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ORIGINAL ARTICLE

Investigation of an equity ethic in engineering and computing doctoral students

Dara E. Naphan-Kingery[1] | **Monica Miles**[1] | **Amanda Brockman**[2] | **Rachel McKane**[2] | **Portia Botchway**[1] | **Ebony McGee**[1]

[1]Department of Teaching and Learning, Vanderbilt University, Nashville, Tennessee

[2]Department of Sociology, Vanderbilt University, Nashville, Tennessee

Correspondence
Dara E. Naphan-Kingery, Department of Social Science, Western New Mexico University, 1000 College Avenue, Box 680, Silver City, NM.
Email: dara.naphan-kingery@wnmu.edu

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Abstract

Background: Research shows that engineering and computing students who are marginalized by race and/or gender and experience social suffering often wish to challenge social inequities through their vocation, an attribute we refer to as an equity ethic. This study explores how doctoral engineering and computing students develop this attribute even when they do not directly experience social suffering.

Purpose/Hypothesis: We explored the relationship between (a) doctoral engineering and computing students' experiences with social suffering and their development of an equity ethic and (b) their equity ethic and career interests.

Design/Method: We present a thematic analysis of the transcripts of in-depth, semistructured interviews with 18 engineering and computing PhD students, coding for experiences with social suffering, degree of equity ethic, and their career interests.

Results: Students with an equity ethic who aspired to reduce inequities within their disciplines personally experienced or witnessed social suffering within and outside academia. Students with "high potential" for developing this attribute who aspired to help others with their disciplines acknowledged social suffering. While both those with an equity ethic and those with high potential saw inequities as socially caused, those with an equity ethic reported more impactful experiences with social suffering, resulting in greater empathy and responsibility to respond. Several students described neither altruistic nor social justice concerns (students with low potential) and did not experience social suffering directly or indirectly. Those with an equity ethic or high potential often showed interest in academia.

Conclusions: Most participants expressed concerns for helping others in their occupations. This result suggests a nascent equity ethic that could be cultivated through intentional programmatic efforts.

KEYWORDS
career paths, doctoral students, equity ethic, gender, race/ethnicity

1 | INTRODUCTION

Engineers and computer scientists design, create, and control the distribution of critical resources across American society (Leydens & Lucena, 2014) and, thus, shape many aspects of postindustrial life (Cech, 2014). While some scholars argue that

these fields embody a spirit of service conducive to equity and justice (Nasser & Romanowski, 2016; Riley, 2008), many in the United States see engineering as a means to achieve personal financial success and increase this country's economic and technological competitiveness (Committee on Public Understanding of Engineering Messages [CPUEM], 2008). Many 21st-century Americans believe that engineers are less likely than scientists to save lives, less sensitive to social concerns, and care less about their communities (CPUEM, 2008). The National Academy of Engineering has called for the field to make a difference in the world (CPUEM, 2008) and has created a list of Grand Challenges for Engineers, including providing access to clean water and making solar energy economical, emphasizing that "rich and poor alike" must benefit from these advancements (National Academy of Engineering, 2019). However, existing rhetoric does not position engineering as concerned with reducing social inequities (Baber, 2015) that result from having different identities (e.g., race, gender, and sexual orientation) or different status (e.g., socioeconomic) and, therefore, different needs.

Research finds that engineering students marginalized by race and/or gender who experience group social suffering (Dumas, 2013) are likely to challenge social inequities through their careers (Diekman & Steinberg, 2013; Garibay, 2015; Gibbs & Griffin, 2013; Thoman, Brown, Mason, Harmsen, & Smith, 2015). Underrepresented groups in engineering and computing that often experience marginalization due to racial and/or gender identities include Black, Latinx, and Native American men and women, and White and Asian women (Camacho & Lord, 2011; National Science Foundation, National Science Board, 2018; Solórzano, Ceja, & Yosso, 2001). We examined the narratives of a diverse sample of doctoral engineering and computing scholars to explore the relationship between their experiences with social suffering due to race and/or gender (i.e., they experienced it themselves or saw others experience it) and their motivations to reduce inequities through their work. This article was inspired by McGee and Bentley (2017), who examined Black and Latinx undergraduate students in science, technology, engineering, and math (STEM) who wanted to use their careers to combat social inequities, referred to here as an equity ethic shaped by adverse experiences as marginalized students and members of society. We explore here whether these findings extend to doctoral students marginalized by race and/or gender and how students who are not marginalized may develop this attribute. Finally, we examine how students' career interests relate to their equity ethic, or lack thereof.

2 | ENGINEERING AND SOCIAL JUSTICE

Social justice work disrupts systems of targeted marginalization, including "oppressive and/or unequal relationships" and distribution of resources (Kabo, 2010, p. 3). A number of engineering departments, organizations, and programs now offer opportunities that demonstrate how engineering can address social justice concerns (Cumming-Potvin & Currie, 2013; Kabo, 2010; Leydens & Lucena, 2014; Schneider, Lucena, & Leydens, 2009; Vandersteen, 2008): a required engineering ethics course at Texas A&M University (Tucker & Ferguson, 2007); undergraduate and graduate programs centered on social justice engineering such as the B.S. program Engineering Plus (Boise State University, 2018; University of Colorado Boulder, 2018), the Colorado School of Mines' Humanitarian Engineering B.S. program (Colorado School of Mines, 2018), and Drexel University's MS program in Peace Engineering (Drexel University, 2018); NSF-funded projects such as Developing Changemaking Engineers (National Science Foundation, 2015); service-learning opportunities (Bielefeldt & Canney, 2015) such as Purdue University's Engineering Projects in Community Service (Purdue University, n.d.); and organizations such as Engineers Without Borders, Engineers for a Sustainable World, Engineers for World Health (Canney & Bielefeldt, 2015; Vandersteen, 2008), and the Engineering, Social Justice, and Peace Network (Engineering, Social Justice, and Peace, n.d.; Kabo, 2010).

