curriculum and Career Goals on Career Outcomes

Participants attributed their BME major and employer preference for traditional majors as factors influencing their desired career outcomes. Specifically, some BME participants perceived a lack of specialization in their major as influencing their job prospects and competitiveness in the job market. For example, Sarah expressed that it was not realistic to go into industry because she had heard from a lot of BME graduates that "*it can be kind of difficult to find a job post grad"* because *"[BMEs] are trained on so many different facets like electrical engineering, computer science, but not really in depth in one or two areas."* When asked whether this perception resonated with her, she replied that it does and explained that "*not a lot of [internship or job] postings are very BME specific. They always kind of look for the other connotations behind it like electrical engineering based or computer science based. So if you're not really specialized, it can be kind of difficult."* Similar to Sarah, Neha, who is interested in a career in surgical robotics, shared that the breadth of her BME curriculum affects her competitiveness for more technical roles as seen in the excerpt below:

> "The thing that I struggle with the most in BME is the fact that ***we learn too much, and we don't go too in depth and that kind of hurts when I want to do something a little bit more technical, like surgical robotics or things like that.*** So the only thing that I would wish could be a little bit better in the program would be the ability to get a little bit more in depth.

Maryam, who is interested in a career in medical devices and instrumentation, expressed that the BME program at SU is "*rigorous*," but "*not as BME as it should be.*" Finally, Summer also shared that *"most of our courses are just learning about the concepts, but not actually doing anything."*

In addition to the curriculum, employer preference for traditional engineering majors was also attributed as contributing to difficulties with obtaining industry positions for BME participants. For example, Maryam explained, "*it's hard to get BME jobs because mechanical, electrical engineers also take the BME jobs*." Neha also said, *"most companies don't take BME majors, even though you are engineering. They are very specifically looking for mechanical, electrical, chemical."* Amira similarly shared her experience searching for BME internships at a career fair and said, "*everybody I went up to were like, we're looking for chemical engineers, we're looking for electrical, we're looking for mechanical."* She further elaborated that there's increased competition within BME which also contributes to difficulties with landing jobs and internships. She explained,

> "I really want a job where I can do medical device design, but so does every other Bme student. ***Every other Bme student either wants to go to med school, grad school, or they want to do medical device R&D. Everybody wants to do it, and there's only, it's like such an emerging engineering industry and there's so few jobs, especially in the [city] area,*** like, you know, [company] can only accept so many people. So I'm kind of preparing myself for that disappointment where it's like, okay, I haven't interned at a traditional Medical Device company and a lot of those job descriptions want experience in medical devices, and I'm like, I know how they work. I can learn." (Amira)

Maryam, Neha, and Amira's experiences highlighted recruiters as gatekeepers to various roles and industries of interest to the participants. Additionally, in line with Amira's observation about BME students' career goals, participants' career goals and awareness of career pathways emerged as another factor influencing their career attainment. More specifically, some of the participants shared very specific career goals while others expressed confusion and uncertainty about the career pathways available to them. For example, Manvi, who expressed some interest in a career in medical device development, also attributed a lack of knowledge about what different companies do as a challenge to her career attainment. She explained,

> ***The whole idea of not knowing exactly what a company does, or trying to apply for a company I'm really passionate about, but them not offering any, I know it's not their fault either, but not offering any internships, for what they're good at.*** Like, a lot of BME companies I was looking, and they recruited a lot of CS majors and a lot of business majors. And I was like, but I want to do what you guys are doing, recruit me.

Mei also shared not understanding the difference between different types of engineering internship roles when she first started her job search, which led her to a manufacturing internship that she did not like, as she described in the excerpt below,

> I remember talking with my mom and it felt like she didn't really know much about the American industry, because she never worked in the U.S. So that has been very blind going into it, just especially since I applied to so many manufacturing jobs. ***I was like, what is the difference between manufacturing and research? And I didn't know that. And going into my manufacturing internship, having that divide between manufacturing interns and the research interns actually was a little negative on my internship experience,*** especially since looking at all the research interns doing the cool stuff.

On the other hand, Neha described the difficulties she has experienced finding jobs relevant to her interest. She shared, *"I feel like the hardest part is just finding things to apply for."* Some participants also described openness to a range of career opportunities while others were focused on entering specific industries. For example, Emma, a 4th year IE major, talked about her curiosity and flexibility as an asset in her internship search. She shared, *"I try not to limit myself in terms of location, and where I want to work or like the company. I'm just really willing to learn anything and everything so I think that also helps when I'm applying to internships that I'm not limiting myself."* On the other hand, participants like Maryam and Neha talked about focusing on finding internships relevant to their interests. Maryam described declining her partner's offer to get her a job somewhere and shared, *"I don't want just an internship. I want something related to what I'm doing so I can have that on my resume as well."* Neha also shared declining internship offers related to quality engineering and explained,

> ***In the past I've gotten offers for quality engineering, or other sorts of engineering that aren't what I want to do, and I have rejected them*** because I would much rather not waste my time or not waste my time, but ***I would much rather not spend 3 months doing something that I absolutely despise just so I could get experience on my resume.***

Structured Programs Supporting Career Self-Management and Career Outcomes

Initiative connecting participants to the workforce and various career resources and social networks played a key role in supporting their CSM. Specifically, initiatives such as engineering peer mentorship, minority outreach, and workforce programs emerged as supports to CSM in participants' narratives. For example, Maya talked about being part of a peer mentorship program coming into college and joining a professional engineering fraternity which provided her with a social network early on and connected her to career support resources as described in the excerpt below,

> I found out about [peer mentorship program] over the summer, and so ***I had one mentor who I would facetime coming into my freshman year of college,*** and so she gave me a lot of insight and advice and connected me to a lot of her friends as well. ***So, coming into***

> ***college, I already had a few connections of people that were really open to contacting me…And then also I ended up joining a professional engineering fraternity during my sophomore year, and so that also gave me a lot of connections and resources to kind of figure out what more I wanted to do with my career***.

Amira also described her experience being part of an outreach program for minority students at SU. She said that the encouragement and scholarship provided by the program resulted in her attending a regional NSBE conference, where peers in NSBE provided her guidance on how to talk to recruiters and navigate career fairs. Therefore, the financial capital provided by the minority outreach program allowed Amira to build her social capital in support of her CSM. She shared, *"It's pretty much like an outreach program for minority students. So some people in [program], they're like, we'll give you a scholarship, we'll support you, just go to this career fair."*

Maya also shared her experiences signing up for diversity workforce programs, which provided her some work experience and exposure to different companies and allowed her to stand out. She explained,

> ***A lot of companies have programs that are aimed to recruit specifically for diversity***. And so this program was like a cohort of, I don't remember how many people, but they were all from diverse backgrounds, and [the company] wanted this opportunity to really share with us why they value diversity. And it was like a two-way street, they were presenting themselves to us, and then we were also positioning ourselves for an internship the next summer. ***But specifically they recruit people from diverse backgrounds so it's a little bit easier, I guess, to stand out as opposed to just throwing your application down a crapshoot. So That was a really cool program. And then I did like a couple other ones through the semester as well.*** But the [company] one basically acted like a mini internship.

Similarly, Summer described being part of a *"workforce development program"* of a company in high school when she was *"exploring engineering routes."* She shared, *"they offered me an internship, even though I wasn't really in the designated engineering pathways that they wanted. But they have a lot of resources open to college students as well, and they made the internship fun for me."* Following her high school internship experience, she described interning with the same company every summer after in college.

RQ3: How Do Undergraduate Women of Color in BME and IE Majors Leverage Their Cultural Wealth to Navigate Career Self-Management?

In this section, I present the specific forms of cultural wealth displayed by participants in the study to answer the third research question. I applied six a priori codes corresponding to the types of wealth described by Yosso (2005) to categorize the cultural wealth of the participants in the study. After categorizing the types of cultural wealth, I analyzed the themes present within and across participants' narratives to identify the most common and salient forms of cultural wealth leveraged for CSM. The types of cultural wealth most prominent in participants' narratives included Familial Capital (Fa-C), and Social Capital (So-C) (presented in findings of RQ1). Some participants' narratives also included instances of Navigational Capital (Na-C) and Resistant Capital (Re-C) influencing their CSM, although present to a lesser extent. Yosso (2005) highlights that the various forms of capital overlap and build on one another to form the collective wealth that communities of color possess. Along these lines, the findings presented below illustrate how different forms of capital acted independently and in overlapping ways to shape the CSM of participants.

