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STEM STUDENT–FACULTY RELATIONSHIPS: THE INFLUENCE OF RACE AND GENDER ON ACCESS TO CAREER-RELATED OPPORTUNITIES

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This study examines how race/ethnicity and gender influence student–faculty relationships, and how such relationships may facilitate or constrain access to career-related opportunities in science, technology, mathematics, and engineering (STEM) contexts. Through retrospective interviews with 40 STEM graduates working professionally for five or more years in STEM, the data revealed that (1) experiences of racism and sexism among women of color affected their ability to build strong relationships with professors and gain access to career-related opportunities through those connections; (2) white females experienced sexism from faculty, but their white privilege buffered the negative effects associated with their gender and allowed them to form closer connections with faculty; (3) being exposed to diverse faculty facilitated conversations between professors and students of color, as well as faculty and female students, about their career pathways in STEM; and (4) the negative influence of race/ethnicity and gender on student–faculty relationships was alleviated, but not eliminated, through research engagement, which in turn expanded students' access to professional opportunities. Grounded on these findings, we provide recommendations for research and practice.

KEY WORDS: *students of color, women, social capital, social ties, student–faculty interactions, STEM, postgraduation, career outcomes*

1. INTRODUCTION

The interactions that students have in college with their professors play a key role in their college experiences (Astin, 1993; Crisp, 2010). Establishing close and positive relationships with faculty is linked with key academic outcomes such as developing cognitive skills, increasing academic competence, enhancing interpersonal skills, and defining career aspirations (Campbell and Campbell, 1997; Kim and Lundberg, 2016; Komarraju et al., 2010; Kuh and Hu, 2001; Pascarella, 1980). In contrast, when students have bad experiences with professors, their academic self-efficacy and performance are negatively affected, hurting their overall college experiences (Cole, 2010; Cotten and Wilson, 2006). In some cases, negative student–faculty interactions can even deter students from pursuing their originally intended majors or completing a degree (Hearn, 1988; Vogt, 2008).

While in theory every student has access to professors, research shows that students of color and women do not obtain the same benefits from their relationships with professors as their white and male peers (Carlone and Johnson, 2007; Kezar and Moriarty, 2000; Sax et al., 2005). These trends are particularly pronounced in science, technology, mathematics, and engineering (STEM) contexts, where students of color and women encounter marginalization in the classroom and are subject to discrimination from faculty (Chang et al., 2011; Creamer et al., 2008; Espinosa, 2011; Park et al., 2020; Rosser, 2004; Seymour, 1995). Previous qualitative studies have documented these unfortunate trends by studying samples of students of color in STEM (e.g., Burt et al., 2018; McGee and Martin, 2011), drawing attention to their unique experiences. Some research has also exposed experiences of marginalization at the intersections of race and gender for women of color, illuminating "the double bind" that these women encounter while pursuing their STEM degrees (e.g., Dortch and Patel, 2017; Espinosa, 2011; Ong et al., 2011). These studies are critical in highlighting the negative conditions experienced by students of color in STEM settings but leave some questions about how the experiences of students of color compare and contrast with their peers of different backgrounds. Being able to compare and contrast the experiences of racially minoritized STEM students and majority-status students (white and East Asian American) within the same investigation allows for a closer examination of structural issues affecting students' collegiate experiences and outcomes. Monoethnic/racial samples amplify the distinct experiences of certain ethnic/racial groups, an important contribution, but may limit opportunities for cross-race comparisons.

We propose that studying the experiences of students of color *alongside* majority-status students can shed new light into the dynamics of inequality that affect student–faculty interactions and relationships, as well as the potential differential payoffs that groups receive relating to career opportunities. By providing multiple points of contrast between students' race/ethnicity, gender, and the intersection of these two social identities, our inquiry seeks to probe deeper into the underlying mechanisms that drive inequality in STEM. Furthermore, we contribute to the literature by studying a sample of STEM graduates who have been working in the field for at least five years, enabling us to uniquely examine the link between undergraduate experiences and participants' transition to the STEM workforce or graduate education from a retrospective standpoint. Most research on student–faculty interactions focuses on student samples, limiting opportunities to understand what happens after college and as STEM college graduates navigate their professions. Our retrospective approach illuminates how relationships with faculty have implications beyond the undergraduate years and exposes the influence that race/ethnicity and gender have on access to career-related opportunities.

2. RESEARCH QUESTIONS

The purpose of this qualitative study is to understand how race/ethnicity and gender influence student–faculty relationships and how such relationships may facilitate or con-

strain access to career-related opportunities in STEM. Through retrospective interviews with 40 STEM graduates, we seek to answer the following research questions:

1. How do race/ethnicity and gender influence the relationships STEM students are able to develop with faculty?
2. To what extent do race/ethnicity and gender influence the access STEM students gain to career-related opportunities through their relationships with faculty?

2.1 Literature Review

In this section, we provide an overview of the literature focusing on the experiences of students of color and women in STEM settings, and on the role that race/ethnicity and gender play in student–faculty interactions and relationships within STEM contexts. We follow the literature review with an overview of the theoretical foundations guiding this investigation.

2.2 Experiences of Women and Students of Color in STEM

Research centering the experiences of STEM students has grown for the past 15 years, uncovering how students navigate various STEM environments and the factors that impact academic outcomes, such as retention and graduation. Within this body of literature, numerous studies have focused on women and students of color, documenting their distinct educational pathways and the unique challenges that they face (e.g., Carlone and Johnson, 2007; Dortch and Patel, 2017; McGee, 2013). While the metaphor of a "leaky pipeline" is often used in STEM environments (Foor and Walden, 2009; Packard, 2016), scholars have found that students of color and women in STEM are not just "leaking out" *ad hoc* but that they are in a way being pushed out due to systemic issues, such as racism and sexism (Dortch and Patel, 2017; Park et al., 2020; Xu, 2017). Foor and Walden (2009) found that part of these systemic issues in engineering are the societally prescribed notions of the field being more fitting for men than for women. Likely resulting from these dominant perceptions, women and students of color in STEM often encounter "chilly climates" and are subject to marginalization from peers and professors (Dortch and Patel, 2017; McGee, 2013; Strayhorn et al., 2013). This not only affects their academic outcomes but their overall career trajectories, because they are more likely than white and male students to change their majors early in their college years and leave STEM fields altogether (Seymour and Hewitt, 1997; Xie and Shauman, 2003). This attrition is consistent in the United States and in European countries (Borrego and Bernhard, 2011). Though significant amounts of research validate this information, some research indicates that white students and students of color have similar STEM major attrition rates (Ohland et al., 2008).

Research has demonstrated that among STEM students, women are less likely to be academically satisfied than their male peers and that their academic dissatisfaction is often associated with the unwelcoming climate that they typically have to navigate (Amelink and Creamer, 2010; Gayles and Ampaw, 2014; Ong et al., 2011). Seymour (1995)

found that women in STEM classes often felt excluded by their professors from class activities, which negatively impacted their academic experiences. They felt that male faculty disapproved of their presence in STEM classrooms, which led many of them to switch out of STEM majors despite their career aspirations (Seymour, 1995). Similarly, Amelink and Creamer (2010) found that the academic satisfaction of female students in STEM was correlated with how they developed relationships with their peers, as well as the respect they received from faculty.

Among the factors contributing to the negative experiences of women in STEM are the competitive, individualistic, and male-dominated nature of STEM contexts (Cheryan et al., 2017; Diekman et al., 2015; Lee, 2002; Reyes, 2011; Seymour, 1995; Seymour and Hewitt, 1997). This not only affects how female students think about their academic and professional aspirations but how they develop a science identity and persist in STEM (Carlone and Johnson, 2007). For example, in a study that examined the gender gaps in participation among several STEM majors, Cheryan et al. (2017) found that women had lower participation in computer science, physics, and engineering disciplines. This was linked in part with the "masculine cultures" (p. 6) associated with the majors, making it more difficult for women to develop a sense of belonging and see themselves as fitting in (Cheryan et al., 2017).