Practitioners and researchers have raised concerns about some well-intentioned social justice efforts. Many researchers caution that "engineering to help" programs often take a deficit approach and primarily benefit students rather than the targeted communities (Grusky, 2000; Kabo, 2010; Nieusma & Riley, 2010; Schneider et al., 2009). Because engineering projects emphasize technical functionality, they often obscure critical dimensions like social power relations, structural constraints, and sustainability (Nieusma & Riley, 2010). When students lack the interdisciplinary coursework necessary to think critically about social justice issues, they are less likely to dismantle underlying social and political systems causing inequity and more likely to provide temporary relief and reproduce the status quo (Kabo, 2010). Thus, some engineering educators propose holistic, equity-based approaches that incorporate social justice throughout the engineering curriculum (Cumming-Potvin & Currie, 2013; Jahan & Mehta, 2007; Kabo, 2010).

2.1 | Disconnect between engineering and social justice

Engineering and social justice are not always seen as compatible (Baber, 2015). Women, who are often socialized to be caregivers and to value communal goals (Diekman & Steinberg, 2013; Schwartz & Rubel, 2005), and marginalized students of color are

generally concerned with helping others and reducing inequity (Gibbs & Griffin, 2013; Jackson, Galvez, Landa, Buonora, & Thoman, 2016). For example, research shows that underrepresented and marginalized engineering doctoral students want to pursue academic jobs to serve as role models for future underrepresented students (McGee et al., 2016). However, STEM majors who want to use their training to help others and disrupt inequities (Espinosa, 2011; Garibay, 2015; Garibay, 2018; Thoman et al., 2015) may be reluctant to work in STEM careers they perceive as unconcerned with equity (McGee & Bentley, 2017).

Research has shown that marginalized students want to mentor students and address issues in their communities (McGee et al., 2016). Less research, such as that conducted by Gibbs and Griffin (2013) showing that White and Asian doctoral students in biomedical engineering cite academic freedom as their motivation to pursue a faculty position, has examined the social justice concerns of engineering students who are not marginalized in their fields. It is important to explore how engineering doctoral students from such majority groups might develop an equity ethic.

3 | EQUITY ETHIC AS A FRAMEWORK

This article focuses on an emerging framework that explains the development of engineering students' equity ethic, a "principled concern for social justice and for the well-being of people who are suffering from various inequities" (McGee & Bentley, 2017, p. 4). This concept is related to concepts such as altruism and social justice. Altruism, a strong regard, motivation, or orientation for helping others regardless of personal benefit (Batson & Shaw, 1991; Pilliavin & Charng, 1990), is colloquially characterized as "giving back" or "helping others." Altruism is distinct from social justice, which entails helping others to reduce social inequities (Kabo, 2010), because it does not reduce inequity by targeting marginalized groups.

We define equity ethic as a psychological attribute characterized by the degree to which an individual's social justice concerns align with their behavior. While altruistic or social justice concerns may or may not be acted on, an equity ethic is a principled concern that is acted on. In this study, our aim was to expand McGee and Bentley's (2017) theoretical framework of how undergraduate STEM students develop an equity ethic by exploring the narratives of engineering and computing doctoral students of various positionalities who exhibited (a) no equity ethic, (b) only altruism, and (c) an equity ethic.

3.1 | Social empathy

Research suggests that individuals can develop an equity ethic regardless of their social positioning, though the process differs according to one's social identity. One line of research shows that individuals can cultivate social justice concerns after developing social empathy, the ability to understand the experiences of different people, communities, and cultures (Segal, 2011; Segal, Gerdes, Mullins, Wagaman, & Androff, 2011). To exhibit social empathy, social actors must show empathy toward individuals; a contextual understanding of the impact of systemic, historical conditions on communities; and a sense of social responsibility—what Segal (2011) refers to as a "prosocial individual perspective that contributes to improving the larger social arena" (p. 267). In the following subsections, we explain how both students marginalized by race and/or gender and those who are not can develop social empathy and an equity ethic.

3.2 | Historically marginalized students' development of an equity ethic

Students who are historically marginalized in engineering and computing are likely to develop an equity ethic because they are likely to experience oppression and discrimination and to recognize inequity and social suffering in similarly situated groups. Unlike personal suffering, which is unrelated to social identity, this term refers to a group's suffering "which inspires a collective imagination of a 'we' who suffer" (Dumas, 2013, p. 6). Those who recognize their collective suffering as structural can develop social empathy by empathizing with their group and other oppressed minorities, developing a contextual understanding of inequity and feeling responsible to effect change. Sirin, Valentino, and Villalobos (2016) found support for their Group Empathy Theory, which posits that because marginalized individuals are tasked with understanding multiple cultures (including their own and the dominant culture), they can identify and empathize with members of other oppressed groups. While Sirin et al. (2016) studied people marginalized by immigrant status and race, the ability to understand multiple cultures also applies to other marginalized groups, like women in engineering. Bonilla-Silva (2018) discusses how White working-class women, who are marginalized by gender and class, are more likely to empathize with oppressed racial minorities than White men or middle-class or upper-class White women. To empathize with others who experience social inequity, it is useful to have similar experiences.

Marginalized students in engineering and computing often endure oppressive environments and hostile terrain (Beasley & Fischer, 2012; McGee, 2016), including overt racism and sexism. Underrepresented individuals in engineering and computing

are often treated as "tokens" or representatives of their social group (Kanter, 1977, p. 37). Their heightened visibility and the pressure to perform well can cause depression and anxiety (Jackson, Thoits, & Taylor, 1995) and can lead to declining performance due to stereotype threat, which is the fear of confirming negative stereotypes about one's group (Steele & Aronson, 1995). Despite having demonstrated success, students who are the "only one" may feel that they must continually prove their worth (Dias-Espinoza, 2015; McGee & Martin, 2011). They also experience microaggressions (Pierce, Carew, Pierce-Gonzalez, & Wills, 1977), which are verbal and nonverbal exchanges that are insulting to people of color, women, and other marginalized groups, including individuals with disabilities and members of the LGBTQ+ community (Burt, McKen, Burkhart, Hormell, & Knight, 2016; Camacho & Lord, 2011; Hughes, 2017; Solórzano et al., 2001).