Familial History Shaping Participants Motivations, Self-Efficacy, and Navigational Capital

Yosso defined familial capital as the "cultural knowledge nurtured among familia (kin) that carry a sense of community history, memory, and cultural intuition" (Yosso, 2005, p. 79). Kin ties teach a commitment to community well-being, provide strategies for survival and success, and model lessons of caring, coping, and providing. For this research, Yosso's (2005) concept of familial capital was conceptualized as the influence of family and community history, values, support, and wisdom on career actions, goals, or outcomes of the participants. Analysis of interview data illuminated the prominent role familial capital played in almost all of the participants' CSM experiences. Specifically, participants provided examples of how their family history shaped their career motivations and actions. For example, Maryam and Mei talked about how their families' experiences of overcoming obstacles shaped their motivations and self-efficacy. Maryam, who identified as a first-generation Bangladeshi woman, described her family's history and her earlier experiences growing up in a low-income household motivating her to graduate and get a well-paying job so she can give back to her parents for the sacrifices they made, as shown in the excerpt below,

> "[my parents] have their associate's but they never graduated with a full degree, because, I guess, growing up for them, they grew up in Bangladesh, so it was kind of like they grew up in the village, so they didn't have that much money to put themselves through university or things or whatnot. And then my dad came to this country when he was 19 just to work, so he didn't come here for university or anything. He just came to work, send money back to his family, make sure his family was well taken care of. So I guess, ***growing up listening to my parents stories and how that affected them, it kind of made me wonder, okay, how can I give back to my parents for all their sacrifices, and things of that sort. And then it also kind of showed, like growing up, we also didn't have that much money compared to the average in [State] as well. So, looking at that, I really don't want my parents to suffer or anything like that. So I wanna make sure I can give back to them.***"

She also talked about feeling humbled and grateful to have the opportunities that her parents as immigrants did not have. Similarly, Mei, who identified as an East Asian woman and an international student, talked about how her and her family's earlier experiences of navigating language, financial, and cultural obstacles when they first moved to the United States prepared her for navigating the job search process. She explained,

> "I feel like I could just go through hardships pretty easily like ***when my mom and my brother and I first got to the States, it was very tough on us***. ***Yeah, like trying to navigate things in a foreign language, foreign culture, things like that. So in a sense in that okay, I do have this knack for like going through obstacles, and it kind of gave me an extra layer of self-confidence compared to my peers***, who were just born and raised here, who didn't have to like worry about working to put food on the table, who didn't have to worry about tuition costs, because, like here, they have [name] scholarship, which is like almost full tuition for in-state students at SU. And ***it's just knowing that the things that my family has gone through, and that I have gone through, it gave an extra like just a confidence boost that like, hey If I can go through that, I can find a job in the United States***."

Mei's experience of her family's shared struggles instilled in her a sense of confidence and resilience that she leveraged to navigate the job search process. Unlike her peers who did not have to worry about basic needs or tuition expenses, Mei shared that facing difficulties, such as adapting to a new country, provided her with a deeper understanding of hardship which served as an asset in her CSM. Another participant, Emma, an East Asian woman, talked about how growing up in an immigrant household and helping her parents navigate life in a new country shaped her agency and approach to CSM. She shared that her parents never went to college and emigrated to the United States and so she, "*throughout high school and whatnot, read legal documents to [her] parents."* Additionally, she shared that she learned to find information and resources for her education early on because she realized her parents would not be able to do that

for her, which she attributed to preparing her for finding opportunities and internships in college as described in the excerpt below,

> My parents aren't gonna find programs for me to join. So I think it prepared me very early on for working for what I wanted and taking that extra step to go research the thing or learn a lot about the college process, or the financial process just so I can understand it, so I can explain it to my parents. So I think, like that helps set me up for college really in the sense of, ***I kind of have the same mindset of, okay, I'm learning a lot of different things so I can better prepare myself. The more I know, the better I feel about making my decisions and whatnot. And then also, having to find my programs, and the opportunities at a young age, I also do that now here in college, finding programs that I can join, or finding internships and whatnot, and not rely on other people to relay that information back to me***. So I think that has prepared me well, that mindset and that mentality of, okay, whatever I want, I kinda have to go work for it.

The narratives presented above illustrate how family history informed participants' motivations as well as shaped their navigational capital and self-efficacy for engaging in CSM.

Familial and Community Values Influencing CSM

Cultural values and wisdom instilled by families and communities also played a role in the participants' CSM. Specifically, participants talked about an emphasis on hard work and job security within families and communities, which shaped their motivations and behaviors. For example, Sarah, an Indian woman, attributed her cultural background with instilling a strong emphasis on job security, which in turn shaped her choice of major. She said that "*having job security and or having a good career, going to a good school, are things that have always been instilled in me, or just things that float around the community."* Additionally, she attributed the tight-knit and collectivist nature of her Indian community as an asset that she tapped into to learn more about job opportunities and the BME field as described in the excerpt below,

> "***So the Indian community, I'm sure you know, is very community based. So if I said I was struggling with something, my mom would be like, oh, there's probably someone who's in the industry that we can reach out to or that can know what to do. So that was definitely a big aspect of it, like reaching out to people within your community to see if there's any job opportunities or just different tips that they can give you.*** Specifically, we have our neighbors that are both in BME, so I was able to talk to them and kind of figure out things that they have maybe done or things that I could be doing, or even different companies that I could be looking at that I hadn't been, so that was definitely a big thing like getting in contact with other people in our community."

Neha, another Indian woman, also shared how her family placed an emphasis on economic and professional responsibility growing up, which directly influenced her CSM in college.

Specifically, having a job since she was 16 gave her experience with preparing job related materials and positioning herself in the job market. She explained,

> My family placed a lot of priority on having a job. So ever since I was 16, I've had a part-time job, which I know is a little bit different than, I guess, like in Indian communities that's not normally like what parents prioritize when you're in high school. ***My parents definitely pushed me to get a part time job to learn responsibility, and, you know, make sure that I knew what it was like to have money and spend it wisely. And so I also had that experience with creating the resumes for that and talking to people, and you know, just like gaining experience that did actually help me get stuff in college.*** So I would say that that sort of priority, and those sort of models that I had were very helpful.

Similar to Sarah and Neha, Maya also talked about how her "*very driven and culturally South Indian*" family emphasized "*doing everything and being on top of everything*" which motivates her to "*always look for new things*" and "*do as many things as possible.*" She further shared that her parents pushed her to take ownership which taught her to be proactive and reach out to people and resources as needed, as described in the excerpt below,

> ***My parents really wanted me to take a lot of ownership myself.*** I feel like they did a lot with [my older sister]. And then, when it was time for me, they were like, okay, she's your role model, like, otherwise, figure it out yourself, which I'm really grateful for. ***Because of that, I learned to take the initiative and if I wanted to do things I would find them, or I would ask people about them. But I also think it's not necessarily like looking for information from people. I think that I surround myself with a lot of successful people***, like obviously my friends that go to like MW1, they had to get into the school. They're all really accomplished people. All my roommates are doing amazing things after graduation. And so I think also, just naturally being surrounded by that.

Finally, Manvi shared how having access to a large Indian community in college helped her embrace her cultural identity and inspired her to cultivate a work ethic to pursue her goals as seen in the excerpt below.

> "I grew up in a really non diverse town… not everybody wants to be your friend because you're Indian. It's really hard to explain, but there's always a slight racism, and I think ***I really struggled with embracing my Indian culture in high school. But after I got to college… It was really diverse, and I was able to make a lot more Indian friends***…I ended up joining an Indian dance team at SU. And the people I met through my Indian dance team, I saw how hard they worked. We would study together when we weren't dancing, because dance teams take up a lot of your time. So I think, us working hard together, like we would travel on the weekends to compete, but everybody would be doing their work in the airport, and then, we would have fun at the competition. And then on the way home, we'd be doing work again. ***So I think that whole like the grind mindset is what the community that I built there has helped me also be just as motivated to reach my goals, like I see how well they're doing, and I want to be able to match their level as well***."

Manvi's access to culturally affirming spaces and people in college provided her with role models and a support system to pursue her goals. Her Indian dance team members' "*grind mindset*" shaped Manvi's work ethic and indirectly influenced her CSM as evidenced in her narrative.

In addition to job security, some participants also shared how their parents emphasized job fulfillment which informed their CSM. For example, Summer, a Black woman, talked about how her mom shaped her career thinking by pushing her to prioritize job fulfillment over economic outcomes. Summer explained that,

> My mom, she definitely guided me to think about the major that I was choosing before going into college. So we talked about what I wanted to do, and my interests and taking my math and science skills and just applying that to whatever, like ***she wanted me to have a job that I enjoyed and not just think about the money.***

Similar to Summer, Mei, an East Asian woman, also talked about how her dad's advice of finding work that is fulfilling influenced Mei's job search and thinking. She shared,

> My dad always told me if I go and study something, and if I work at something in the future, I have to end up really liking it. So it's just it made it seem like I have to really like the job I'm working at, if that makes sense? ***So I'm looking for a job where I'd actually be fulfilled going into it.***

Both Summer and Mei's narratives describe how parental wisdom influenced participants' career thinking. Overall, familial capital in the form of cultural and familial values such as, job security, professional and economic responsibility, and job fulfillment influenced participants' CSM by shaping their motivations, work ethic, and career actions.

Parental Involvement and Siblings as Role Models

Some participants talked about parental involvement and advice which influenced participants' career behaviors and provided direct support for their career navigation and attainment. For example, Amira, a Black woman, described her parents as "*light tiger parents*" and provided examples of her mom pushing her to learn new things, pursue engineering early on, and be proactive with her CSM. Amira's mom also provided her with practical advice on how to present herself when talking to recruiters, such as what to wear and how to do her hair and makeup as described in the excerpt below,

> ***My mom would give me more practical advice for interviews***. I told her I was interviewing for these companies and ***she was sending me all these articles, and she was***

> ***like, okay, this is what you do, this is what I did when I interviewed. These are the colors you wear to the interview. She's like, you have to take out all your piercings. This is how you're supposed to wear your hair. This is how you're supposed to do your makeup,*** like all the practical advice for your interviews and how to conduct yourself.