Negative stereotypes about women in STEM fields, such as them having lower academic abilities than men, as well as the phenomena of stereotype threat (being afraid of reinforcing negative stereotypes), also influence the experiences of female students and, specifically, women of color in STEM (Beasley and Fischer, 2012; Smith et al., 2007). For example, women in mathematics are often inundated with the stereotype that math ability is innately stronger in men; this leads to women experiencing an eroded sense of belonging in mathematics (Good et al., 2012). Unsurprisingly, Black women are often described as facing a "double threat" due to their membership to multiple minoritized groups (Brown, 2000). They can also experience stereotype threat if they detect any salience of the stereotype being perpetuated in their environment (Steele and Aronson, 1995). Intersections of racism and sexism continue to present significant and unique challenges to these women (Ong et al., 2011). Some of these hurdles include finding peer study groups (Justin-Johnson, 2004) and establishing a sense of belonging within and outside STEM settings (Dortch and Patel, 2017). For example, Dortch and Patel (2017) found that Black women pursuing STEM majors experienced microaggressions on a regular basis, resulting in feelings of self-doubt about their academic aptitude.

Moreover, various scholars have found that students of color in STEM settings experience feelings of isolation and lack of sense of belonging, regardless of their gender identification (Cole and Espinoza, 2008; Strayhorn et al., 2013). This is related to being one of the few students of color in their majors and encountering tokenization, stereotyping, microaggressions, discrimination, and cultural incongruity in STEM contexts (Carlone and Johnson, 2007; Chang et al., 2011; Cole and Espinoza, 2008; Hurtado et al., 2007; Johnson, 2007; Ong, 2002). Due to their underrepresentation in STEM classrooms, students of color often feel pressured to prove that they are intelligent and competent because their academic performance and actions can be generalized and used

to reinforce negative stereotypes about racial minorities (Chang et al., 2011; McGee and Martin, 2011). For example, McGee and Martin (2011) found that Black students in engineering and math majors felt the need to prove people wrong by excelling academically in their classes. In another study by McGee et al. (2017), they found that stereotypes that portray Asian/Asian American students as high achieving and as model minorities added stress to students as they made decisions related to their STEM majors. A large number of students in this study spoke about how they were encouraged to pursue STEM majors because there is a dominant perception of Asian/Asian American students being good at science and math. While Asian/Asian Americans are generally not underrepresented in STEM writ-large (although Asian American women may be), McGee et al.'s (2017) work speaks to the pressure imposed on a student population due to racialization.

2.3 Student–Faculty Interactions in STEM

The positive outcomes associated with student–faculty interaction are well established in higher education literature (Cole, 2010; Crisp, 2010; DeAngelo, 2014; Kim and Conrad, 2006; Kim and Sax, 2009). Specifically, positive and close relationships developed between college students and faculty strengthens retention and graduation rates, as well as college GPA within and outside STEM contexts (Barnett, 2011; Cole, 2010; Comeaux, 2008; Crisp, 2010; DeAngelo, 2014; Flynn, 2014; Gayles and Ampaw, 2014; Jones et al., 2010; Kim et al., 2009; Tovar, 2015; Vogt et al., 2007). Additionally, a few studies have uncovered how engaging in undergraduate research with a faculty member can make a difference in students' educational pathways and shape the graduate school aspirations of STEM students (Eagan et al., 2013; Posselt et al., 2018; Strayhorn, 2010).

Some formal settings for interaction include the classroom, office hour visits, or a professor's laboratory (Astin, 1993). Informal contexts may include campus programs through cocurricular student involvement or community service opportunities. While favorable individual interactions between students and faculty can support the academic achievement of students and allow them to build meaningful connections (Astin, 1993; Pascarella, 1980; Santos and Reigadas, 2004), some students have negative encounters with faculty and/or may feel intimidated by their professors (Vogt, 2008). Such interactions may be detrimental to academic performance and satisfaction (Chang, 2005; Pascarella and Terenzini, 1991, 2005).

Research shows that not all students experience the benefits typically associated with student–faculty interaction and that students' race/ethnicity and gender may influence whether they have positive or negative relationships with professors (Kim, 2010; Kim and Sax, 2009, 2011, 2014). Women and students of color are likely to receive the least positive interactions with faculty in both formal and informal settings (Lee, 2002; McGee and Martin, 2011; Ong et al., 2011; Seymour, 1995). For example, Hurtado et al. (2011) found that students of color enrolled at predominantly white institutions (PWI) perceived STEM faculty as uncaring, distant, and inaccessible. Furthermore, women in STEM repeatedly describe their interactions with professors as cold and unreceptive,

which discourages them from fully participating in classroom discussions (Amelink and Creamer, 2010; Chang et al., 2011; Crawford and MacLeod, 1990; Dortch and Patel, 2017; Johnson, 2012; Ong et al., 2011). Some women even report a decline in health from encountering conversations with condescending or unsupportive faculty (Sax et al., 2005). On the other hand, receiving faculty support and perceiving professors as accessible has the potential to strengthen the experiences of women in STEM (Xu, 2016).

Recent literature focused on student–faculty interactions within STEM contexts illuminates some of the inequities that students of color continue to face during their college years. Park et al. (2020) found that Black students have the lowest retention rates within STEM majors, even though they are more likely to ask questions regarding course materials during and after class, as well as during office hours. In addition, compared to students of other racial/ethnic backgrounds, Black students were most likely to report encountering discrimination from faculty members (Park et al., 2020). These findings imply that Black students are increasingly exposed to negative interactions with faculty, which consequently impacts their retention and academic success in STEM (Park et al., 2020).

This body of research demonstrates how positive and negative student–faculty interactions can affect the academic outcomes and experiences of women and students of color within STEM contexts (Hurtado et al., 2011; McGee and Martin, 2011; Ong et al., 2011). However, student–faculty engagement has rarely been studied in multiracial and multigendered samples that enable for the direct comparison of experiences between different groups. Such a focus can help clarify if and how race/ethnicity and gender influence the way that student–faculty interactions expand or constrain access to career-related opportunities among STEM students. Since the relationships that STEM students form in college with professors have the potential to meaningfully impact their postgraduation plans (Posselt et al., 2018), it is critical to understand the complexities and the conditions that influence students' ability to gain access to career-related opportunities beyond college through their connections with faculty.

3. THEORETICAL FOUNDATIONS

In this paper, we use the concepts of social ties—the connections that people have among each other (Granovetter, 1973)—and social capital—the valuable resources and information that are exchanged within networks of social ties (Bourdieu, 1986; Dika and Singh, 2002)—in combination with the intersectionality lens associated with critical race theory (Crenshaw, 1989, 1991; Crenshaw et al., 1995; Delgado and Stefancic, 2012). By combining these two theoretical lenses into one conceptual framework, we are able to examine the influence of multiple social identities, such as race/ethnicity and gender, on STEM students' access to career-related opportunities through their relationships with professors. In this section, we provide an overview of key concepts associated with both theoretical approaches and explain how they have been integrated to inform the data analysis process in this study.

3.1 Social Ties and Social Capital

Social ties are the connections that people have among each other, which can occur individually or within larger networks (Granovetter, 1973; Wasserman and Faust, 1994). When these social relationships lead to professional and economic advancement opportunities through the exchange of information and resources, they are often referred to as social capital (Bourdieu, 1986; Dika and Singh, 2002). Social capital can also be defined as an "investment in social relations with expected returns" (Lin, 2002, p.19). The expectation is that an individual who invests time and energy into building and fostering a relationship with someone can result in gaining a "profit" from such connection (Lin, 2002). Lin (2002) conceptualizes four key forms in which profit from social capital investment occurs. The first form of profit is information; through social capital, an individual can gain important information they may otherwise not garner without the appropriate social ties. The second form of profit is social influence, which can lead to bolstering an individual's ability to persuade others for personal or professional gains (Lin, 2002). The third form of profit is social credentials, which can result in an individual gaining access to exclusive resources through their social networks. The final form of profit through social capital investment is reinforcement of identity and resources. Reinforcement of an individual's worthiness through their social connections helps them to maintain their access to various resources. Also, reinforcement through the public acknowledgment that an individual is a member of certain social groups preserves their mental health (Lin, 2002).