3.3 | White and Asian men's development of an equity ethic

Although marginalizing experiences can help one develop an equity ethic, this is not automatic, nor do the privileges of majority status preclude the development of an equity ethic. While we position White and Asian women as marginalized and subject to various forms of social suffering because of their gender (e.g., gendered microaggressions and sexual harassment), here we position White and certain Asian men (excluding Southeast Asians and Pacific Islanders, who are underrepresented in STEM; Pak, Maramba, & Hernandez, 2014) as nonmarginalized members of their fields (National Science Foundation, National Science Board, 2018). However, we acknowledge that White and Asian men may experience oppression in other ways (e.g., socioeconomic status and first-generation college status). We also acknowledge that Asian men have different experiences than White men, due to their intersectional race and gender identities (Ong, Wright, Espinosa, & Orfield, 2011) and their being stereotyped as model students naturally gifted in math and science (Sakamoto, Takei, & Woo, 2012; Trytten, Lowe, & Walden, 2012). However, being members of dominant racial and gender groups in these spaces "affords them greater latitude to negotiate and transcend" (Patton & Bondi, 2015, p. 491) most oppression resulting from temporary or perhaps concealed identities. Thus, they may be more likely to develop social empathy and an equity ethic by vicariously experiencing others' social suffering and becoming social justice allies, members of dominant social groups who work to end the oppression that gives them greater power and privilege (Broido & Reason, 2005). This process requires recognizing one's power, privilege, prejudice, and complicity in perpetuating social suffering (Washington & Evans, 1991).

Research suggests that students who are privileged in terms of race and/or gender can develop social justice interests through volunteering or service-learning opportunities where they can witness inequity and learn to link such inequity to larger social forces (Einfeld & Collins, 2008). Such opportunities allow engineering and computing students to understand their privilege and how they can use their knowledge to help others (Bielefeldt & Canney, 2015). By witnessing inequity, understanding the structural factors that cause it, and developing a sense of responsibility to change the situation, majority group students can develop social empathy and an equity ethic. This research explores how students' positioning and experiences relate to their developing an equity ethic and how this influences their career goals.

4 | DESCRIPTION OF THE RESEARCH

The purpose of this qualitative inquiry is to explore the following research questions:

1. What is the relationship between engineering and computing doctoral students' experiences with social suffering and their expressions of an equity ethic?
2. What is the relationship between their expressions of an equity ethic and their career interests?

This work extends research on the development of an equity ethic among racially minoritized undergraduate STEM students (McGee & Bentley, 2017) and work on the development of constructs like social responsibility among undergraduate engineering students that did not account for their racial identities (Bielefeldt & Canney, 2015). We extend this work to doctoral students in engineering who are preparing to take their skills and values into the workforce.

5 | CONTEXT AND METHOD

During the Spring and Summer of 2017, our research team conducted in-depth phone interviews with a sample of engineering doctoral students to better understand their doctoral experiences and career plans, and used thematic analysis to address our questions (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006). We interviewed 18 doctoral students from

10 predominantly White institutions (PWIs) classified as very high research activity (R1) institutions according to the Carnegie Classification System (Indiana University Center for Postsecondary Research, 2017). While all of the team were involved in the data collection, only some participated in the analysis and the writing of this manuscript.

5.1 | Selection criteria

Participants were a subset of respondents to a larger survey ($N = 744$) conducted in 2015 and 2016 on the experiences and career interests of engineering and computing doctoral and postdoctoral scholars; we focus only on doctoral students in this study. The original survey was designed to compare the experiences of Black doctoral students with students in other racial groups, so our recruitment oversampled Black students by recruiting at institutions with Black engineering tenured or tenure-track faculty and at the annual convention of the National Society of Black Engineers. Because the larger sample included people of all races, the sample in this study is diverse, enabling us to examine variations in the development of an equity ethic across diverse students. We solicited 200 of the 744 survey respondents for this study, offering them a $20 gift card.

The 18 participants were those who scheduled, confirmed, and completed phone interviews. Table 1 includes participants' names and institutions (both pseudonyms), their years in their programs, disciplines, race/ethnicity, gender, and citizenship status. Our request for follow-up interviews described our interest in engineering and computing students' doctoral experiences and career interests, particularly for underrepresented groups. Thus, there may be selection bias as those who volunteered may have been interested in broadening participation in engineering and more concerned about equity than the average students.