Amira attributed her dad on the other hand to instilled boldness and leadership in her and providing her with emotional support and reassurance for navigating job search and attainment. Summer also shared that her mom's aspirations informed her proactiveness. She said, "*knowing that [my mom] wants the best for me. And she did certain things so that I could have a good education*" reinforced her motivation to succeed. Summer further explained that her mom is *"very adamant about having a mentor and reaching out to people,"*

Participants like Sarah, Mei, Maryam, Neha, and Maya also talked about the key role their siblings played in their CSM. For example, Sarah talked about her older brother, who is a CS major, helping her with career navigation and attainment by giving her tips on what worked and did not work for him. Sarah recalled her brother sharing his experiences and advice on navigating career fairs early on in college, which she found really helpful as described in the excerpt below,

> [my brother] started attending career fairs before me. Even in our freshman year he would attend them and tell me what's going on. Even if you know, looking for jobs wasn't at the forefront of my mind in my first year. ***It was really helpful to kind of see his experience going through it, even if it was in a different major or career landscape. He would give me a couple of tips and maybe what to do, or things to avoid going into the career fairs that I would attend. So that was really helpful. And it's still something I talk with him on a day to day basis.*** Even last night we were looking at LinkedIn's and trying to figure out what would work for other people, and maybe things that we wanted to do.

She also talked about them both continuously supporting each other by discussing job strategies and LinkedIn profiles as described above. Similar to Sarah, Mei also talked about the critical role her brother played in supporting her career navigation and CSM. She described watching him applying to internships when she was in high school and receiving updates from him about his experience, which provided her with an idea of what to expect with regard to career attainment as seen in the excerpt below

> On the job search side, it was a lot of just apply everywhere, that's what my brother told me. He applied to a bunch of internships his junior year, and ***I remember getting updates from him when I was still in high school about how stressful it was applying to all of these software engineering internships. So I felt like I got a little bit of, I guess, trigger warning from that,*** from just listening to his stories.

She further described receiving encouragement and hope from her brother about navigating the job market as an international student on an F-1 visa, an experience that she felt her mentors and college faculty and staff were removed from, as she explained in the excerpt below,

> ***[My brother] supported me in just giving me encouragement and applying to things and then also giving me hope that, hey, you'll be able to get out of this F-1, whatever. Especially, being an international student, I feel like he could relate with me the most.*** A lot of the college faculty and staff, cause they work with F-1 students a lot, they know of these things, but they're not very hands on in helping you find a job. And then I feel even further removed from it is industry. So my mentors, they're really good at helping me identify what I'm interested in, what I'm not, like helping me find opportunities. But they're not really familiar with the visa and everything related to that. ***So my sibling has most definitely helped with the career process the most, I would say***

As a first-generation student, Maryam also talked extensively about her older brother as her role model. She shared, *"growing up for things like school, I didn't really have anybody to look up to."* As a result, she described observing him navigate high school and college and *"learning through the mistakes he made."* She mentioned following in his footsteps and initially enrolling as a CS major before switching to BME. She also described her brother advising her to follow his example of mass applying to internships to get his foot in the door. She shared, *"because [my brother] went through the whole internship process, and like mass applied to a bunch and was able to get his foot through the door, he basically told me the same advice."*

Similarly, Neha talked about her family and upbringing heavily influencing her approach to CSM. Specifically, she attributed her dad and her sister to helping her understand what to expect when it comes to obtaining a job. Watching her older sister go through the job search process made her realize the importance of getting involved on campus early on and gaining experience as she explained in the excerpt below,

> I have an older sister that's four years older than me. So as soon as I started college, she graduated. So ***I got to see a lot of her job searching process and what she had to do to get through. So I feel like I was pretty prepared in knowing that getting on campus experience was super helpful*** and like join clubs and join research and try to get experience.

Neha's sister, who was an aerospace engineering major, also gave her detailed advice on how to apply to jobs, fix her resume, talk to people, and navigate career fairs, while her dad who works in the CS industry and recruits for his company made her realize the importance of networking and what it takes to get a job as seen in the excerpt below,

> My sister was definitely the most influential on that one, because she'd actually done it. I feel like until you're standing there in those lines, and you're sweating, and your feet are...And you're overwhelmed by the noise, you don't really understand what it's like to be in a career fair, especially when you're surrounded by actually, hundreds of people trying to do the exact same thing that you are. And so, ***because she had gone through that exact same experience, she was great in telling me basic things like what shoes to wear, or how to carry your resume, and what sort of things to focus on when you're talking to people. That was the sort of thing that was really helpful in just having that sort of first hand experience and the advice that she gave me from that.***

Finally, Maya talked about her sister, a business major, supporting her career aspirations and career attainment. Despite the difference in their fields of study, Maya described that her sister "*has helped me a lot, and she's definitely someone that I immediately go to if I need to vent to them, or if I have questions*." She also said, "*I feel overall, just like how to pursue a career, how to go about recruiting for things. I think she was really helpful in that way.***"**

The narratives above demonstrate that parents and siblings often provided instrumental support to participants for various aspects of their CSM. Sibling in particular acted as role models, indirectly shaping participants' navigational capital. Further, watching siblings engaging in different career behaviors and attain jobs seemed to positively influence some participants' (Mei, Maryam) outcome expectations for engaging in CSM as seen in the examples above.

Contrasting Cases/Narratives

In this section, I present example narratives that differ in significant ways from the primary analysis. The examples in this section present a more nuanced understanding of how race, class, and CCW might intersect to shape the CSM experiences of women of color. While participants described relying heavily on their familial capital and social capital for different types of support related to their CSM, one of the participants Layla, who is a Black woman in BME at EU, described the difficulties she experienced connecting with her peers and transitioning to college, which negatively influenced her CSM. Layla described her program as *"challenging"* because she *"never had to study"* in high school and said, "*it feels like I was supposed to come in knowing stuff that I just didn't know, whether it be because of COVID or because I went to a very underfunded public school, or whatever. I just went in not knowing what I should know."* In addition to feeling underprepared for college, she explained that it was hard for her to rely on her peers because she *"doesn't get along"* and *"can't see [herself] spending time with those people."* Layla alluded the difficulties she experienced in connecting with her

peers to the differences in their socioeconomic backgrounds and life experiences and to not having any common ground with them, as seen in the excerpt below,

> But I'm just sitting here, and I'm listening, I'm going to study abroad, I'm taking a vacation, and this that, and the third. ***And I'm sitting here like I can't really afford the plane tickets back home, how are we going on vacation. So then it's just like you're talking about what you can do, and when I can't do it because I can't afford it. Or I don't know if it's just a me thing, but even like the sports, the activities you choose to do, shoot even when they talk about Greek life.*** A lot of people in BME are in Greek life, and I'm in Greek life, too, but I'm in a different council than they are. So they're in the Panhellenic Council, I'm in the Multicultural Greek Council here at EU. So can't even talk to you about Greek stuff because how we run things Greek wise is even two different things.

Additionally, Layla also shared how her anxiety, which causes her to overthink, further impacts her ability to connect with the peers in her program and results in her withdrawing from others. She explained,

> ***It's like me interacting with people. It's hard cause if I'm overthinking about schoolwork, I'm overthinking about my interactions with people, I'm overthinking everything. So now, since I'm overthinking about my interactions with people, what's the solution to overthinking about interacting with people? Don't interact with people. So now, I'm kind of secluding myself.*** And, I just can't, it's not healthy. So now I'm mad because everybody else is like interacting with everybody, laughing joyously, whatever. And when I'm there, I'm upset cause I'm annoyed. I'm tired of all these people, but then, when I'm not there, I'm still upset, because, like, I want to be there. I want to be having fun with everybody joyously, whatever whatever whatever whatever. But I can't. It's a lose lose situation whether I'm there or not, like I'm going to be upset.