Importantly, social capital is unevenly distributed throughout society. "Inequality of social capital occurs when a certain group clusters at relative disadvantaged socioeconomic positions, and the general tendency is for individuals to associate with those of similar group or socioeconomic characteristics" (Lin, 2000, p. 787). Considering that women and people of color are often categorized as disadvantaged groups in STEM, experiencing marginalization inside and outside of the classroom (Cole and Espinoza, 2008; McGee and Martin, 2011; Strayhorn et al., 2013), the isolation that they experience in STEM likely leads to an uneven distribution of social capital. In STEM education settings, social networks contain important resources that students need to successfully navigate higher education and professional settings, from the support of study groups to the connections needed to land a job (Espinosa, 2009; Grandy, 1998). Faculty, preprofessional associations, lab partners, friendship groups, and colleagues and mentors from internships or coops are important sources of social capital (Chang et al., 2014). In particular, social capital in the form of mentors, institutional agents such as academic advisors, and supportive peers are critical to the academic and professional success of women and students of color in STEM, given their underrepresentation in most contexts (Chang et al., 2014; Ellington, 2006; Johnson, 2007; Ong et al., 2011). These contacts can help women and students of color gain access to exclusive information and opportunities through social influence and credentials within their social networks (Lin, 2002). However, research shows that not all students have the same access to forms of social capital that include connections with faculty and peers because the formation of social

ties is influenced by race/ethnicity and gender (Carlone and Johnson, 2007; Feeney and Bernal, 2010; Hurtado et al., 2011; Ong, 2002); this in turn, can exacerbate the uneven distribution of social capital (Lin, 2000).

Furthermore, existing literature also demonstrates that experiences of discrimination with professors mediates the otherwise positive outcomes of student–faculty interactions among STEM students of color, such as higher GPA (Park et al., 2020), which can turn into social capital by helping students qualify to professional internships and other career-related opportunities. The connections that STEM students are able to develop with faculty should not be underestimated since they have the potential to promote or block students' access to professional opportunities through letters of recommendations or sponsorship and must not be overlooked in STEM education research. Knowing that racial/ethnic and gender student characteristics influence how STEM students develop relationships with faculty in unequal ways (Cole and Espinoza, 2008; Ong et al., 2011; Vogt, 2008), we seek to probe deeper into these dynamics by incorporating the intersectionality framework associated with critical race theory into our theoretical foundations (Crenshaw, 1989, 1991; Crenshaw et al., 1995; Delgado and Stefancic, 2012).

3.2 Intersectionality

Critical race theorists place race at the center of their discourse, but they also acknowledge the multiple social identities people hold and discuss how those identities intersect and shape people's experiences with power and oppression (Delgado and Stefancic, 2012). As an original tenet of critical race theory that evolved to be its own theory, an intersectionality framework allows us to acknowledge that racism is endemic in U.S. society and within educational contexts, and that racism along with other intersecting systems of marginalization (e.g., sexism and classism) distinctively affects people based on their multiple social identities (Crenshaw, 1989, 1991; Crenshaw et al., 1995; Delgado and Stefancic, 2012; Zamudio et al., 2011). Based on existing research that documents how students of color and women in STEM experience inequities (Beasley and Fischer, 2012; Chang et al., 2014; McGee, 2013; Ong et al., 2011), in this study we focus solely on the intersections of race/ethnicity and gender. Through this focused approach, we seek to deeply analyze the intersecting structural issues affecting women and students of color in STEM in comparison to majority-status students (e.g., white, East Asian American, men).

Using an intersectionality framework, in combination with the concepts of social ties and social capital, provides a unique platform for us to examine how participants' relationships with faculty were influenced by their race/ethnicity and gender, and how those connections with professors affected their access to career-related opportunities in STEM in unequal ways. For example, based on existing research, at the start of the study we posited that participants of color could speak about experiences of discrimination with professors based on their ethnic/racial background, which may have hindered their access to career-related opportunities. In addition, we theorized that women of color in particular could recount incidents of marginalization based on *both* their ethnic/

racial background *and* their gender, bringing light to the importance of intersectionality theory. Without an intersectional lens, the unique experiences of participants, such as women of color, resulting from interlocking systems of oppression could have been overlooked.

In addition, this conceptual framework creates an opportunity for us to deeply interrogate how racial/ethnic and gender inequalities have an effect beyond higher education settings and academic outcomes. Through this conceptual lens, we can examine and expose the extent to which relationships with faculty unevenly influence the access of STEM students to career-related opportunities based on their social location. Finally, through this theoretical approach, we seek to challenge master narratives that portray students of color and women in STEM as underachieving and less successful in their careers than their white and male counterparts by focusing on the systemic oppression affecting their experiences in STEM educational contexts.

4. POSITIONALITY STATEMENT

Among the most important considerations that qualitative researchers must contemplate as they design their studies is how their lived experiences and epistemologies influence the process of data gathering and analysis, as well as the entire approach to an investigation (Guido et al., 2010; Rohleder and Lyons, 2014). All authors are people of color and underrepresented in our professional field as Latinx and Asian American scholars; two of us are women and one is a man. Throughout our personal and professional lives, we have experienced different forms of racism, sexism, bigotry, and other direct or indirect manifestations of biases. However, these negative experiences have been distinctive based on our individual intersecting racial/ethnic and gender identities, as well as other social experiences grounded in our social class and immigrant generation, among others. As a result of personal lived experiences and our prior research examining issues of discrimination within higher education settings, we are aware of how power, privilege, and oppression operates in the United States. Thus, we seek to interrogate these structures as critical scholars. However, in this investigation, we aimed to understand these systemic issues from participants' experiences and not our own. Engaging in reflexivity throughout the study helped us enhance the trustworthiness of the research. In particular, via memos and peer-debriefing sessions, we were able to decrease potential biases and understand participants' insights from their perspectives through the data collection and analysis process (Elo et al., 2014; Lincoln and Guba, 1985).

5. METHODOLOGY

In this study, we employed a qualitative methodology and multiple case study research design (Merriam, 2001; Yin, 2014) to understand how race/ethnicity and gender influenced student–faculty relationships in STEM, particularly in relation to students' access to career-related opportunities, among 40 participants. The participants were 40 STEM graduates working in diverse STEM fields for at least five years. Through a purposeful

sampling method (Merriam, 2001), we recruited STEM graduates instead of university students so they could speak about their undergraduate experiences in retrospect. This retrospective approach allowed us to examine how student–faculty relationships facilitated or hindered participants' access to career-related opportunities at the time of their graduation and through the early years of their STEM careers. This sampling method resulted in information-rich cases related to the purpose of this investigation (Merriam, 2001) and created unique opportunities to contribute to STEM education literature. Most research focused on student–faculty relationships does not examine how student–faculty relationships affect students beyond college settings, limiting the scope of understanding we have in STEM education research about such connections.

A qualitative methodology allowed us to gain an in-depth understanding of the phenomenon under investigation—the influence of race/ethnicity and gender on access to career-related opportunities via student–faculty relationships from participants' perspectives (Merriam, 2001). A case study research design provided an opportunity to consider different contextual conditions that may have influenced participants' experiences in STEM (Yin, 2014). In this investigation, each participant is a case (Stake, 1995) experiencing and representing the phenomena under study. We decided to consider each participant a bounded case to engage in an in-depth investigation of how participants experience and are influenced by the boundaries around the case phenomena of interest in this study (Mills et al., 2010). We specifically examined the different contextual factors influencing participants' experiences in STEM separately, since each participant was conceptualized as a case, and then conducted a cross-case analysis (Yin, 2014). Examples of different contextual factors include racial/ethnic background, family life, peer interactions, and student–faculty relationships. By treating each participant as a bounded case first we were able to more thoroughly understand the phenomenon under investigation and if the different phenomena were transferable or relatable to others of similar backgrounds (Mills et al., 2010; Stake, 1995).

5.1 Sample Description

We interviewed 40 STEM graduates living the District of Columbia, Maryland, and Virginia (DMV) metropolitan area who had been working in STEM careers for at least five years. We recruited half of the participants through various STEM professional organizations' mailing lists (e.g., National Society of Black Engineers, Latinos in Information Sciences and Technology Association, The Society of Asian Scientists and Engineers, Society of Women Engineers, American Chemical Society); the rest were recruited through snowball sampling techniques (Patton, 1990). Our sample was racially diverse, consisting of Black/African American (n = 12), Latina/o/x (n = 9), Asian/Asian American (n = 9), and white (n = 10) participants. Out of the 40 participants, 57.5% were women (n = 23) and 42.5% were men (n = 17). In each of the racial groups, we had a minimum of five women. Fifty percent (n = 20) of our participants had degrees in various engineering disciplines, 25% (n = 10) had degrees in the sciences, such as biology and physics; 10% (n = 4) had technology degrees; and 7.5% (n = 3) had gradu-

ated with mathematics degrees. The rest of the participants (n = 3) had college degrees outside of traditional STEM majors but were working in STEM-related careers. For example, one participant was working as an environmental engineer and had graduated with a construction management degree granted by the School of Engineering at his institution. The Appendix contains a table with detailed information on the participants' backgrounds.