TABLE 1 Participant characteristics by expression of an equity ethic

	Equity ethic								
Pseudonym	**Rashanique**	**Ashley**	**Braxton**	**Jarod**	**Kerri**	**Lindsey**	**Abhay**	**Hassan**	**Oscar**
Institution pseudonym[a]	ES	SS1	SS3	SS1	SP	WS1	MWS	ST	ST
Year in program	2	2	7	6	2	5	5	6	2
Field[b]	Eng Edu*	Mat Sci	Biomed*	CE & CS	Mech	CE & CS	E&C	EE	Envi*
Race/Ethnicity[c] (%Field[d])[e]	B (2)	B (1)	B (2)	B (1)	W (31)	W (19)	A (6)	ME/W (19)	L (4)
Citizenship[f] (%Field[d])	U.S. (58)	U.S. (46)	U.S. (58)	Intl (67)	U.S. (43)	U.S. (32)	Intl (42)	Intl (42)	U.S. (58)
Gender (%Field[d])	W (30)	W (27)	M (69)	M (85)	W (14)	W (15)	M (85)	M (85)	M (69)
Social suffering	Direct: Experienced					Indirect: Witnessed			
Interest in academia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	High potential for an equity ethic					**Low potential for an equity ethic**			
Pseudonym	**Marissa**	**Sam**	**Harrison**	**Eli**	**Justin**	**Jun**	**Jessica**	**Javier**	**Jahan**
Institution pseudonym[a]	WP	MWS	ES	WS1	SS2	MWS	WS2	ES	WS2
Year in program	6	1	6	5	2	6	5	3	4
Field[b]	Mech	E&C	Aero	CS	EE	Ind	Biomed*	Chem	Aero
Race/Ethnicity[c] (%Field[d])[e]	L/W (31)	W (19)	W (48)	W (19)	W (19)	A (5)	W (37)	L (3)	ME/W (48)
Citizenship[f] (%Field[d])	U.S. (43)	U.S. (32)	U.S. (63)	U.S. (32)	U.S. (32)	Intl (69)	U.S. (58)	Intl (53)	U.S. (63)
Gender (%Field[d])	W (14)	W (15)	M (85)	M (85)	M (85)	W (34)	W (31)	M (70)	M (85)
Social suffering	Indirect: Acknowledged					Neither			
Interest in academia	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes

[a]Institution: ES, Eastern State; MWS, Midwestern State; SS1, Southern State 1; SS2, Southern State 2; SS3, Southern State 3; SP1, Southern Private; ST, Southern Technical; WP, Western Private; WS1, Western State 1; WS2, Western State 2.

[b]Field: CE, Computer Engineering; CS, Computer Science; EE, Electrical Engineering. *Asterisks indicate if the field falls under an "Other" engineering field in the National Science Foundation, National Science Board (2018) Appendix Tables 2–32 and 2–29.

[c]Race/Ethnicity: A, Asian; B, Black; L, Latinx; ME, Middle Eastern; W, White.

[d]%Field indicates the percent of doctoral students in participant's field who have the same race/ethnicity, citizenship, and gender.

[e]%Field for Race/Ethnicity represents for international students the percent of U.S. citizens of the same race as the NSF does not disaggregate Temporary Visa Holders by race.

[f]Citizenship: Intl, International/Temporary visa holder.

TABLE 2 Gender, race/ethnicity, and citizenship breakdown of our sample and U.S. doctoral engineering recipients in 2015

	Nationally[a] (%)	Our sample (%)
Gender		
Men	77	56
Women	23	44
Total	100	100
Race, ethnicity, and citizenship (U.S. citizens)		
Hispanic	3	11
American Indian or Alaska Native	0	0
Asian American	6	0
Black or African American	2	17
Native Hawaiian or Other Pacific Islander	0	0
White	29	44
Two or more races	1	0
Other or unknown race and ethnicity	4	0
Temporary visa holder (non-U.S. citizens)	56	28
Total	100	100

[a]National data are from National Science Foundation, National Science Board (2018) Appendix Table 2–20. Participants who identified as Middle Eastern were categorized as White. Temporary visa holders included 2 Asians, 1 Black, 1 Latinx, and 1 White participant.

This sample does not reflect a national sample of engineering and computing doctoral students in the United States. It overrepresents women, Latinx, Black, and White respondents and underrepresents temporary visa holders and Asian Americans (see Table 2). All the participants attended R1 institutions; nationwide, approximately 75% of engineering doctorates attend R1 institutions (National Science Foundation, National Science Board, 2018).

5.2 | Data collection

To follow-up with survey respondents, we conducted qualitative telephone interviews about their doctoral experiences, career interests, and how they felt their race and gender affected their experiences. We obtained Institutional Review Board approval, and participants gave their consent at the time of the interviews. The interviews lasted between 27 and 84 min ($M = 52$ min), and interviewers took notes throughout. All interviews were audio-recorded and professionally transcribed. Due to poor audio recording from one recorder, the first and third authors reinterviewed six participants.

Our data collection method allowed us to explore the experiences that influenced participants' personal, academic, and professional trajectories. Our hybrid approach iteratively used both inductive and deductive reasoning, and used the data to generate a theoretical explanation for how diverse students develop an equity ethic and how it might impact their career interests (Creswell, 2014). Participants' subjectivities were critical to the data collection and analysis. Thus, interviews were participant-led and followed a semistructured interview protocol that allowed for probing and follow-up questions (Rubin & Rubin, 2012). Questions included (a) Why did you decide to pursue a PhD? (b) What are your career goals? (c) How would your doctoral experiences be different if you had different identities (race and gender)? and (d) What are your thoughts on the limited numbers of Black, Latinx, and Native American faculty in engineering and computing? Interviewees brought unexpected concepts to our attention, including an equity ethic, which emerged as a theme in the early coding stages.

5.3 | Data analysis

Our analysis team included one faculty member, two postdoctoral researchers, and three graduate students. The primary data artifacts were the transcripts and notes taken during interviews. We imported these data into QSR International's NVivo 12 data analysis software (2018) that stores/retrieves data and documents the analysis process. We analyzed the transcripts using thematic analysis, a method for identifying, analyzing, organizing, interpreting, and reporting patterns within data (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006). Using this method, we took both a data-driven approach in which

we searched for emerging themes and a deductive approach in which we determined a priori codes from our semistructured protocol, which were adapted into a coding architecture (Boyatzis, 1998).