While Layla initially attributed the difficulties in connecting with her peers to her anxiety and their dissimilar backgrounds and life experiences, she later explained that her struggles are also a result of personal shortcomings. She shared her belief that despite her circumstances, she just had to work harder and put herself out there as seen in the excerpt below,

> Being involved, it's stressful. ***And in all honesty, as much as I say how different it is to be like a person of color in my academics, and how hard my academics is, it honestly, low key is still my fault partially as well, because it's like I have to make the effort to put myself out there even if it's with people I don't really get along with,*** because I do get along with you, I just don't see me hanging out with you outside of.. but that's what makes it hard, It's like it's not. It's not. I don't know what I'm saying. It's low key my fault that everything is so hard, like sure I was put in this predicament by happenstance due to culture or whatever. I went to this underfunded high school that's predominantly Black filled with very ghetto people. ***But at the end of the day, it's about how hard I gotta work. And of course they have to work harder than some people who were just placed in the right spot at the right time. So it's just stuff like that. So I'm just gonna learn how to balance it while still putting myself out there which is why I joined two***

> ***organizations. I'm trying to put myself out there to help the people who were in my position, so they won't struggle like I do and am. I'm still struggling, let's be real.***

Layla's difficulties with transition to college and connecting with her peers as explained above left her with inadequate support and capacity to engage in CSM. She also described several financial and logistical barriers to participating in internships as seen in the excerpt below,

> ***Work is still is so overwhelming for me as a junior. I'm trying to emphasize finding things and stuff, but it's hard. And it's also hard as a student to leave, and like I said, where am I staying? A lot of BME companies are on the east coast or the West coast, and I'm from the Midwest. So where am I staying? I'm broke. My family can't afford to pay for this, that, and a third. So really, the only experience I can get is through EU***, so like, there's this internship program that's new, this would be the 1st year that I signed up for, and I'm hoping that I get it. There was a pediatric research flyer posted in my dorm so I'm gonna reach out to them. I meant to do it 2 weeks ago. My bad, time sucks with me. What else? There's a clinical experience class for both biomechanics and something else that I want to do. So I feel like those are the closest things I'm gonna get to experience that I need because ***it's too hard to try to look for an internship and then have to figure out how I'm staying there, like everything else with it.***

While Layla experienced several barriers rooted in race and class structures, she leveraged her community cultural wealth to navigate these barriers. Specifically, she exhibited resistance capital when she got involved with different organizations to support others with similar backgrounds and ease their transition. Similarly, she exhibited navigational capital when, in the face of limited time and resources, she focused her search on finding opportunities at EU to gain industry relevant experience.

Similar to Layla, participants like Summer and Maya reflected on how being a woman of color influenced their experiences. For example, Summer shared her perspective on the difficulties of navigating career attainment as Black woman at a PWI without social capital and support. She explained,

> I don't know how to address it, but ***I feel like being at a PWI, it is harder to find your support unless you know people. Like I only found these people because of the clubs that I was in. And then also because my mom reached out to these people during my freshman year.*** So yeah, I don't really know where I'd be without these resources. But yeah, I just take pride in the fact that I have so many resources.

Maya, a 4th year IE student at MU1, also reflected on her experiences navigating CSM as a South Asian woman. She shared that not seeing any role models in her field initially affected her and made her hyper aware of her identity throughout the process. She further explained that while she initially struggled to connect with people, she used her marginalized identity to her

advantage by seeking out workforce diversity programs, an example of her navigational capital, as seen in the excerpt below.

> ***I just think that for me, something else like being a woman of color in the field was definitely difficult at first because I didn't see a lot of role models in the same fields. I didn't see a lot of people that looked like me. I would go to the career fair and it'd be a bunch of white men in these engineering roles. And so I felt like it was really difficult to connect to people initially.*** And so I would say that for sure one thing I could never forget was my identity, and I felt like it was always, I don't want to say haunting me, but it was always in the back of my mind. And I was like, I'm walking up to the career fair trying to strike up a conversation with this person, but I know that I have a disadvantage with, like the white guy in line behind me. And so I feel like that was definitely something that was extremely apparent throughout the whole process, like relating to my identity, and I felt like also could have been a big setback in the process. But I mean, ***I did also use it to my advantage when looking for diversity programs. So I do think it's a double edged sword.***

The narratives presented in this section demonstrates how race and class dynamics can have a direct influence on the CSM processes of women of color. The narratives also highlight how women of color leveraged their community cultural wealth in the face of various barriers to persist in their CSM.

Chapter 6 Discussion

In this chapter, I briefly summarize the key findings, present various interpretations of the results, and situate them within broader conversations on career self-management, career attainment, social capital, and community cultural wealth in engineering. I also discuss possible alternative interpretations and address limitations. This research aimed to understand the career self-management experiences (CSM) of women of color in interdisciplinary majors using Social Cognitive Career Theory (SCCT) and Community Cultural Wealth (CCW). Specifically, I examined the career actions/behaviors, contextual factors, emotions, and community cultural wealth of undergraduate women of color in BME and IE majors to understand their CSM experiences.

Career Self-Management Experiences of Women of Color

The findings indicate that participants engaged in a variety of career behaviors, including attending career fairs, utilizing institutional resources, leveraging platforms like LinkedIn, Handshake, and university specific job sites, mass applying to opportunities, and utilizing social media platforms such as Reddit as part of their CSM. However, many participants expressed frustration and dissatisfaction with their CSM experiences and institutional resources meant to facilitate their career attainment (e.g. in-person career fairs). Most BME students perceived both general (all majors fairs) and targeted career fairs (BME specific and NSBE fairs) as ineffective avenues for obtaining internship/job opportunities because of disinterest from recruiters, recruiter preference for traditional engineering majors/graduating students, and limited opportunities for BMEs. Further, while some participants found career resources from affinity-based organizations useful, they also felt that recruiting events by these organizations were geared towards traditional engineering majors, and therefore unhelpful for BME students. Finally, many participants experienced career services and academic advisors as generic and unhelpful, which caused them to minimally engage these resources and turn to their social networks and online platforms like Reddit for support.

Previous research by Desing et al (2024) examining the career attainment processes of engineering students using SCCT-CSM found that BME students experienced an academic major bias (preference for broadly applicable engineering majors) from recruiters, which acted as a barrier to their career attainment. The authors also suggested that contextual factors intended to be supports (e.g. on-campus career fairs, student affinity groups) could act as barriers to career attainment based on a combination of a student's personal factors. Some of the findings of this research, which identify traditional recruiting events and the gaps in support by institutional resources and affinity-based organizations as contextual barriers, align with findings from Desing et al (2024). The findings of this study also suggest alternate explanations for the difficulties in BME students' career attainment processes. Specifically, viewed through the lens of the SCCT-CSM model, the findings presented above suggest that students may have high outcome expectations of obtaining internships and jobs as a result of taking certain career actions (e.g. attending career fairs, utilizing institutional career supports and resources). However, when career actions do not result in intended outcomes due to the presence of various contextual/environmental influences (e.g. disinterest from recruiters, long-lines at career fairs, availability of opportunities, lack of industry specific supports and contacts), students might adjust their outcome expectations, with some becoming disillusioned with engaging in certain career behaviors. Therefore, findings of this research provide good evidence that students' career actions are shaped both through outcome expectations pathways, and through the impact of contextual/environmental factors on career actions and career outcomes in the SCCT-CSM model.

Additionally, while most participants did not make direct attributions to their race or gender as a factor influencing their CSM, the excerpts shared by participants like Layla, Summer, Mei, and Maya suggest that navigating CSM is isolating for women of color, especially when they lack access to role models, experience difficulties connecting with peers and other relevant individuals, and face additional obstacles related to their economic background or immigration status. The study by Design et al (2023) noted that some students in their study described race and gender bias from recruiters. While almost none of the participants in this study made direct attributions to their identity influencing their career fair outcomes, the career fair experiences of Summer, Maya, and Amira suggest that gendered and racialized bias and preferences of recruiters at career fairs might negatively influence women of color's career

attainment. In fact, previous research indicates that women in STEM face stereotypes, bias, and discrimination barriers during the recruiting process (Anderson, 2024). This research adds to the existing literature on the barriers present in the career attainment process by showcasing the compounding barriers that undergraduate women of color in engineering are likely to face in their CSM. The compounding barriers women of color face also provide some explanation for their underrepresentation in the engineering workforce as well as phenomena such as *occupational marginalization*, wherein college graduates who are women, racial and ethnic minorities, first-generation, and foreign-born students are found less likely to be employed in the most sought-after occupations (Attewell & Witteveen, 2023).

Participants in this research also attributed a lack of depth and specialization in their BME major as barriers influencing their competitiveness and career outcomes. Additionally, some participants shared very specific career goals and described competition within BME for roles in medical device design/research and development, while others expressed confusion and uncertainty about the career pathways available to them. Participants in the study also varied in the flexibility they demonstrated related to their career goals and preferences, with some expressing openness to a range of opportunities and others focused on entering specific pathways. Recent research implicates the emphasis on design in BME curriculum for biasing students in favor of research and development jobs (Suresh et al., 2024). Other research on job search and employment outcomes suggests that using an exploratory job search strategy might be more beneficial for students in STEM who experience anticipatory socialization into predefined career trajectories (Okay-Somerville & Scholarios, 2022). Drawing on these prior works and the findings of this research, while students attributed a lack of specialization in their majors as a barrier, I propose that a lack of comprehensive education about potential career pathways and how to leverage interdisciplinary training for diverse careers is a larger contextual/environmental factor influencing BME students' career attainment. Finally, while lack of awareness of career pathways explains some of the career behaviors and challenges in BME students' career attainment, participants in the study also described mass applying to opportunities with little success. Emerging statistics on the labor market indicate a high unemployment rate (5.7% in March 2025) for recent college graduates (Federal Reserve Bank of New York, 2025). Advances like generative AI are also predicted to reshape the careers landscape and impact entry-level positions. These larger labor market dynamics could also offer some explanation for the career

attainment difficulties reported by undergraduate BME students in this study, in which case, there is a need to rethink how BME graduates can be better trained to leverage their interdisciplinary skills to navigate jobs beyond focused engineering careers.