In this investigation, to narrow the focus of the study we particularly examined the intersections of racism and sexism within STEM settings and collected information on participants' ethnicity/race and gender. However, since we considered each participant a case and we were interested in contextual factors that may have affected their experiences in STEM (Yin, 2014), we asked all participants to voluntarily submit additional details about their undergraduate and professional experiences via a demographics form. In particular, we asked participants to indicate the year when they had completed their undergraduate degrees, what they did immediately after graduation, and if they had obtained graduate degrees. From these data we learned that the majority of participants (n = 31) had graduated from college between 2000 and 2012. All but one participant indicated their graduation year. Of the 40 participants, 16 indicated that they had earned a master's degree in STEM, and nine had a doctoral degree in STEM. In addition, four participants had earned graduate degrees in a non-STEM field. Finally, 26 participants attained STEM jobs immediately after graduating college, while six participants went to graduate school directly after completing their undergraduate programs. The remaining eight participants listed "other" and did not specify on the demographic forms what they had done after completing their bachelor's degrees. The interviews revealed that most of these participants were unemployed for a period of time.

5.2 Data Collection

All 40 interviews were conducted in-person by the first author from October 2017 to April 2018 in a location chosen by participants. Most interviews were conducted in public places, such as coffee shops and restaurants, and a small number of them were conducted in the participants' office spaces. On average, interviews lasted 60 minutes. All but one interview was audio recorded, since one participant did not grant us consent to record the interview. Through a semistructured interview protocol (Horton et al., 2004), the interviewer was able to expand on participants' answers and incorporate probing questions as needed. The interview protocol included questions about educational and professional experiences, as well as the nature of relationships participants developed during their time in college and as professionals. The protocol was informed by the theoretical foundations guiding the study, as well as previous research related to STEM students and student–faculty interactions. For example, some of the questions we asked participants included: Who were some of the people that you relied on during college for support in your major?, What were your experiences with professors like?, Did you have any particularly positive or negative experiences with professors and what were those like?, Can you share about how you got your first job in STEM after you graduated from

college?, Who has provided you information about jobs, graduate schools, etc. over the years?, and Could you name the five most influential people in your professional development? After all interviews were completed, they were transcribed verbatim by an independent service provider and verified by the research team for accuracy (Poland, 1995).

In addition to conducting interviews, the research team asked participants to submit their résumés or LinkedIn profile links at the time they submitted their demographic information. All but one participant completed this request. As a research team, we received a total of 14 résumés and 25 LinkedIn profile links. Since we employed a multiple case study research design in this study, we were able to gather more than one source of data (Yin, 2014). We opted to collect participants' professional profiles to enhance our understanding about their career trajectories and learn about their overall academic and professional contexts. In particular, the participants' résumés and LinkedIn profiles helped us identify employment gaps as they were transitioning to the workforce after college and learn about their graduate school pathways when applicable. Prior to interviewing participants, the interviewer was able to review and study each professional profile and use it as a grounding to probe further during interviews. After each interview, the interviewer wrote analytical memos, allowing her to make connections between the interview content, the research questions, and the theoretical foundations of the study. These memos also noted the interviewer's general impressions and reflections about the interview content and the résumés or LinkedIn profiles of participants in relation to the purpose of the investigation.

5.3 Data Analysis

To begin the data analysis process, we engaged in inductive and deductive coding techniques (Saldaña, 2016). As a research team, we coded all interview transcripts using the online software platform Dedoose. Each research team member was assigned an equal number of transcripts, and the entire research team contributed to the development of an inductively and deductively derived codebook. The first author served as the codebook editor (Saldaña, 2016), making sure that all codes were unique and clearly defined. Inductive techniques allowed us as researchers to derive emergent or *in vivo* codes through the data analysis process and find patterns among the entire corpus of data (Creswell, 2013). Deductive coding techniques allowed us to include *a priori* codes, derived from the conceptual framework and literature, throughout the coding process (Creswell, 2013). The initial codebook resulted in 222 codes, including subcodes. Some of the codes that were derived through this process included student–faculty interactions, positive experiences with faculty, negative experiences with faculty, insignificant relationships with professors, research engagement with faculty, internship while in college, discrimination, racial identity–centered experiences, and women-centered experiences.

After each transcript was coded line-by-line by a research team member (Saldaña, 2016), the research team met several times to collectively discuss their interpretations of the data. Each participant was conceptualized as a bounded case, representing the

phenomena under study (Stake, 1995; Yin, 2014). This method allowed for in-depth derivation of information regarding participants' experiences (Mills et al., 2010) and the contexts and factors that influenced participants' relationships with faculty and their access to career-related opportunities in STEM. Having multiple bounded cases served as a form of triangulation to increase the trustworthiness of the study (Hastings, 2010). We then engaged in a second round of data analysis by comparing and contrasting initial findings across cases (Yin, 2014). This helped us moved from codes applicable to each case to categories across cases, and from categories to themes that represented the overall findings (Creswell, 2013; Saldaña, 2016). Having multiple researchers engaged in the process of data analysis also served as a form of triangulation because diverse perspectives were used to interpret participants' experiences, and to make sure all appropriate codes were elicited and accurately derived (Hastings, 2010; Merriam, 2001; Yin, 2014). The dataset in this study is rich and vast, so to navigate the challenges associated with multiple data points, we grounded the data analysis process on the research questions and conceptual framework (Yin, 2014).

5.4 Trustworthiness

As described above, to bolster the trustworthiness of the study we engaged in two key forms of triangulation: investigator triangulation and methodological triangulation (Hastings, 2010). Multiple researchers examined participants' interview transcripts and consulted on the creation of emerging categories and themes through peer-debriefing sessions. This investigator triangulation process fosters consistency in the analysis process and minimizes potential bias through collective reflexivity (Hastings, 2010). Our methodological triangulation was instituted through gathering multiple rich cases of information and engaging in cross-case data analysis (Yin, 2014). This process facilitates the identification of similarities and differences among the multiple cases and enhances the quality of information derived during the analysis process (Hastings, 2010).

To further enhance the trustworthiness of the study, after data analysis was completed and the themes were identified, a member of the research team reached out to all participants who were quoted and included in this manuscript to obtain their feedback on the findings. We emailed the manuscript to all participants and asked them if the interpretations we had made about their experiences in STEM were truthful. We asked participants to let us know if they had any concerns about how we were making meaning of their interview comments and presenting their stories. Most participants responded to our inquiry thanking us for sharing their narratives and indicated that what we were presenting in the manuscript matched their lived experiences. A small number of participants did not respond to our request. Only one participant responded asking us to change some of the grammar in her quote, which we did. Engaging in these member-checking techniques increased the trustworthiness of the study and empowered us to move forward with the findings of the investigation (Creswell, 2013).

5.5 Limitations

As with all research, there are some limitations associated with this study. First, due to the purpose and focus of this investigation, we did not collect information from participants on their social identities beyond ethnicity/race and gender, such as socioeconomic class, sexuality, and national origin, among others. We acknowledge that the multiple social identities of participants could have played a role on their interactions with faculty and access to career-related opportunities, so future research would be well suited to investigate these intersections.

Second, it is important to note that we did not collect information regarding where participants were raised or where they specifically went to school based on the focus of this research, but future investigations may consider collecting such information to further explore the influence of contextual factors, such as school location, on participants' experiences. Finally, since we garnered rich and detailed descriptions of participants' experiences in STEM as undergraduate students and as professionals, which required considering past events, we might have dealt with the issue of recall bias (Vianden, 2012). Recall bias entails possible misremembering or misinterpreting events (Vianden, 2012), so to mitigate this issue, we often asked participants to critically reflect on their experiences and share their interpretation of the phenomena they were remembering (Creswell, 2013). While recall bias may have been present in this investigation, the subjective experiences of how participants perceived experiencing issues of racism and sexism is what matters and what is at the center of the research.

6. FINDINGS

The data revealed four important themes about how race/ethnicity and gender influenced student–faculty relationships and how such connections facilitated or constrained access to career-related opportunities in STEM. First, the experiences of racism and sexism among women of color affected their ability to build strong relationships with professors and gain access to career-related opportunities through those connections. Second, white females experienced sexism from STEM faculty, but their white privilege buffered the negative effects associated with their gender and allowed them to form closer connections with faculty. Third, being exposed to diverse faculty facilitated conversations between professors and students of color, as well as faculty and female students, about their career pathways in STEM. And fourth, the negative influence of race/ethnicity and gender on student–faculty relationships was alleviated, but not eliminated, through research engagement, which in turn expanded students' access to professional opportunities. In this section, we present each of these four findings.