Thematic analysis prescribes six steps: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report (Braun & Clarke, 2006). In the first step, we immersed ourselves in the data by reading through the transcripts, and during the second step, beginning with the same three transcripts, we coded participants' responses to our questions and any other text that illustrated participants' doctoral experiences and career interests. We then compared our codes to test the reliability of the a priori codes and refined our coding architecture by defining emergent codes. We repeated this process until all transcripts were coded. During the third step, as we searched for potential themes, we noticed that multiple participants said their career interests were informed by social justice concerns and that this seemed to be patterned by the participants' experiences. After observing the coded data related to this theme, we reviewed relevant literature. At this point, we developed our research questions for this analysis and incorporated the following codes into our coding architecture: participants' (a) experiences with social suffering, (b) expressions of an equity ethic, and (c) career interests (Table 3). We agreed on a final coding architecture, and two coders recoded all the transcripts, focusing on these codes.

To code "experiences with social suffering" based on a devalued social identity, we highlighted text illuminating participants' direct (personal) or indirect (witnessed or acknowledged) experiences with social suffering. If a participant described stress from their advisor switching institutions, this was considered personal suffering, not social suffering. We coded whether they aspired to reduce social inequities and suffering through their work and to help people more generally. Each participant was ultimately classified as (a) having an equity ethic (they expressed both social justice and altruistic concerns); (b) having high potential for an equity ethic (they expressed only altruistic concerns); or (c) having low potential for an equity ethic (they expressed neither). We based these coding definitions on research by McGee and Bentley (2017), which showed that students' expressions of an equity ethic were inextricably linked to their desire to "give back" more generally (i.e., altruistic concerns), suggesting that individuals with an equity ethic are likely to be altruistic, while individuals who are altruistic may not necessarily have an equity ethic. Thus, an engineer who engages in outreach to increase high school students' interest in engineering would be considered altruistic and coded as "high potential," whereas an engineer who does so to broaden participation of underrepresented groups would be doing social justice work and would be coded as having an equity ethic. We also coded their career interests, which we ultimately dichotomized by whether they had ever been interested in working in academia, regardless of the institution type or position.

After systematically recoding all of the data, during the fourth step, we reviewed the themes or patterns across the data by clustering the participants into the three equity ethic levels and observed similarities and differences in their experiences with social suffering and career interests across groups. At this point, we visually mapped these patterns. Doing so aided us in

TABLE 3 Coding architecture

1. Experiences with social suffering: Experiences of socially caused inequity on the basis of a devalued social identity	
1A. Direct suffering	Describes personally experiencing and suffering from inequity (e.g., in the form of tokenism, microaggressions, or discrimination) on the basis of a social identity (e.g., race or gender)
1B. Indirect suffering	Describes others experiencing and suffering from inequity (e.g., in the form of tokenism, microaggressions, or discrimination) on the basis of a social identity (e.g., race or gender)
Witnessed	1. Describes a first-hand experience of interacting with others who experienced social suffering
Acknowledged	2. Describes an awareness of social suffering, which they learned second-hand
1C. Neither	Does not describe in the course of their interview either personally experiencing social suffering or the social suffering of others
2. Equity ethic: A principled concern for social justice and for the well-being of people who are suffering from various inequities	
2A. Expressed an equity ethic	Describes aspirations for work to address social justice concerns (help disenfranchised groups)
2B. High potential for an equity ethic	Expresses aspirations to address altruistic concerns (help others) but not social justice concerns (help disenfranchised groups)
2C. Low potential for an equity ethic	Does not discuss aspirations for their work to address either altruistic concerns (help others) or social justice concerns (help disenfranchised groups)
3. Career interests: The career path(s) participant is interested in	
3A. Interested in academia	If participant describes their interest in any type of postsecondary career (research focused, teaching focused, etc.) at any point in time
3B. Never interested in academia	If participant expressed that they had never been interested in a postsecondary career

refining and naming the themes we had found, many of which appear as subheadings in our findings section. In the sixth step, producing this report, we selected extracts of the participants' narratives, described the relationships we outlined in our research questions, theorized how they are causally linked, and related the findings to extant literature.

5.4 | Researchers' positioning and subjectivity

We must acknowledge our research backgrounds and our positions as women, social scientists, and members of a group that researches the racialized experiences of STEM doctoral students and faculty. We all identify as women, three of us identify as Black, and three of us as White. One of us has an engineering degree and later studied STEM education. We believe that discrimination is pervasive, systemic, and institutionalized within and outside academia and has differential effects on personal, academic, and professional outcomes, depending on one's identities. Our identities influence our interpretations of racism and gender bias in engineering education. For example, because we believe that having an equity ethic is beneficial to the academy and society, our interpretation of the group categorized as having "low potential for an equity ethic" was biased, so we consciously took a step back to try to understand why they have these viewpoints. Because our identities and perspectives differ from those of our research participants, to make sense of our findings, we explicitly focused on their narratives and words and reached intersubjectivity through individual analysis and collective discussions.

6 | FINDINGS

Table 1 presents participants' demographic and academic information, their expressions of an equity ethic, experiences with social suffering, and interest in academia. Additionally, based on National Science Foundation, National Science Board (2018) data, we present the percentages of all doctoral students in the participants' specific fields who have the same race, gender, and citizenship status. In the following, we first discuss participants with an equity ethic ($n = 9$, 50%), then those with high potential ($n = 5$, 28%), and finally those with low potential ($n = 4$, 22%). For each group, we first address Research Question 1, regarding the relationship between social suffering and expressions of an equity ethic, then Research Question 2, regarding the relationship between expressions of an equity ethic and career interests.

6.1 | An equity ethic developed through experiencing social suffering

Five of nine participants who demonstrated an equity ethic had personally experienced race-based and/or gender-based discrimination that informed their equity ethic. Four identified as Black men or women (Braxton, Jarod, Rashanique, and Ashley) and one as a White woman (Kerri). Each described experiencing social suffering in the academy and their desire to become professors to serve as role models for underrepresented students.