Emotions Associated with Career Self-Management

Research on emotions in engineering education is nascent and has been primarily explored in the context of teaching and learning, mental health, and ethics (Lönngren et al., 2023, Lönngren et al., 2024). Recent research advocates for developing emotionally responsive student support by exploring the emotions that surface as undergraduate students navigate engineering, also conceptualized as "engineering education emotions" (Josiam et al., 2025, p. 3). This dissertation study advances research on engineering education emotions by uncovering the emotions that arise for women of color in interdisciplinary engineering programs as they navigate the career attainment process. Specifically, participants described experiencing difficult emotions such as anxiety, overwhelm, and stress because of the ambiguity associated with engaging in various CSM behaviors and resources. Participants also experienced emotions such as frustration and sadness when they encountered disappointments and obstacles in their job search, such as dealing with rejections, a competitive job market, or unresponsive employers (contextual/environmental factors of SCCT-CSM model). As a result, some participants described using self-regulation strategies or relying on their social networks to cope and persist, while others used avoidant strategies to manage their emotions.

Engineering students are known to experience elevated levels of stress, anxiety, and depression (Asghar et al., 2024; Coley & Jennings, 2019; Jensen & Cross, 2021), often associated with the heavy workloads of engineering coursework (Asghar et al., 2023; Jensen et al., 2023; Sánchez-Peña et al., 2025). Previous research has also described the job search process as very demanding for early career engineering students (Stiwne & Jungert, 2010). Similarly, findings of this research suggest that the career attainment process requires students to exert significant effort, navigate ambiguity, and deal with repeated difficulties obtaining jobs and internships, which can be emotionally taxing for many. This process therefore potentially acts as an additional stressor for engineering students, who are expected to navigate CSM alongside their rigorous coursework. Some of the women of color in this study also described instances where their race, class, and immigration status introduced additional difficulties and distress (e.g. experiencing isolation and intimidation, anxiety talking to recruiters and/or disclosing

immigration status, stress and overwhelm associated with finances/relocation for internships) into their CSM experiences. Together these findings suggest that the stressors associated with CSM might have compounding effects on women of color in engineering who must navigate career attainment processes that are not designed for students with diverse backgrounds and experiences.

Participants in this study also described experiencing positive emotions such as hope and happiness associated with their CSM. Josiam, Jurkiewicz, and Lee, (2025) suggested that students in engineering associate emotions such as hope with their future career plans as a way to cope with the uncomfortable emotions associated with their coursework. The findings of this research nuance the idea of hope in future career plans as a coping mechanism by showing that engaging in future career planning can invoke both positive and negative emotions for students because of the ambiguity and pressures associated with post-graduation. Nevertheless, hope served as a motivational influence on the career actions of participants in this research, a finding which bears similarities to research on hope as an important psychological resource in the career development literature (Hirschi, 2014).

Social Networks of BME and IE Students

Participants in this study described relying extensively on their social network for career support. Previous research documents the influential role of social capital on engineering students' career decision-making and career plans (Abhyankar et al., 2018; Martin et al., 2013; Martin et. al., 2020; Skvoretz et al., 2020). This research extends existing literature on social capital in engineering by illuminating the key individuals supporting women of color students career attainment in interdisciplinary engineering, and by describing the types of support the key individuals provided across three specific areas of CSM: *1) exploring career interests, 2) job search, and 3) networking and career fairs*. For example, previous research indicates that BME students' career perceptions are influenced by undergraduate research, volunteering, attending alumni networking lunches, talking to professors, and attending programming by BME departments and professional fraternities (Jamison et al., 2021). In the study by Abhyankar et al (2018), parents, peers, professors, and work supervisors emerged as the four dominant socializers influencing the post-graduation career planning of mechanical and chemical engineering students. This study builds on this existing literature by illuminating parents, peers, and faculty as some of the key individuals supporting women of color in BME and IE with their career

exploration. Additionally, mentors, who included graduate students and engineering and non-engineering industry professionals, also emerged as another group of key individuals supporting participants' career exploration. All of the individuals mentioned above helped participants with *exploring their career interests* by primarily providing them with emotional and navigational support.

For other CSM related behaviors such as *job search*, parents, peers, and faculty emerged again as the key individuals providing participants with navigational and instrumental support, whereas for *networking and navigating career fairs*, peers were overwhelmingly recognized as the key individuals providing emotional, navigational, and instrumental support. Notably, of the alters described above, those currently in the engineering industry or with previous exposure to the engineering industry provided more specific navigational and instrumental support compared to the general support provided by non-engineering alters. This finding is unsurprising given that individuals who have experience attaining engineering industry positions are more likely to possess insider knowledge on industry career pathways and how to enter them. Further, of all the alters described, peers provided diverse forms of support across all aspects of CSM . The finding that peers play a critical role in the career attainment of women of color is similar to the findings of other recent research on the job attainment experiences of undergraduate students in computing, which attributed peers to helping students learn about and prepare for the hiring process (Lunn et al., 2024). Engineering workload has been identified as a defining stressor, leaving students with limited time in their schedules in previous research (Jensen et al., 2023). The same authors also found peers were primary sources of support due to the "shared understanding of the Engineering Way of Doing and Being an Engineer" (Jensen et al., 2023, p.17). In similar ways, the findings of this study suggests that the shared understanding of the pressures and difficulties associated with navigating job search and career fairs positions peers as behaviors models and emotional supports for students CSM. Further, in a culture which places significant constraints on students' time, peers support engineering student career attainment process in crucial ways by sharing the workload associated with CSM, as evidenced in some of the participants' narratives. Social capital, which is the network of people who provide emotional and instrumental support to women of color (Yosso, 2005), was operationalized as a contextual/environmental factor of SCCT-CSM in this study. The findings provide good evidence for social capital influencing the career behaviors of participants' directly through the

contextual/environmental factors pathways (instrumental and emotional support by peers) as well as indirectly through the outcome expectations pathways (peers as behavioral models).

While peers emerged as key individuals supporting women of color in this study, the findings also suggest that students like Layla, who experience isolation because of difficulties connecting with their peers, are at a significant disadvantage in the form of loss of access to various career supports. Previous research highlights how race, gender, and social class dynamics can influence peer collaboration and secure institutional advantages for privileged and class-advantaged students (Johnson, 2018; Johnson, 2022). The race and class context of high school influences the ease with which students are able to collaborate with peers and interact with authority figures (Jack, 2015; Johnson, 2018; Johnson, 2022). Since CSM experiences of the participants in this study involved collaborating with peers and interacting with authority figures (e.g. recruiters, industry professionals), findings of this research suggest that women of color's pre-college experiences and perceived cultural mismatch with peers can negatively influence their ability to access career related support for CSM.

Finally, this research also provides crucial information about the backgrounds and occupations of the alters supporting women of color, with the findings indicating that women and/or racially minoritized individuals make up the majority of the individuals supporting women of color's career attainment in engineering. The career behaviors of the participants coupled with the occupation information of the individuals in their social networks also indicates that participants did not have many alters from the engineering industry represented in their social networks. The limited industry contacts in participants' social networks explains some of the difficulties some women of color faced in their CSM, such as a lack of knowledge about different career pathways and how to enter them. Therefore, while the individuals described above supported participants CSM in many meaningful ways, not all participants had access to engineering alters in their networks, leading to disparities in the types of CSM support available to women of color in this study. In the section below, I dive deeper into how women of color leverage their CCW to navigate CSM and overcome some of the barriers described so far.

Community Cultural Wealth of Women of Color

Previous research highlights the crucial role that community cultural wealth (CCW) plays in shaping the career aspirations and persistence of students in STEM (Denton et al., 2020; Rincón et al., 2020) and engineering, more specifically (Bae, 2022; Samuelson & Litzler, 2016;

Sellers et al., 2022; Tolbert Smith, 2022). The findings of this study contribute to the engineering education literature by providing examples of CCW leveraged by East Asian and South Asian women in engineering, populations whose experiences are minimally examined. The findings also extend existing literature on CCW in engineering by illuminating the multiple ways in which CCW influenced the CSM of women of color. Findings of RQ3 suggest that Familial Capital, which sometimes overlapped with Social Capital (discussed above), played a key role in shaping some participants' Navigational Capital, self-efficacy, motivations, and outcome expectations. Specifically, some participants (Maryam, Mei, Emma) talked about the influence of their families' lived experiences with immigration shaping their motivations, self-efficacy, and Navigational Capital for CSM. Other participants (Sarah, Neha, Maya, Manvi, Summer, Mei) talked about values of collectivism, economic security, job fulfillment, and professional responsibility informing their work ethic, motivations, and career behaviors. Parental involvement also influenced participants' (Summer, Amira) career behaviors and provided direct support for their CSM, and siblings were influential as role models who provided instrumental, navigational, and emotional support to many participants (Maryam, Sarah, Mei, Neha, and Maya). Finally, narratives of Layla and Maya demonstrated how women of color leveraged their navigational capital in response to race and class barriers/dynamics

Together, these findings provide evidence of the Familial, Social, and Navigational Capital leveraged by Black and Asian women to realize career attainment in engineering. The narratives of Maryam, Mei, and Emma extend our understanding of how lived experiences of students with immigrant backgrounds could influence their career attainment. In line with research by Tolbert Smith (2022) that challenged deficit perspectives of Black families and demonstrated Black parents' engagement influencing the learning and development of Black men in engineering, the parental involvement of two of the Black women in this study (Summer, Amira) provides some evidence of the influential role of Black familial support for engineering career attainment. Further, Familial Capital was operationalized as a person input in the SCCT-CSM model in this study. The findings above provide some evidence that Familial Capital might influence the career actions of women of color through self-efficacy and outcome expectations pathways in the SCCT-CSM model. Familial and Social Capital, also overlapped in significant ways and provided instrumental support for participants CSM. Findings of RQ1 and RQ2 also indicate that when participants' encountered barriers (unhelpful support, financial constraints,

lack of role models) they drew on these same CCW to navigate CSM, which suggests that CCW could be a stabilizing influence for women of color navigating CSM.