6.1 Experiences of Racism and Sexism among Female Students of Color

In discussing how racial/ethnic and gender identities influenced how STEM graduates associated with faculty when they were pursuing their degrees, we found that women

of color (WOC) experienced significant challenges in building relationships with professors in STEM settings due to instances of overt and subtle discrimination. Several WOC in our study recalled occurrences of racism and sexism that they experienced from faculty and teaching assistants (TAs). In particular, the data revealed that WOC were subject to discrimination that manifested in the way faculty evaluated their academic work and classroom performance. Felicia,* a Black woman who completed a degree in mechanical engineering, talked about more than one negative experience she encountered with faculty; she said:

> *I remember we had an exam and I had the same exact work, the same exact answer as one of my [white peer] colleagues and my professor's assistant wrote on my paper 'So, you don't know what you're doing.' And I was like, you could have just said it was wrong, you didn't have to express how you felt. And I took it to the professor, and I was thinking, this is not good for you [herself] to do. You [herself] could get a worse grade. But said [to the professor] 'Look at his work [white peer] and look at mine. It is the exact same thing. It looks like we may have cheated. How is it that his overall score is an 84 and mine is a 52?'*

After that conversation, the professor changed Felicia's grade to an 80, but she continued to face similar issues in other classes. Felicia kept advocating for herself and even filed official complaints against her professors with the Office of Diversity and Inclusion and other departments on her campus. She once had to go through a grade change process that took over a year because she received a failing grade in a class when she had gotten an A in her final exam and had turned in all her work on time. After the long process, the professor changed her grade to a B, but those experiences took a toll on Felicia's well-being and made her question if persisting in college and in STEM "was worth it." Felicia felt discouraged by the multiple negative encounters she had with STEM professors, which distanced her from them and created barriers to the social capital investment profits she could have gained through them (Lin, 2002), particularly in relation to information about internships and career-related opportunities. Instead of going to STEM faculty for professional guidance, Felicia relied on the Office for Minority Student Affairs, who helped her connect with prospective employers and also assisted her through the grade appeal process. Upon graduation, Felicia did not have a job and did not think she could ask her professors for career advice due to her negative experiences with them.

Reyna, a Latinx female who majored in computer telecommunications engineering, also talked about her academic work being graded unfairly by a STEM professor. She commented:

> *So, it's me and this kid. He [white professor] partnered me up with this kid who was an international student. He was from China. He was an exchange student*

* All participants' names have been changed for privacy.

> *for a year. And so, it was me and him [Chinese student]. He did computer science. He did the same project for computer science, the same exact project, and I did the same exact project for electrical engineering. We submitted the same exact report. We both cowrote this report, it was like 30 or 40 pages. At the end, my report was double what his was. He got an A. I got a D. And I was like so mad. I even went to the dean and I was like, 'How is this fair?'*

Unlike Felicia's case, Reyna's grade was not altered even after filing an official complaint against the professor with the dean's office. Reyna spoke about two more instances when she perceived that that she was given worse grades than her peers, and she believed that it was based on both her racial/ethnic and gender identities, reflecting how intersectional systems of oppression influence a WOC experience (Crenshaw, 1989, 1991). Reyna expressed her frustrations and shared how she was still affected by those negative interactions with her professors even as a professional. She mentioned experiencing "imposter syndrome" (Clance and Imes, 1978) as a result of those interactions, which affected her as she was searching for career-related opportunities. Reyna was unable to secure a job for months after graduation and perceived that her diminished self-efficacy influenced her postgraduation outcomes. Reyna said that she did not stay in touch with any of the faculty at her institution after graduation because she had "terrible" experiences with most of them; this lack of student–faculty relationships was especially challenging when she was seeking graduate school admission. She had not invested in social capital development as a result of negative experiences with professors, so she could not profit from the influence and credentials of such connections (Lin, 2002). Luckily, Reyna was able to rely on her professional networks and obtain the required recommendations to apply to graduate school and keep growing professionally in STEM.

Similarly, Ebony, a Black woman who graduated with a degree in computer information systems, mentioned that there were instances during her undergraduate years where she had to "defend [her] grades or defend [her] work." Ebony shared that when she started college, she quickly realized that there "was not as much help [from faculty], or not as much grooming or nurture as there was for other [white] students." She explained:

> *So, my professors didn't relate much. I can't tell you any of my professors in my undergrad. But I did find that the majority of them were white male and they related better to the white males in the class . . . . I definitely recognized the camaraderie outside of myself in those classes and I was like, it's fine. As long as I'm doing what I need to do, if I have an issue then I would approach, but I was okay with being just a number in the class and making sure that I was doing what I needed to do.*

These experiences led Ebony to maintain distant relationships with her professors and mostly communicate with them via online platforms. Anytime she needed to ask her STEM faculty a question about class, she would email them instead of attending office hours since she did not feel connected to them. From Ebony's perspective, not having

strong relationships with faculty did not affect her much because she was still able to obtain information about class when she needed it, and gain details about professional opportunities through other college resources, such as the Career Center.

In addition, other WOC participants recounted moments of overt and public discrimination from faculty during their undergraduate years that negatively influenced their relationships with them. Natalia, a Latinx female who graduated with an electrical engineering degree, spoke about one of her white male professors making biased jokes about her; she said:

> *There was this particular professor that was very outspoken. He thought he was just making jokes, but he would pick a lot on me. He would say, 'Natalia, it's okay. In case this [engineering degree] doesn't work for you, you can marry anyone from this classroom.'*

Natalia also recalled another instance when the same professor made a similar statement in front of an entire classroom of STEM students. She remembered how the faculty member said that she was "very smart" because she was surrounding herself with engineers that she could marry if she did not become an engineer herself. These comments pushed Natalia to distance herself from her professor, who was well-regarded in the engineering field. She continued, "I didn't feel comfortable to even go to his office and ask him a question, because in my head I was like, oh, he's going to think I'm dumb." Instead of seeking support from her professor when she had questions about class content, Natalia asked a close family member, who had an engineering background, to help her. From her perspective, Natalia would rather miss out on the benefits of her student–faculty relationship than be the subject of further jokes about her ability to become an engineer due to her gender and racial/ethnic identities. After graduating with an engineering degree, Natalia struggled to find a job and felt discouraged to ask faculty at her institution to help her examine potential career options.

While several WOC recalled negative experiences with faculty, we think it is important to note that not all WOC in the study articulated that they encountered discriminatory experiences with their professors. For example, Lynn, an Asian/Asian American woman who graduated with a degree in civil engineering, did not develop close connections with faculty members but did not recall any negative experiences either. Surprisingly, very few men of color in this study spoke about encountering discrimination and microaggressions while undergraduates; hence this is not a theme in this investigation. In addition to WOC experiences with intersecting structures of inequality such as sexism and racism (Crenshaw, 1989, 1991), the experiences of white women were also distinct and noteworthy when analyzing all participants' cases.

6.2 White Privilege among White Female Students

In analyzing the relationships that participants were able to develop with their professors, we found that to an extent, being white (or having white privilege) lessened some

of the negative experiences of white female participants in STEM contexts. Our data shows that in contrast to the large number of WOC who experienced both sexism and racism from faculty, many white female participants felt supported and comfortable with their professors in formal and informal settings, in spite of being underrepresented due to their gender. When speaking about her experiences with faculty during her undergraduate years, Cathy, a white female participant who graduated with an architectural engineering degree, said:

> *It [STEM college experience] was really nice because the faculty was more hands-on, and they knew all the students. So, it was easy to feel comfortable to ask them questions and then also go to them during their office hours because since it was a smaller college, all the classes were near each other. All the faculty offices were close by. So, it was very easy to talk to them [professors].*

Cathy attributed her close relationships with faculty to the size of her program. She mentioned that although she attended a large public university, her major had about 100 students per year and that about 20% were female, so being part of a smaller community made a difference in her college experiences. Cathy went on to share that most of her faculty were white men and that every student was assigned a faculty mentor for their required capstone project. When talking about that particular experience, she recounted:

> *He [assigned faculty mentor] happened to be one that traveled a lot and did a lot of research, so he wasn't always around, so I tended to go to some other professors too, to ask some questions. But from my classes previously, I was at least comfortable enough to approach him.*

For Cathy, it was not an issue that her capstone advisor was busy because she felt supported by other professors in her program. Through those social ties she was not only able to get her academic questions answered, she also obtained critical information about summer internships and career fairs, which increased her social capital investment returns (Granovetter, 1973; Lin, 2002). Cathy said that professors in her program "would give [students] information about interview questions or how to dress for certain interviews or just the career fair in general." Through these faculty connections, Cathy was able to understand different professional pathways she could pursue and create a plan for her postgraduation endeavors. Before graduating, Cathy secured a job that she perceived to be a good fit personally and professionally.