Some forms of social suffering these participants described stemmed from the disproportionate representation and stereotyping of their race or gender in their fields. Ashley, a second-year materials science student, explained that her biggest career challenge would be to "mak[e] sure that I can make my voice heard without being the angry Black lady or the sassy one that has an attitude." When probed about potential challenges in her career, she appeared to recognize the threat of such stereotypes specific to her intersectional identities as a Black person and a woman (Lewis & Neville, 2015), stating that they might hold her back from reaching her career goals.

Similarly, Braxton explained that tokenism exacerbated academic pressure: "I've got to prove myself. You know it makes it tough on top of everything else. . . .If you're having a bad day, you're not just letting yourself down, you're letting all, you know, minorities down." Although he said that the stress of marginalization compromised his mental health to the point of seeking counseling, he remained motivated to improve the experiences of future Black engineering students (McGee, Griffith, & Houston, 2019). At a workshop on underrepresented engineering students, he learned that his experiences mirrored those of other Black students and linked them to a broader context. Braxton explained:

> *I started to feel I have a responsibility to teach, and help the next generation—you know what I'm saying? The question is always. . .how do we get more, you know, PhDs, et cetera? And one of them is to let people see. . .that you can do it, you know.*

He also reflected, "Man, it's like almost, if I don't do it, then who will?" Clearly, he felt an urgent sense of responsibility to help other Black students navigate the academy (McGee et al., 2016).

Other participants experienced more overt forms of racial and gender bias, typically microaggressions from peers. Rashanique, who was raised in a Black community, described experiencing "White shock" when she began classes at a PWI and realized she was one of only four Black students in her department. She recounted an instance when she approached her peers to discuss homework, and they dismissed her and then turned away to continue their conversation. Rashanique explained, "I knew that it wasn't because I was a woman because there was a White girl in my class who conversed with them all the time and worked with them on homework assignments all the time." Such experiences made her feel isolated, rejected, and invisible, and she questioned whether she wanted to stay at the PWI to complete her master's degree (she did). However, she explained that she wanted to return to the institution where she earned her master's degree to "help students avoid the flaws that [she] encountered while there. . .[and] hopefully increase their number of minority students, Black students who are graduating from the School of Engineering each year." As a first-generation graduate student, she also aspired to help future first-generation students navigate the academy, demonstrating her equity ethic.

Kerri, a White woman in mechanical engineering who wanted to return to the academy to be a role model for women, was asked how her experience would be different if she were a man. She replied:

> *Throughout my career as an engineer, short as it's been, every now and then you'll get some idiot who makes a comment. . .like, "that's great we have so many talented engineers here and some women." And you're like, okay, well I'm in the first category, not just the second. . .and I, you do kind of get occasionally some harassment and I don't think that would have happened obviously if I were a guy. So yeah. I think my career would be different.*

Kerri believed that her experiences were largely shaped by gender and the stereotypes about women in engineering that challenge their intelligence and legitimacy. It is also noteworthy that she is in mechanical engineering, a subfield in which 86% of doctorates were awarded to men in 2015 (National Science Foundation, National Science Board, 2018). Operating in a world shaped by and for men, Kerri's identity as an "engineer" is qualified by her gender.

6.2 | An equity ethic developed through witnessing social suffering

Witnessing and empathizing with the social suffering of others due to group-based stigma and discrimination are significant factors in developing an equity ethic. In this category, we include Lindsey, a White woman in computer science. Although her gender is marginalized in engineering and computing writ large, she explained that her research area, assistive technology, is much more gender balanced than other fields and she, thus, had not experienced gender bias in her doctoral program. The other three participants in this group—Abhay, Oscar, and Hassan—said that they never felt marginalized in their programs. Oscar, who identifies as Hispanic, did not feel marginalized because he had previously attended an Hispanic Serving Institution and later a racially diverse institution for his doctoral studies. They all described impactful experiences witnessing social suffering within and outside of the academy and exhibited awareness of race-based and gender-based discrimination and disparities in the academy. Abhay, an international student from India, explained:

> *In engineering, I don't have the problem of being a racial minority because there's so many Indian people in engineering. . . .So, I see myself represented across the board, but I've spoken to a lot of African American students and that experience is not theirs, often times.*

Through observation and conversations, Abhay recognized the social suffering of marginalized students. He attributed the lack of women's restrooms in engineering buildings to patriarchy and described his engagement in an engineering class that helped men become better allies for women. Both Abhay and Hassan, an electrical engineering student from Saudi Arabia, have sisters who also are engineers and through these sibling relationships were keenly aware that women engineers experience microaggressions, such as having their expertise questioned because of their gender.

6.3 | The impact of personal relationships

These students were familiar with injustice in their fields, but witnessing social suffering outside the academy was what shaped their long-term career interests. Witnessing inequities outside of the academy sometimes led them to their discipline as they recognized the potential it gave them to help reduce social suffering. Because of personal relationships with people with disabilities, Lindsey and Hassan both pursued computing degrees to develop technology that assists them. While taking computer science classes and working as a personal care assistant, Lindsey connected technology with the potential breakthroughs

computer science presented for persons with (dis)abilities. She explained, "I decided I wanted to go to grad school, so I looked specifically at programs that had people who did technology for people with disabilities." After his sister lost sight in one eye, Hassan entered a master's program in computing to study devices that restored people's vision. Asked why he pursued a doctorate, Hassan explained:

> *I always had an interest in academics but mainly I felt like the most contribution I would give in this life and get back was through research. I felt like a lot was given to me in this life and I'm very privileged to have it.*

As he suggested, his desire to help disabled individuals through research goes hand in hand with recognizing his many privileges and skills, resulting in a sense of responsibility to act.