Limitations

While this research provides a deeper understanding of the CSM experiences of women of color in interdisciplinary engineering majors, it is not without limitations. Participants were interviewed at a single timepoint about their CSM, a process which unfolds over the course of their undergraduate years. Therefore, participants' narratives might not fully capture the complexity of their experiences and how they changed over time. Longitudinal studies might provide additional information about how students CSM behaviors and experiences evolve over the course of their undergraduate studies. The participants were also asked to retroactively recollect the different individuals supporting their CSM and the emotions they associated with different career behaviors, information which can be subject to participant memory recall and bias. Further, the Premo instrument and related questions were intended to help participants articulate their emotions in addition to the questions probing for their emotional experiences throughout the interview. However, it's possible that participants felt limited by the 14 Premo characters in the instrument and shared a subset of their emotional experiences related to CSM during the interviews. Students were also not provided with definitions for various emotions so they might be some inconsistencies between how participants attributed different emotions to their CSM experiences. Finally, while the interview protocol contained questions to elicit responses about how participants leveraged their CCW in their CSM, it did not contain any questions directly prompting participants to think about how their identity influenced their experiences. Therefore, participants' narratives of their CSM experiences and any barriers they encountered included minimal reflections and attributions to their identities as women of color. Research that includes explicit questions about the influence of participants' identities on their CSM experiences may have generated stronger insights and conclusions into the experiences of women of color. Finally, as previously stated, a key feature of multiple case study approach is to develop an understanding of the phenomena of interest in depth over making broad claims about the experiences of students. Therefore, the findings generated from this research are not intended to be widely generalizable. However, the insights generated from this work may be relevant in specific situations that share similarities with the contexts and characteristics of the cases examined in this research.

Chapter 7 Conclusion, Implications, and Future Research Recommendations

Conclusion

This study makes important contributions to the engineering education literature by providing a deeper understanding of the career attainment experiences of undergraduate women of color in BME and IE majors, as well as the different factors influencing their career attainment. Findings indicate that women of color engaged in several proactive career behaviors typically expected to lead to employment. However, the presence of various contextual/environmental barriers including gaps in support by institutional resources and affinity-based organizations, hindered participants' efforts and caused them to rely on their social capital and cultural wealth. Social capital, which was operationalized as a contextual/environmental factor of SCCT, played a key role in supporting participants' CSM. Specifically, parents, peers, mentors, and faculty emerged as the key individuals supporting the CSM of women of color. Peers and siblings served as behavioral models who provided instrumental, navigational, and emotional support related to CSM. Familial capital, which was operationalized as a person input, also shaped the career behaviors of participants through its influence on participants' self-efficacy, motivations, navigational capital and outcome expectations. Despite leveraging their rich community cultural wealth, not all participants had equal access to traditionally valued social capital such as industry connections, which further reinforced the inequities present in the career attainment process. Finally, engaging in CSM was associated with negative emotions such as anxiety, stress, overwhelm, frustration and disappointment as well as some positive emotions, such as hope and happiness.

Implications For Research and Practice

The findings presented in this dissertation contribute to engineering education literature in multiple ways: 1) by providing a deeper understanding of the career attainment experiences and contextual/environmental factors of CSM for undergraduate women of color in BME and IE, 2) by uncovering the emotions that arise for women of color as they navigate the career

attainment process, 3) by highlighting the key individuals and the specific ways they support the career attainment of women of color, 4) by expanding the application of SCCT and CCW models to East Asian and South Asian women in engineering, and 5) by considering how SCCT and CCW might work together to shape career attainment for women of color. The findings also have important practical implications for institutions, engineering programs, educators, career service professionals, and engineering students. The findings suggest that there is a need to rethink how BME students are trained and how they are supported to navigate jobs beyond focused engineering career pathways. Specifically, to improve the career outcomes of BME students, educators and career service professionals should first increase the career awareness of BME students by exposing them to diverse careers. Recent research on a course-based initiative exposing BME students to diverse industry speakers demonstrated a positive impact on students' career awareness (Novak & Jamison, 2024). Other authors have reported success with integrating technology like generative AI into classroom exercises to improve students' career understanding in marketing (Flink et al., 2025). Innovative career development initiatives, such as the ones described above must be incorporated into BME education. Specifically, rather than creating additional out of class programming for students with an already demanding workload, faculty can work with career services to design career assignments and activities that connect course content to opportunities and jobs in the workforce. For example, faculty can create graded assignments that require students to research and present on the career roles and pathways related to the course topic (e.g. biomechanics, biomedical instrumentation, thermodynamics, etc.,). Students can also be graded on assignments such as conducting informational interviews with industry professionals who are working in areas of relevance to their course. Such career exploration assignments would provide students with the opportunity to not only connect their coursework to roles in industry but also help build their social networks and improve their communication skills and CSM abilities. Integrating career education into the curriculum would also mean that students would not have to choose between coursework or engaging in CSM in the limited time available to them, which could be particularly beneficial to students who may be struggling with their course load and transition to college. In fact, a previous study found that a 4-week, one-credit experiential incubator course which provided BME students with relevant skills in different areas in BME helped them clarify their career goals, with students reporting

being motivated to enroll in the experiential option because of the low credit hours and workload associated with it (Vempala & Huang-Saad, 2022).

Along with integrating career education into the curriculum, the findings also indicate a need to develop career programming that is specific to the needs of women of color. While most of the participants in this study relied on their cultural wealth such as familial and peer support and wisdom for their CSM, participants' career behaviors and social networks indicate many did not have access to traditionally valued social capital such as contacts in the engineering industry, which served as a barrier in their CSM. Additionally, many of the alters, including mentors and faculty, who supported the CSM of the participants in significant ways were women and/or racially minoritized individuals, and participants like Summer gravitated towards the Black woman faculty member in her department when her department failed to connect her with a Black alumnus through their mentorship program. These findings all suggest areas of opportunity for interdisciplinary engineering programs to better support the career attainment of women of color. Specifically, to support women of color, BME and IE programs must invest in building relationships with their racially minoritized and/or women alumni and develop programming (e.g. alumni and peer mentorship and networking) specifically to connect women of color to industry professionals and opportunities in the engineering workforce. Departments must make efforts to hire more women and racially minoritized faculty as well as faculty and lecturers with industry experience as participants in the study described receiving unhelpful and generic advice from faculty and advisors with no prior industry experience. Further, for participants such as Layla, Mei, Maryam, and Emma, their socioeconomic, first-generation, and/or immigrant backgrounds were more salient in shaping their CSM experiences. These findings highlight the importance of adopting a more nuanced and inclusive approach to supporting the needs of women of color rather than essentializing their experiences and needs based on a single shared identity.

Many of the participants in this study also demonstrated a collective and interdependent orientation to CSM, often relying on family and peers for different career support. Therefore, promoting CSM as a community endeavor rather than an individualistic process is essential for nurturing the cultural wealth of women of color. Accordingly, career services should adopt a more collectivist approach to supporting the career attainment of women of color by engaging family members of students, encouraging students to engage their existing social networks, and

pairing students with peers to navigate CSM, as authors examining the community cultural wealth of Hispanic/Latino students have previously suggested (Bañuelos et al., 2022). Beyond raising career awareness, personalizing career support, and nurturing students' cultural wealth, career services professionals should articulate the relevance of developing CSM skills for job and life satisfaction, which could motivate students to persist in their CSM in the face of barriers. Educators should also articulate to students the relevance of their interdisciplinary training to contemporary work environments so that students in interdisciplinary engineering programs understand how to leverage their skill to enter careers beyond engineering. Accordingly, to improve the career attainment of BME students, the curriculum should be reformed to better align with industry demands and the interdisciplinary nature of the discipline. Career services must also consider working with engineering departments to collect and share data about the career outcomes of alumni as well as current industry openings for entry-level jobs to better inform students of workforce needs and opportunities available to them. Such efforts would aid in improving students' understanding of the careers landscape in their field, a barrier noted by some of the participants in this study. Similarly, engineering departments and career services must work together to better market the value of interdisciplinary engineering graduates to potential employers.

Recent research by the Burning Glass Institute and Strada Institute for the Future of Work (2024) indicates that graduates with internship experience are 49 percent less likely to be underemployed than graduates with no work experience. Given the strong relationship between internship participation and post-graduation employment, engineering programs must place students in internships and mandate such experiences as requirements for graduation. Engineering departments and career services must also explore the possibility of creating on-campus internship experiences and providing relocation support to alleviate some of the financial barriers to internship participation (e.g. relocation and housing costs). To support women of color who are immigrants and international students, career services and engineering departments must educate themselves and potential employers about the additional requirements and barriers present for these students and create specific programming and pathways to connect them to opportunities in the workforce. The findings of this research also support the implementation of more small scale targeted career events, such as company information sessions, alumni resume reviews, and industry guest lectures over on-campus career fairs to

better serve the career needs of BME students at large public universities, where they are likely to face increased competition from within and outside their major and might have to spend considerable time and effort to connect with potential employers. Career initiatives such as industry immersions and shadowing opportunities should also be adopted to exposure students to various opportunities in the workforce. Further, to counter the gender and racial bias that women of color might face during career fairs and other recruiting events, career services must make efforts to establish industry partnerships with companies who have expressed explicit interest in recruiting diverse talent.