Similar to Cathy, other white female participants talked about feeling supported academically and professionally by their professors and being comfortable going to office hours when they faced challenges in their courses. Emily, who graduated with a math degree described her professors, most who were also white men, as "amazing at helping" and "very encouraging." She recalled her professors going out of their way to help her understand concepts during office hours and spending time with her talking about the next steps in her career. Kristen, who graduated with an engineering science and

mechanics degree, mentioned that she formed "friendships" with some of her professors who were willing to support her through her academic and career struggles. At the time of her interview, Kristen had remained in contact with a few of her undergraduate professors and had met with them when she had visited her campus as an alumnus. Like Kristen, Cathy also talked about remaining connected with her undergraduate professors after graduation and even speaking with them about best practices and innovations within her professional field.

While several white female participants spoke positively about their relationships with professors, a few others talked about experiences of sexism in relation to faculty. For example, Amanda, a white female who studied civil engineering, said: "I'll be honest, there were a few [professors] at the time who were outright hostile to having women in the class so that didn't help the relationship." When asked to expand on her comment about the hostility perpetuated by faculty, Amanda mentioned that some male professors advised women and students of color in STEM to leave the fields altogether. She recalled a male faculty member telling her: "You [she] will never succeed." At the time, Amanda did not know if the professor's comment was related to her gender identity or another reason, but in retrospect, she perceives that the faculty member was being sexist and assumed that because she was a woman she did not have what it takes to be successful in a STEM major. Those negative experiences deterred Amanda from establishing close relationships with faculty, even when she knew those social networks could be beneficial to her (Bourdieu, 1986; Dika and Singh, 2002). Distancing herself from professors led Amanda to miss out on "good opportunities" available to her peers, such as serving as TAs for undergraduate STEM courses, that could have enhanced her relationships with faculty and eventually expand her access to career-related opportunities.

Although a few white female participants spoke about experiences of sexism which were deeply troubling, none of them mentioned that their academic work was actually judged poorly because of their gender identity. In addition, most white female participants were able to develop some sort of connection with faculty during their undergraduate years, which promoted their access to key information about internships, jobs, and graduate school options, and also enhanced their social networks in STEM through their professors' influence and credentials (Lin, 2002). Also, it is important to note that while most white male participants spoke about developing at least one strong relationship with a professor who guided them academically and professionally, not all of them did. Mark, a white male who graduated with a fire protection engineering degree, said:

> *I didn't have much relationships with the professors . . . . But there were a couple that if you stayed late and you had extra questions, you could get them answered. But that was about the extent of it; I didn't maintain much of a relationship with them outside of the classes.*

From Mark's perspective, his relationships with faculty were limited to class matters; he perceived that he could not go to his professors to discuss career-related information. Although Mark did not develop strong social ties with professors (Granovetter,

1973), he did not experience discrimination as the WOC and white female participants did. Overall, these participants' cases demonstrate how their intersecting social identities uniquely influence the interactions they have with faculty in STEM settings and can result in differential access to career-related opportunities based on race/ethnicity and gender (Bourdieu, 1986; Crenshaw, 1989, 1991).

6.3 The Influence of Diverse Faculty on Students of Color and Female Students

In speaking with participants about the racial/ethnic and gender identities of their professors, a large number of them spoke about the noticeable lack of diversity among STEM faculty. For example, Amanda said: "I don't think I ever had a female professor in the engineering school . . . Overall it was fine. I just was never close with any of them [faculty]." Similarly, Emma, a white female participant who completed a geology degree, said: "I don't recall any female professors in any STEM class I took in college." Emma also spoke about having negative interactions with male professors who did not think she could be a geologist and work in the field as a woman. For these participants, the underrepresentation of diverse faculty created barriers to the formation of strong social ties in STEM settings (Granovetter, 1973).

However, when women and participants of color were exposed to faculty of diverse racial/ethnic and gender backgrounds, their experiences were notably different, allowing them to obtain valuable resources and information that positively influenced their access to academic and career-related opportunities (Lin, 2002). Kim, an Asian/Asian American woman who graduated with a chemical engineering degree talked about a close relationship that she developed with a female faculty member in STEM:

> *I did [develop a strong relationship] with one other professor [besides her faculty advisor] who would come in and teach one of the classes that I was really interested in. It was a biotechnology class. And it was a female and she was great; she was really approachable so like even after class I would go and talk to her when I was interested in graduate school. I chatted with her about what are good programs, where are good places to apply or look into for research if I was interested in x, y, z research. So, she was really helpful at that point.*

As noted by Kim, having access to a female faculty member in her field allowed her to seek guidance regarding her postgraduation plans and obtain career-related information (Lin, 2002); in this case it was knowledge about graduate school. A few years after Kim graduated from college, she took into account the female professor's advice and pursued a doctorate in STEM. Kim has a fruitful career working in biochemical research and attributes part of her success to the mentorship she received in college.

Sonya, an Asian/Asian American female who completed a degree in environmental science, spoke very clearly about the positive influence of having a faculty member

with whom she could relate based on social identities. When speaking about her STEM undergraduate experiences, she said:

> *It [STEM major] was hard, but I was very lucky that I had a mentor, in a way. And she was only during my undergrad, but that was when I needed it, looking back. So, during my second year of undergrad, I had to take statistics and I had a female professor who was of [Asian ethnicity] descent and that's what I am, [Asian ethnicity] descent. And she was a phenomenal statistics professor. She was the one who told me that, as a female, I didn't need to be intimidated by statistics or math. And in fact, it was because of her that I ended up loving statistics.*

Sonya mentioned how her father was a STEM professor who held very strong gendered stereotypes, which she had internalized. She recalled how her female faculty mentor would challenge her: "Sonya, why do you believe that you're bad at math? I mean, girls can be good at statistics." Sonya went on to share that because her mentor had a PhD in statistics, she became "a living example" and showed her that women could "be good at physics and at math and at the quantitative side of things." In retrospect, Sonya attributed part of her career success and aspirations to the female faculty member who shared valuable information about STEM career pathways when she needed it the most.

Additionally, Courtney, a Black woman who graduated with a biochemistry degree, spoke about developing a strong relationship with a Black female professor who helped her understand more about her social identities within STEM. Courtney said that her professor taught her "to not be afraid to be Black and present, and to say, 'This is what our experiences are and it's okay.'" For Courtney, this relationship helped her feel confident with her chosen academic and career pathways. After college, Courtney remained in touch with her professor, and now as a medical doctor, she tries to connect with that faculty member for mentorship because she considered her mentor "pivotal" during her college years, creating opportunities for her to see her potential as a Black woman in a STEM field. Another participant, Midori, an Asian/Asian American woman who graduated with a biomedical engineering degree, also spoke about the value of connecting with a female faculty member on campus, even when they did not share racial/ethnic backgrounds. She said: "I was pretty close with her [white female faculty] . . . She was great, and it was nice to see how she balanced her life and things like that." Though Midori did not take any classes with the female professor she talked about, she connected with her through an on-campus student organization that centered the experiences of women in STEM. For Midori, this connection expanded her access to information about how to navigate STEM careers as a woman.

In talking to participants about their relationships with faculty, we also found that those who attended historically Black colleges and universities (HBCUs) and all-women's colleges felt very supported by their professors, indicating the importance of university contexts. Malik, a Black man who switched from computer science to elementary education and was teaching math at the time of the study, attended an HBCU

and shared that he developed a very close relationship with his statistics professor, who was also a Black man. Malik recalled how this faculty member wrote a letter of recommendation for his first job after college and how they frequently talked about his career. For Malik, his professor's influence and credentials within STEM education social networks increased his professional opportunities even after he switched out of his STEM major (Lin, 2002). Similarly, Gloria, a Latinx female who graduated with a neuroscience degree from an all-women's college, spoke about being "mentored by female faculty" early on her college years and finding a strong support network as a STEM female student. Gloria shared that she was part of a group that helped WOC in the sciences, and through that opportunity she was able to connect with a WOC professor in STEM who could relate to her unique experiences and provided her important career advice.