6.4 | The impact of service activities

Abhay and Oscar both witnessed social inequities in service trips outside of the United States that influenced their development of an equity ethic. Oscar described a trip focused on water treatment in Bolivia:

> *Being Hispanic and having this knowledge, it really does provide me with a little bit of a sense of responsibility and duty to pass this knowledge on to other people and help all these other people that just don't have access to this knowledge that we do.*

Demonstrating his understanding of the broader context that shaped this inequity, he explained that he was helping to solve a water crisis caused by "privatization of the water system, which became too expensive for people to be able to actually afford the drinking water system and the piping system." After experiencing how he could effect change, he realized he could leverage his skillset to reduce inequities and felt responsible to take action. After engineering-related service trips to Central America and Louisiana, Abhay founded a campus organization that targeted segments of the local community that engineering design often ignores: people experiencing homelessness and cognitive disabilities. He explained: "I think the one thing which I've learned through humanitarian engineering or interacting with folks in the community is. . .I think it's empathy."

6.5 | Expressed interest in academia

Of the nine participants who expressed an equity ethic, eight expressed interest in academia (Oscar felt that he could best address his equity ethic through policymaking). Rashanique, Jarod, Braxton, Ashley, and Kerri directly linked their marginalization and social suffering based on race and/or gender to their interest in being role models for future underrepresented students in academia. Those passionate about teaching—Rashanique, Lindsey, and Kerri—were more firm in their decision to pursue tenure-track academic jobs than those who were not. Lindsey explained: "I think that it's pretty exciting to share what I love about computer science with the next generation of computer scientists." She added that the development of accessibility technology is not well funded in the private sector because it does not necessarily deliver profits.

Braxton, Jarod, Hassan, Abhay, and Ashley, the remaining participants who expressed an equity ethic and some interest in academia, were not planning to apply for academic jobs exclusively or immediately after graduation. They had lost interest in academia, because they experienced racialized and/or role-related stress in the academy, felt their equity ethic aligned with both academia and industry, and/or realized their equity ethic did not align with the academy. Jarod, a Black international student, said that he wanted to distance himself from academia because of his experiences of severe social suffering:

> *I'm not going to go to academia to help students right now because. . .I've experienced so much racism and mistreatment in academia that I really want a break from it, in a new industry, for maybe five or ten years. When I feel like myself, I'll come back to academia.*

His experiences, which may have contributed to his equity ethic and desire to improve that experience for future Black students, also deterred him from this path.

Ashley lost interest in academia because it conflicted with her equity ethic. She realized "teaching is not really an emphasis for tenure-track professors." She learned that the academic areas with the greatest potential to attract and retain students of color were often devalued by institutions. She explained: "Most minorities come from a very community-based and a familial background [so] that cutthroat and no-real-care-for-other-people-if-it-doesn't-directly-benefit-you [mentality is]. . .I think that's

one of the reasons that they don't go into academia." She instead decided to work in industry researching and developing prosthetics, using her research skills to increase equity in a different way.

6.6 | High potential for an equity ethic: A lack of response to acknowledged social suffering

Harrison, Justin, Eli, Sam, and Marissa demonstrated high potential for developing an equity ethic because they wanted to use their engineering and computing skills to help others. They are all White, including Marissa, a White Latinx woman, and thus privileged in terms of race within and outside the academy. Neither Sam nor Marissa, both women, emphasized gender-based suffering in their interviews. Each participant acknowledged others' social suffering, especially in their doctoral programs, but their acknowledgement did not translate into an equity ethic. When asked how his experiences would be different if he had different identities, Harrison responded:

> *I identify as a member of the privileged class in almost every identity sphere. So, I identify as a White, cisgender male, born to highly educated parents in a predominately White male field, at predominately White universities. . . .Until very recently, I was very blind to the amount of struggle that folks from less privileged groups deal with as a part of getting the same degrees. . .that my privilege presented.*

He developed this realization after joining several diverse groups on campus that discussed topics such as "concepts of privilege and identity." His experience was an indirect experience with social suffering because he became aware of it by conversing with others who had such experiences. Harrison recognized his own privilege stemming from his raced, gendered, and classed identities, and when asked how he became aware of social inequities, he said, "I probably don't have to tell the researchers in this study that people who are a member of the privileged class. . .don't see how people who aren't privileged have to struggle." He described his inability "to quantify what struggles I miss on a daily basis," and that he was blind to these struggles "until someone showed it to me." Harrison now seems to understand that he had "colorblindness," which enables White people to maintain their privilege by "not seeing race," and therefore not seeing racial inequities and not working to reduce them (Bonilla-Silva, 2018). Harrison's emerging awareness is likely linked to his altruism; however, his acknowledgement of social suffering does not appear to translate into an equity ethic.

Participants with high potential to develop an equity ethic aspired to benefit others generally through their work, but not to help disenfranchised groups. Harrison described his research on unmanned aerial systems that could be deployed in the event of natural disasters as "benefitting humanity." Justin, an electrical engineering student, described his decision to pursue a PhD:

> *I ended up finding out that there was a specific concentration where I could [apply] my enjoyment of computers and electronics to working with people and animals to basically help my fellow human beings have a better way of life.*

Unlike Lindsey and Hassan, who intentionally selected programs that aligned with their equity ethic, Justin was motivated by wanting to help all of society. He also described empathetically engaging in engineering outreach service with high-schoolers: "If I could have had somebody help guide me and show me what I'd be getting myself into when I was, you know, thinking it in high school, I definitely would have appreciated it." Although he wanted to increase access to engineering and be a role model, he did not specifically want to reach out to groups lacking access to engineering. Nevertheless, we consider this desire to "give back" important because it is likely a prerequisite to developing an equity ethic.

6.7 | Expressed interest in academia

All participants with high potential for developing an equity ethic expressed a desire to work in some academic setting, and all wanted to "make an impact" through their teaching and/or research. Eli described his interest in a teaching-focused position because "it's a way that I can have a real impact." Marissa, who was already searching for faculty positions, explained that her ability to "make a difference in the world" was a critical factor in deciding where to apply and accept a position.