Recognizing that CSM can be an emotionally taxing experience, efforts should be made to reduce the ambiguity associated with CSM, and mental health support should be integrated with career support. Some suggestions for integrating mental health support with career services could look like creating formal structured spaces and groups for students to gather and process the emotions associated with their career experiences. Career services can also work with alumni centers and engineering departments to highlight the career journeys and challenges of past and present students and women of color from different backgrounds to normalize the emotions that might be present in the career attainment process. Given that peers served as behavioral models who provided both emotional and instrumental support, engineering departments and career service should consider appointing knowledgeable students with internship experience as career ambassadors to engage and support their peers in CSM, paying attention to recruiting students from diverse backgrounds and experiences as ambassadors. Alongside such initiatives, departments and educators should encourage students to engage in career discussions, creating structured spaces (e.g. drop-in career self-management hours) for students to work together and share opportunities. Students should also be provided with more opportunities throughout the year to interact with industry professionals in relaxed social settings to reduce the nervousness and anxiety associated with interacting with recruiters. Recognizing that students are likely to use online social platforms for career advice and support, career services should aim to proactively reach students where they are rather than waiting for students to engage career services. Finally, while career education is a starting point, merely enhancing the career knowledge and skills of students might be insufficient for addressing their career attainment, especially in times of increased uncertainty in the workforce. To facilitate equitable career outcomes for students, workforce programs and pipelines enabling the transition of women of

color into entry-level jobs have to be developed alongside interventions aimed at fostering students' career self-management skills.

Future Research Recommendations

Several opportunities for future research exist. First, longitudinal research exploring how BME student develop CSM skills through their undergraduate years and utilizing them after entering the workforce can provide greater insight into their career pathways and the factors influencing their career outcomes. Second, given the saliency of peers in the CSM of participants in this study, future research should examine how peer interactions and collaboration influence career attainment of engineering students from different backgrounds, particular those who experience multiple marginalizations. Third, the findings of this research provide some preliminary evidence for how SCCT-CSM and CCW models might work together. Specifically, CCW was operationalized as a person input of SCCT-CSM model in this research, with the findings providing some evidence for Familial Capital influencing career actions through self-efficacy and outcome expectation pathways. Future empirical research should test these relationships for different racialized groups and examine how various CCW factors interact with elements of the SCCT-CSM model to shape engineering students' outcomes. Fourth, participants' reliance of their Social Capital and social media sites for personalized support and major specific career advice emerged as an interesting finding in this study. Future research should explore how engineering students interact with various online resources and tools (LinkedIn, Reddit, Instagram, ChatGPT) to navigate gaps in support in their engineering programs and career attainment. Finally, future research should more deeply explore the emotional experiences associated with school to work transitions as well as the impact of transient and state emotions on the career actions of engineering students to inform the development of more holistic career programming.

Appendices

Appendix A: Consent Form

EXAMINING THE CAREER SELF-MANAGEMENT OF WOMEN OF COLOR IN INTERDISCIPLINARY ENGINEERING PROGRAMS
HUM#00253655

Principal Investigator: **Vibhavari Vempala, University of Michigan, Engineering Education Research**
Faculty Advisor: **Dr. Joi Mondisa, University of Michigan, Department of Industrial & Operations Engineering**

You are invited to participate in a research study about the career planning and management experiences and social networks of undergraduate women of color in Biomedical (BME) and Industrial Engineering (IOE) majors.

Taking part in this research project is voluntary. You do not have to participate, and you can stop at any time. Please take time to read this entire form before deciding whether to take part in this research project.

The purpose of this study is to understand the experiences of women of color in Biomedical and Industrial Engineering programs with career planning and management.

Women of color continue to be underrepresented in the science and engineering workforce. To address the underrepresentation of these students, it is important to understand their career goals and behaviors so they can be adequately supported in pursuing their career goals. Therefore, this study aims to understand how women of color use their agency to leverage various resources and social networks in pursuit of their career goals and how different factors influence the actions of these students to foster diversity in science and engineering careers.

If you agree to continue with this research study, you will be asked to complete a Qualitrics survey which will take approximately 20 minutes. Depending on your survey responses, you may be contacted in the future to participate in one interview over the University of Michigan

Zoom software. The interview will take approximately 75 minutes and will be audio and video recorded with your permission.

You may be contacted at a later date to verify or clarify the contents of your survey and interview responses.

Benefits of the research
While you may not directly benefit from participating in this study, the findings of this work could provide an increased understanding of the career planning experiences and social networks of women of color in engineering.

Risks and discomforts
This study is expected to involve minimal risk. The risks involved are no greater than those involved in existing daily practices, including going to school. However, a breach of confidentiality is a risk common to this type of research. To protect your information and minimize the risk of loss of confidentiality, the researchers will 1) encrypt the recordings and store them on password-protected systems and accounts, 2) transcribe the recordings and replace any names mentioned in the transcriptions with codes/pseudonyms and then delete the recordings, and 3) delete the original online survey data after downloading and storing it in password-protected accounts and systems with all the names replaced. In addition, for both the survey and interview portions of this study, you do not have to answer any questions you do not want to answer.

Each participant will be assigned a pseudonym after completing this informed consent form. A key document will be created that links all the participants' pseudonyms to their names. Any names mentioned in the surveys or the interviews will also be replaced with a pseudonym. This is done to reduce the chances of inferring participants' identity or the identity of the people in their social network. The key document and all the data collected from the participants will be stored on password-protected systems, accounts, or web-based storage provided by the University of Michigan. Only research team members will have access to these files.

Compensation
You will be compensated $20 for completing the survey. If you are selected to participate in a follow-up interview, you will receive an additional $35 for completing the interview. All compensation will be emailed to you in the form of an Amazon gift card.

Voluntary Participation
Your participation in this study is entirely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer any survey or

interview questions for any reason. If you decide to withdraw before this study is completed, your information (i.e., survey data, recordings, interview transcripts, informed consent forms) will be destroyed. If the researchers have already used your information in a research analysis, it will not be possible to remove your information.

Sensitive and Identifiable Data Collection

All recordings will be stored on password-protected systems, accounts, or web-based storage provided by the University of Michigan. Only researchers will have access to the recordings. Audio recordings will be transcribed, all names will be replaced with a code, and the recordings will be destroyed. The document that links the codes to the participants' names will also be stored on password-protected systems or web-based storage provided by the University of Michigan. It is possible that other people may need to see the information you give us as part of the study, such as organizations responsible for making sure the research is done safely and properly, like the University of Michigan. We may use transcripts from the audio data in publications and presentations. However, these records will not include your name or any personally identifiable information.

Storage and Future Use of Data

We will keep the information we collect about you during the research for recordkeeping purposes. Your name and other information that can directly identify you will be stored securely and separately from the research information we collect from you. All audio and video recordings will be stored in Zoom cloud or password-protected systems and will be deleted after checking the Zoom-generated transcription for accuracy. The original online survey data will be deleted after downloading and storing it in password-protected accounts and systems with all the names replaced. The key document linking participants' pseudonyms to their names will also be deleted after creating profiles of participants and at the end of all data analysis.

We may share your research data with other investigators without asking for your consent again, but it will not contain information that could directly identify you. Any data collected can be destroyed at any time if you request it. Otherwise, we will destroy any remaining data seven years after you have stopped participating in the research for recordkeeping purposes.

If you have questions about this research study, please contact Vibha Vempala at vvempal@umich.edu or Dr. Joi Mondisa at jmondisa@umich.edu.

As part of their review, the University of Michigan Institutional Review Board Health Sciences and Behavioral Sciences has determined that this study involves no more than minimal risk and is exempt from on-going IRB oversight.

Appendix B: Name Generator Survey Protocol

EXAMINING THE CAREER SELF-MANAGEMENT OF WOMEN OF COLOR IN INTERDISCIPLINARY ENGINEERING PROGRAMS
HUM#00253655

[Section 1: Informed consent form]

[Section 2 - Screening]

Thank you for participating in this research study. This study aims to learn about the experiences of women of color in biomedical and industrial engineering programs and how they use their agency and social networks to achieve their career goals. As a first step, I would like to check your eligibility to participate in this study and learn a bit about you and your goals after graduation. Please take a few minutes to answer the following questions.