Although not a large number, a few participants of color spoke about building close relationships with white faculty despite their racial/ethnic differences. For example, Kenji, an Asian/Asian American male who moved to the United States for college and graduated with a degree in electrical engineering, said, "All the faculty were very nice." During his undergraduate years, Kenji received several invitations from the assistant dean of the engineering school, who was a white male, to have dinner with him and his family, facilitating opportunities to discuss his professional endeavors. Janae, a Black woman with a science degree described her faculty, most of whom were white males, as "phenomenal" and shared that they wrote letters of recommendation for her when she was applying to medical school. For Janae, these connections positively influenced her career pathway in STEM. These collective accounts show the complex influence of social identities on student–faculty relationships and how race/ethnicity and gender were not always indicative of participants' access to social capital.

6.4 Alleviating the Negative Influence of Race/Ethnicity and Gender on Student–Faculty Relationships through Research Engagement

In analyzing how and whether participants' race/ethnicity and gender influenced their relationships with faculty and consequently the access they had to career-related opportunities through professors, we found that when participants across all racial/ethnic groups and genders were able to engage in research with faculty, they were able to gain valuable career advancement opportunities. However, not all participants were able to conduct research as undergraduates. In particular, participants spoke about how engaging in research with professors helped them to expand their social networks and increase their knowledge about professional pathways. Midori started conducting research in her sophomore year of college with a faculty member, a white male, who had been assigned as her advisor in the engineering school. She recounted:

> *I started doing research my sophomore year. I did research in the lab, and I had a really good experience. I had a great advisor. I had a great graduate mentor . . . . I was able to attend conferences when I was an undergrad, present the re-*

search, and just see the PhD students that I was working with talk to these other people from other institutions and give oral presentations. It was very cool.

Midori's access to career opportunities in STEM expanded through her research engagement as an undergraduate student. She was not only exposed to graduate students and faculty at her university, but also to a vast network of professionals through their social ties and influence on the field (Granovetter, 1973; Lin, 2002). Midori entered directly into a PhD program and worked with the same advisor at her undergraduate institution because she had developed a strong relationship with him. The graduate mentor who worked with Midori in the lab when she was an undergraduate student was also an Asian woman, which Midori described as "great" and "very helpful." In addition to mentoring Midori in the lab, the graduate mentor helped her find a job after her doctorate and provided her critical information about how to navigate the field.

Jamal, a Black man who graduated with a physics degree from an HBCU, talked about how "helpful" it was for him to get involved in research throughout his undergraduate years. In particular, engaging in research allowed Jamal to develop strong relationships with a community of researchers within and outside his campus. During his first year in college, Jamal conducted research with a professor who managed a lab outside of campus, so he traveled with his professor to the research site and spent a significant amount of time with him in informal and formal settings. In addition, with the support of a white female professor who shared internship postings and wrote letters of recommendations for him, Jamal was able to get two more paid research opportunities as an undergraduate student; one of those was in Europe. Jamal shared that these experiences were valuable for him because they exposed him to different career possibilities but that there were other factors that influenced his decision to not pursue a research-focused profession upon his graduation. He said that he "was always the only minority" and that working in a lab was not as "fun" for him anymore, so he decided to work as a physics high school teacher instead.

Similarly, Malcolm, a Black man who also attended an HBCU and graduated with a biology degree, shared that his summer bridge program and undergraduate research exposure helped him think more critically about his career plans. When speaking about the summer bridge program prior to his first year in college, he said: "They took us to [national science organization], around the campus to the different labs, and just kind of exposed us to what research was, as an enterprise, as a future career." As Malcolm approached his senior year, he started considering a master's degree, so he reached out to an advanced science professor and asked him if he could work at his lab to learn more about his research. Instead of bringing Malcolm into an existing project, the professor asked him to draft an original research proposal. Malcolm drafted the proposal and applied to graduate school at the same time, so he ended up working on his own research project under the supervision of the professor while he was pursuing his graduate education. For Malcolm, this was a unique and important opportunity that allowed him to gain experience and information through his relationship with the professor (Lin, 2002), which he used as he searched for professional opportunities. Malcolm now works for

a national organization focused on STEM research and plans to go back to school to pursue a doctorate degree.

While engaging in research alleviated some of the negative influence that participants' racial/ethnic and gender identities had on student–faculty relationships, it did not eliminate occurrences of discrimination from faculty in STEM contexts among women and participants of color. For example, Courtney, who conducted research in a biology lab for years as an undergraduate and generally described her experiences with professors as positive, said:

> *There was, I would say, maybe one or two professors within the chemistry department who definitely made students of color feel quite uncomfortable. He would just make very off-centered remarks. It was always hard to know whether or not they were intentionally malignant. But it was definitely a shared feeling of discomfort among people of color.*

Courtney's experiences reflect the pervasive nature of discrimination within STEM settings and the microaggressions that STEM students of color and women continue to encounter (Dortch and Patel, 2017). Her case demonstrates how engaging in research may help some students develop close relationships with a few professors and expand their access to career-related opportunities through them, but it does not eliminate the prevalence of discrimination from other faculty. Jamal's experience, mentioned earlier in this section, provides another example of how marginalization could coexist with involvement in research. While undergraduate research helped him foster positive relationships with faculty, the feeling of being "the only minority" still influenced Jamal's decision to not pursue a research career.

7. DISCUSSION AND IMPLICATIONS

The data suggests that race/ethnicity and gender notably influenced student–faculty relationships and the access to career-related opportunities that participants obtained through such connections. Integrating social ties and social capital theories with an intersectionality lens into a conceptual framework helped us to examine how race/ethnicity and gender identities together, as well as the interconnected systems of racism and sexism, affected participants' relationships with professors in STEM settings (Bourdieu, 1986; Crenshaw, 1995; Delgado and Stefancic, 2012; Lin, 2002; Ong et al., 2011; Zamudio et al., 2011). With the exception of a small number of WOC in the study, such as Courtney and Midori, the data showed that the majority of WOC participants were unable to gain access to career-related opportunities and information through faculty social ties due to negative experiences with professors. As a result of either explicit or subtle forms of discrimination, many WOC participants did not invest their time and energy into building connections with faculty and limited their exchanges to classroom settings. While participants engaged in retrospective reflections about their undergraduate years, it is important to note that these negative experiences are still occurring in STEM settings

and are consistent with current literature indicating that women experience marginalization in the classroom by both faculty and male peers (Dortch and Patel, 2017; McGee, 2013; Strayhorn et al., 2013). These restricted interactions not only affected how these women experienced college but hindered their access to social capital returns, such as information and influence, that they could have gained through their student–faculty connections (Lin, 2002).

The fact that Felicia, Reyna, and Natalia, who are all WOC, struggled to find their first professional position and chose not to approach their professors for help, is compelling. Despite high demands for STEM professionals nationwide, these women felt lost and insecure about their STEM pathways after college. In part, these feelings could have been caused by their lack of sense of belonging as WOC in STEM fields as prior research suggests (Good et al., 2012) or because they did not have access to social networks, including faculty, who could offer support as they transitioned to the workforce. This finding is significant and raises questions about equity that extends beyond higher education settings because it implies that even when WOC graduate with STEM degrees, they may be less likely to reap the full benefits associated with their education. Existing research also documents that STEM graduates of color are less likely to intend to pursue a career in STEM than their white counterparts (Park et al., 2020), suggesting that inequities experienced during college have implications for entry into the STEM workforce. Future studies could further examine the longitudinal effects of student–faculty relationships in the career pathways of STEM graduates and use additional sources of data, such as ethnographic observations and longitudinal data, to better understand the nature of these interactions.