1. How would you describe your race and ethnic identity? [multiple choice]
    a. American Indian or Alaska Native
    b. Asian or Asian American
    c. Black or African American
    d. Hispanic or Latino/a
    e. Middle Eastern or North African
    f. Native Hawaiian or Pacific Islander
    g. White or European
    h. My race or ethnicity is best described as:

[If the participant selects only White or European option, close the survey and direct them to the end of the survey page with the message, "Thank you for your interest, but you are not eligible to participate in this study"]

2. How many **years** in college have you enrolled in so far? [single choice]
    a. One
    b. Two
    c. Three
    d. Four

e. Five and above

[If the participant selects one or two above, close the survey and direct them to the end of the survey page with the message, "Thank you for your interest, but you are not eligible to participate in this study"]

[Section 3 - Background/Demographics]

3. Do you identify as transgender? [single choice]
    a. Yes
    b. No

4. How would you describe your gender identity? [multiple choice]
    a. Gender nonconforming
    b. Genderqueer
    c. Man
    d. Nonbinary
    e. Woman

5. What is your major? [multiple choice]
    a. Biomedical Engineering/Bioengineering
    b. Industrial Engineering
    c. Other, please specify:

6. What are your plans for after graduation? [multiple choice]
    a. Graduate/Professional School
    b. Industry
    c. Other, please specify:

7. Do you identify as a first-generation college student? (i.e. a student whose parents did not complete a four-year college degree) [single choice]
    a. Yes
    b. No

8. Are you an international student? [single choice]
    a. Yes
    b. No

9. Do you have any previous internship/co-op experience? [single choice]
    a. Yes

b. No

10. Are you actively involved in any engineering-related student organizations? [single choice]
    a. Yes
    b. No

11. In general, how often do you meet with your academic advisor? [single choice]
    a. Once a month
    b. Once every couple of months
    c. Once a semester/quarter
    d. Once a year
    e. Never

12. How often do you use the career services provided by your university? [single choice]
    a. At least once a month
    b. Once every couple of months
    c. Once a semester/quarter
    d. Once a year
    e. Never

[Section 4 - Social Network Information]

Now, I would like to learn about the people in your social network and how they may have supported you with your career goals and plans.

1. Think of the names of up to five people who have helped you in exploring career interests. For each person, please provide the following details:
    a. List their relationship to you [multiple choice]
        i. Parent/Guardian
        ii. Sibling
        iii. Other Family Member
        iv. Peer
        v. Partner/Significant Other
        vi. College/University Faculty
        vii. College/University Staff
        viii. Mentor
        ix. Other, please specify:
    b. On a scale of one to six, with six being the strongest, how would you rate the strength of your relationship with them? [sliding scale 1-6]
    c. In general, how often do you reach out and interact with them for support on this matter? [single choice]

i. More than once a week
ii. Once a week
iii. Once a month
iv. Once every couple of months
v. Once a year
vi. I only reached out to them once

d. List their gender identification (if known) [multiple choice]
i. Gender nonconforming
ii. Genderqueer
iii. Man
iv. Nonbinary
v. Woman
vi. Trans
vii. Their gender is best described as:

e. List their race and ethnic identification (if known) [multiple choice]
i. American Indian or Alaska Native
ii. Asian or Asian American
iii. Black or African American
iv. Hispanic or Latino/a
v. Middle Eastern or North African
vi. Native Hawaiian or Pacific Islander
vii. White or European
viii. Their race or ethnicity is best described as:

f. List their occupation (if known) [multiple choice]
i. Academic Professional
ii. Currently Not Working
iii. Engineering Industry Professional
iv. Non-engineering Industry Professional
v. Self-employed
vi. Stay-at-home Caretaker
vii. Student
viii. Do not know
ix. Other, please specify:

[Section 5 - Social Network Information Contd]

2. Think of the names of up to five people who have helped you with searching and obtaining jobs, internships, research, or co-op experiences. <u>It is okay if you already listed the person before</u>. For each person, please provide the following details:
    a. [list same choices as above question]

b. Have you already listed this person before? [single choice]
    i. Yes
    ii. No

[Section 6 - Social Network Information Contd]

3. Think of the names of up to five people who have helped you with networking and preparing for career fairs. It is okay if you already listed the person before. For each person, please provide the following details:
    a. [list same choices as above question]
    b. Have you already listed this person before? [single choice]
        i. Yes
        ii. No

[Section 7]

Thank you for taking the time to complete this survey. I look forward to reviewing your responses. Depending on your survey responses, I may contact you in the future to learn more about your experiences in a follow-up interview. In the meantime, please provide the following information so I can email you a $20 gift card for completing the survey.

1. Please provide your full name (Required for providing compensation)
2. Please provide your email address (Required for providing compensation)
3. Please provide your mailing address (Required for providing compensation)
4. Optional: Please forward the message below to anyone who you think would be interested in participating in this study

You are invited to participate in a research study about the **career planning experiences of women of color in engineering.** If you 1) self-identify as a woman of color, 2) are at least a third-year student enrolled in a Biomedical or Industrial engineering program, and 3) have intentions to pursue a career in industry, please consider participating and sharing your experiences. Your participation will involve completing a survey and might involve completing one 75-minute interview. **You will be compensated $20 for completing the survey and $35 for completing the interview**.

To participate in the survey, please click here: (Qualtrics survey link).

[*End of survey message*]

Appendix C: Semi-structured Interview Protocol

Sample Interview Script

Hello, my name is Vibha, and I am a Ph.D. candidate in the Engineering Education Research program at the University of Michigan. Before joining this program, I received my bachelor's and master's degrees in biomedical engineering (BME), and my experience as a BME student motivated me to pursue this program and this research study.

Before we start, do you approve of me recording this meeting and taking notes? As we are meeting over Zoom, you can choose to turn your camera on, but it is not required. [wait for response].

First, thank you for participating in this interview. The purpose of this study is to learn about the experiences of women of color in interdisciplinary engineering programs and how they use their agency, background, and social networks to achieve their career goals. The information you provide will only be used for research purposes, and to protect your identity, you will be given a pseudonym. Your participation is voluntary, and you are free to withdraw at any point during this interview. You also have the right not to answer any questions you are uncomfortable answering. You were provided with a consent form when we scheduled the interview. Could you please verbally confirm that you are consenting to participate in this interview? [wait for response]. This interview should take about 75 minutes. Do you have any questions before we get started?

Background

1. What is your preferred name, and where are you attending college?
2. What is your year and major?
3. Can you tell me about how you got interested in engineering?
4. Why did you choose this particular engineering major and this particular program?
5. Can you describe your experience in your program so far?
6. What are you hoping to do after graduation?
    a. Please tell me about any specific job or career goals you have.
7. How did you get interested in the job/position/industry you mentioned?

Career Actions

8. What are some specific actions/steps you have taken so far, such as networking, seeking career guidance, attending career fairs, etc., to make progress toward your career goals? Please be as detailed as possible.
    a. Prompts: Tell me more/Can you expand on that?/How did you feel when taking these steps? Why did you feel that way?
9. Please tell me about any other actions you plan to take, such as searching for internships, expanding your network, etc., to help you with your career goals?
    a. Prompts: Tell me more/Can you expand on that?/How do you feel about taking these steps? Why do you feel that way?
10. What has been your experience searching and applying for any previous internship or job-related opportunities?
    a. Prompts: Tell me more/Can you expand on that? How do you feel about your experience?
11. In what ways do you feel like your family, culture, and upbringing prepared you for the steps you might have to take to make progress toward your career goals?
    a. Prompts: Tell me more/Can you expand on that?

[Screen-share sociogram of participant's social network]

12. In the survey, you mentioned that [peers/family/mentor] helped you with [searching and applying for internships/networking/career exploration]. Can you tell me more about how they supported you? (Repeat as needed)
    a. How do you feel when you're seeking support from this person?
    b. Are there any changes or additions you would like to make to the information you provided about your social network?

Environmental Factors (EF)

13. What, if any, challenges have you faced while finding and applying to internships and jobs or navigating the career resources available to you?
    a. How did you choose to deal with the challenges?
    b. In what ways do you feel like your family, culture, and upbringing prepared you to deal with the challenges?
    c. How did you feel navigating these challenges?
14. What, if any, particular resources do you think played a significant role in helping you make progress toward your career goals?
    a. Why do you think so?/Tell me more
15. What do you consider to be the most significant factor that has influenced your progress toward your career goals?
    a. Why do you think so?/Tell me more

Outcome Expectations (OE) and Emotional Experiences (EE)

[Screen-share Premo to accompany the questions below]

16. Describe the range of emotions that come up for you when you think about making plans for your career.
    a. Please pick one or more characters on the screen that express how you feel and rank them
    b. Please explain, in your own words, the emotion expressed by the character(s) you picked
    c. Why do you feel that way?/Tell me more
    d. Are there any other emotions that show up for you?
17. How do you feel overall about engaging in the process of finding and securing internships or jobs? You can use the characters on the screen again if you like.
    a. Prompts: Why do you feel that way?/Tell me more
18. How do you feel overall about navigating the career resources available to you? You can use the characters on the screen again if you like. (Ex: Could be anything from websites to various centers on campus)
    a. Prompts: Why do you feel that way?/Tell me more
19. How do you feel about your chances of securing a job that aligns with your interests after graduation? You can use the characters on the screen again if you like.
    a. Prompts: Why do you feel that way?/Tell me more

Wrapping up

20. Is there anything else you would like to add that we haven't already talked about?

Thank you so much for taking the time to participate in this study. Your insights are valuable and will help me better understand how students plan and manage their career goals. I will follow up via email to provide you with compensation for your participation. If you have any further questions or concerns, please do not hesitate to reach out to me.

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