The stories that WOC shared about how their academic performance was evaluated worse than their peers demonstrated the detrimental effects that those interactions had on them, impacting their undergraduate and career pathways. These experiences extend available literature that documents how women of color experience a "double bind" in STEM settings (Brown, 2000; Dortch and Patel, 2017; Espinosa, 2011; Ong et al., 2011) and illuminates additional manifestations of academic inequities. Interestingly, neither white women, white men, nor men of color talked about their academic work being graded unfairly, bringing attention to a unique form of discrimination that WOC in STEM encounter on college campuses and the significance of intersectionality (Crenshaw, 1995; Ong et al., 2011). In addition, the narratives that WOC shared about advocating for themselves and filing official complaints highlights the additional emotional and psychological burden placed on these women as a result of this form of discrimination (Ong et al., 2011; Seymour and Hewitt, 1997). The WOC in our study were forced to either accept the lower grades they were given or to courageously advocate for themselves, which involved risking relationships with professors. This finding adds to the literature in a unique way by exposing a less discussed but very damaging and demoralizing form of academic discrimination encountered by WOC in STEM that can ultimately lead to lower retention and graduation rates. Being subject to this method of academic discrimination also has implications for the access to career-related opportunities that WOC have because internship and job placement sites often require competitive GPAs and recommendations from professors. Scholars interested in further examining

this phenomenon could conduct case study research within specific STEM contexts, such as engineering classrooms at research universities, to critically examine whether there are significant differences by race/ethnicity and gender in the way the academic performance of students is evaluated.

Our findings also confirm key harmful experiences influencing students of color, such as facing racial/ethnic microaggressions (Carlone and Johnson, 2007; Chang et al., 2011; Cole and Espinoza, 2008; Hurtado et al., 2007; Johnson, 2007; Ong, 2002). Yet, in examining a multiracial sample and providing a comparative analysis, our study goes one step further by highlighting how white privilege manifests among white female students in STEM contexts. While a few white female participants spoke about having negative interactions with some of their professors, they did not feel that their grades suffered as a result of those interactions. In a way, their whiteness acted as a shield that buffered them from the full impact of discrimination and preserved their ability to have relationships with faculty that were not clouded by this particular form of unfair academic treatment. Arguably, for white females in the sample, the protective factor of their race had a stronger influence that outweighed many negative impacts of gender in the relationships that they developed with faculty. As a result, many white women in our study spoke highly about their professors and talked about remaining in contact with them after graduation. By comparing the experiences of WOC and white women in relation to student–faculty relationships through an intersectionality lens we were able to further examine the effects of systemic inequities that extend beyond college as they relate to both race/ethnicity and gender (Crenshaw, 1995; Delgado and Stefancic, 2012). Future research can continue to examine the ways in which white privilege manifests within STEM contexts and may protect students, despite having other marginalized social identities.

Additionally, our findings illuminate the importance of having a diverse STEM faculty, extending previous work that highlights the positive role that female faculty and professors of color can play on STEM students' experiences, sense of belonging, and self-efficacy (Chang et al., 2014; Good et al., 2012; Hurtado et al., 2011; Johnson, 2012). From the participants' narratives, it was evident that simply having access to female professors and faculty of color made a difference in their experiences as STEM students and increased their sense of belonging in the field. Even if participants did not remain in touch with faculty after graduation, they were able to foster closer connections, and these mentors often extended their support beyond the classroom. In some cases, through these informal connections, some participants of color and female participants, such as Kim and Sonya, were able to discuss their postgraduation plans and receive career-related information from professors of similar backgrounds (Lin, 2000). While female participants and participants of color did not speak about negative experiences with diverse faculty, it is important to not assume that negative interactions do not occur between minoritized students and minoritized professors. Future research could further examine the dynamics of student–faculty interactions by race/ethnicity and gender and look into the additional expectations placed on diverse faculty within STEM contexts. If professors of color and female faculty are disproportionately mentoring and serving students of color and female students in STEM fields, they may be more likely

to burn out or "suffer" professionally by not dedicating more of their time to activities typically related to tenure and promotion, such as research (Ford, 2011; Padilla, 1994).

Lastly, our findings also add to the body of literature that explores the benefits of participating in undergraduate research, especially for diverse student populations (Eagan et al., 2013; Hathaway et al., 2002; Posselt et al., 2018; Strayhorn, 2010). Our data emphasizes how through research engagement, students of color and women in STEM may be able to alleviate, but not eliminate, the otherwise negative effects of race/ethnicity on student–faculty relationships. Through research opportunities, some of the participants of color and female participants in our study developed positive and strong connections with faculty members who helped them academically and professionally. For participants, these faculty relationships expanded their access to career-related opportunities and graduate school through social capital returns, such as information and influence (Lin, 2000). Conducting research with professors as undergraduate students also expanded participants' social ties and networks (Granovetter, 1973), such as graduate student mentors who became valuable and additional sources of social capital (Bourdieu, 1986; Lin, 2000). This finding is important because it emphasizes the extent to which positive relationships with professors and graduate student mentors can shape the access that undergraduate STEM students have to career-related opportunities. Unfortunately, undergraduate research experiences are still limited and underfunded on college campuses. Future studies should further explore the factors that deter students of color and women from engaging in research during their undergraduate years (e.g., finances and access). This research can result in a deeper understand of the type of programs and strategies needed to promote research engagement among diverse student populations.

8. CONCLUSION

Overall, our data reveals the degree to which race/ethnicity and gender continue to influence the nature of student–faculty relationships within STEM environments, illuminating how the inequities encountered by people of color and women as undergraduates in STEM affect their access to career-related opportunities beyond college. In particular, through an intersectionality lens (Crenshaw, 1995; Delgado and Stefancic, 2012), our findings show the tangible effects of intersecting systems of oppression (racism and sexism) that disproportionally hindered the access of WOC to career-related opportunities through faculty relationships and professor's networks, influence, and information (Lin, 2000). Further, our work advances the study of white privilege in STEM contexts (Johnson, 2012) by flushing out how white privilege manifests itself within student–faculty relationships.

Additionally, our study brings to the forefront a unique but very harmful form of discrimination encountered by WOC—their academic performance being evaluated unfairly. This less overt manifestation of discrimination raises questions about ethics and equity within STEM educational environments. It also elevates the need for accountability measures within STEM classrooms and demands further examination of professors' grading practices, which may be affected by implicit biases. In particular, knowing that there is a high need for more diverse STEM graduates and professionals in the United

States (Ong et al., 2011; Xu, 2016), it is critical to pay close attention to the mechanisms that may be hindering the academic success and career promotion and retention of women and people of color in STEM settings.

Our research also adds to the critical conversations about equal opportunities and the equalizing effect of attaining a higher education within the broader U.S. society. As demonstrated by our findings, even after successfully completing their undergraduate degrees, women and people of color in STEM contexts are still unable to reap the full benefits associated with their undergraduate education. Structural issues, such as racism and sexism, continue to block minoritized groups' access to valuable relationships and information that they could leverage for career-related opportunities and social advancement (Lin, 2000, 2002). This is distressing and points to the larger need of working collectively toward social and racial justice.

Higher education institutions, as the hubs for knowledge and development, must take the lead in addressing systemic injustices and set the example by first addressing the racism, sexism, and others forms of discrimination manifested within various academic environments. To start, colleges and universities could focus on examining the retention, graduation, and postgraduation patterns of students and disaggregate the data by race/ethnicity, gender, and major. Through these analyses and institutional reports, inequities existing in programs/departments by student characteristics may be exposed, bringing to the forefront opportunities for faculty and administrators to evaluate their own biases and practices.

By comparing and contrasting the experiences of minoritized students with those from dominant groups, this research reveals some of the underlying mechanisms driving major inequities that still exist in STEM contexts by race/ethnicity and gender. It also demonstrates the need for transformation within STEM settings, institutions, and the field of higher education altogether, because the disparities faced within college contexts reproduce and affect inequities beyond college settings. Without these structural changes, women and people of color will continue to experience marginalization within and outside of college campuses based on their social location, so colleges and universities must assume the responsibility of leading national efforts to promote equity and social justice for all.

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APPENDIX

APPENDIX: Participants' race/ethnicity, gender, and STEM field

Race (*n* = 40)								
Black or African American							12	
Asian or Asian American							9	
Latina/o/x or Hispanic							9	
White							10	
Gender (*n* = 40)								
Female							23	
Male							17	
Major Discipline (*n* = 40)								
Science							10	
Technology							4	
Engineering							20	
Mathematics							3	
Other							3	
Race, Gender and Major Discipline (*n* = 40)								
	Black or African American		**Asian or Asian American**		**Latina/o/x or Hispanic**		**White**	
	Female	Male	Female	Male	Female	Male	Female	Male
Science	3	2	1	0	1	0	1	2
Technology	1	0	0	1	1	0	1	0
Engineering	1	3	4	2	3	2	3	2
Mathematics	0	0	0	1	1	0	1	0
Other	1	1	0	0	0	1	0	0