6.8 | Low potential for an equity ethic: A lack of response to unacknowledged social suffering

Participants Jun, Jessica, Javier, and Jahan did not express interest in using their engineering or computing skills to reduce social inequities or for altruistic purposes. When interviewed, Jun and Javier were international students from China and

South America, respectively; Jahan is a Middle Eastern U.S. citizen; Jessica is a White woman and a U.S. citizen. None described personally experiencing social suffering but acknowledged inequities and/or suffering where they saw them—*but not that they were socially caused*. Jun and Jessica both explained that women were well represented in their fields (industrial and biomedical engineering, respectively). Jessica said, "[My] whole lab is all women, pretty much. Actually, we just got our first male student, which is kind of funny. My other lab, also the majority are women." Jun explained that men and women "go through the similar process," and Javier said that, as an international student, he did not need to prove himself:

> *We all have to go take the same GRE and take the same exams and pass the same classes after you get here, [so] no I don't think that you have to prove more or less than other people. . .I think that the assumption is you've already gone through the filters of the Department and the College of Engineering. . .everyone assumes that hey, if you survived all that then you deserve to be here.*

These participants perceived that all students were treated equally and had equal opportunity to succeed; their experiences and perceptions likely shaped what we coded as a lack of equity ethic.

The participants recognized the underrepresentation of certain groups in their fields but did not explain how such patterns of inequality are shaped by social forces. When asked about discrimination in her program, Jun replied, "I don't see any discrimination, but I still think that, they're [Black, Latinx, and Native Americans] underrepresented." Javier explained that "it's really obvious that they're [Black, Latinx, and Native American engineering students and faculty] underrepresented," but said that his experiences would be the same regardless of his racial identity:

> *In engineering, we're kind of lucky in the sense that most of our classes are not about opinions. . .it's more like trying to solve the number problem in front of you. . . .So I don't think in the sense of race or ethnicity that may be really making a difference in the sense of an engineering classroom.*

His response that race does not influence one's experiences in engineering reflects a mindset that prescribes engineering and computing to be divorced from identity, objective, apolitical, meritocratic, and providing equal opportunity for all (Baber, 2015; Riley, 2008; Slaton, 2010; Stevens, Amos, Jocuns, & Garrison, 2007). Similarly, when asked how his experience in his field would be different if he had a different race, Jahan replied, "I don't think it would be any different, especially in [South Western State 5], where it's so diverse." Jahan appears to dodge the question by focusing on his institution, which he suggests is an anomaly. He recognizes that there is a relationship between representation and quality of experience, but he does not recognize other oppressive experiences that occur regardless of representation or how his experience might be different in another context.

The participants in this group often recognized social disparities when discussing the underrepresentation of certain groups in engineering, but did not discuss how structural forces may have caused them. Unlike participants with an equity ethic, who understood the social foundations of inequity, these participants had a colorblind perspective (Bonilla-Silva, 2018). They saw inequity but explained or implied that race did not impact one's experiences and that everyone in their program was held to the same standards. As Bonilla-Silva (2018) discusses, such maneuvers minimize the significance of race and racism and advance the narrative that everyone has equal opportunities. Such support for equal opportunity may seem antiracist, but equal treatment only results in equality when groups are equal to begin with, and the participants recognized that this was not the case. By dismissing the social nature of inequity, they suggested that individuals were responsible for their own social suffering instead of constructed systems of power and privilege. Majority group members' belief in a postracial society holds individuals responsible for their problems and absolves themselves from effecting systemic changes that would redistribute power, thereby maintaining their privilege (Bonilla-Silva, 2018).

6.9 | Expressed disinterest in academia

Among participants, only Jahan was interested in working in the academy. Javier said there was "too much red tape" in securing academic research funding, which, according to research exploring why engineering and computing students are dissuaded from academic careers, is a common reason for disinterest in this career path (McGee et al., 2019). When asked if anything attracted him to academia, he conceded that "it may be somehow easier to have an impact in other people's lives when you're in [the] academy," but this did not sway his interest. Jahan said he was interested in teaching-focused faculty positions because "I think the idea that you can never get fired, I mean, that's the best job security you can ever have. Yeah, that's the biggest appeal for me." By our definition, his motivation was neither altruistic nor motivated by social justice concerns.

7 | DISCUSSION

When engineers value and work to achieve equity, the odds of achieving a more equitable society increase (Hunter et al., 2010); thus, it is important to understand the educational conditions that cultivate an equity ethic. Figure 1 depicts the relationships that we found between experiences of social suffering, expressions of an equity ethic, and participants' career interests.

As depicted in this figure, we found a clear relationship between students' experiences with social suffering and their expressions of an equity ethic. First, participants' narratives suggest that direct personal experiences and impactful vicarious experiences shape students' development of social empathy (Segal, 2011), which involves understanding inequity, the ability to empathize with those affected, and taking responsibility to act. As shown in Figure 1, we propose that social empathy is necessary for developing an equity ethic.

Participants with high potential for developing this attribute acknowledged the existence of social suffering within their fields; however, perhaps due to their social positioning (all were White) and distance from social inequity and suffering, they could only speculate on the struggles of their underrepresented engineering counterparts. This lack of personal experience could influence their perceptions of being responsible for or able to reduce inequities in the academy. Acknowledging inequity likely improves majority group students' interactions with students with different identities, but not acting to reduce it allows these individuals to maintain their privilege (Bonilla-Silva, 2018).

Low potential participants did not definitively lack an equity ethic, but they did not report any experiences with social suffering or career goals that included altruism or social justice. They agreed that there were social disparities in engineering but did not attribute them to structural factors. These findings reflect the myth of meritocracy common in engineering (Pawley, 2009; Slaton, 2010; Stevens et al., 2007). Furthermore, two participants were international students, whose understanding of race likely differs from how U.S. citizens think about equity and social suffering. For example, international students may lack a socio-historical understanding of inequity in the United States and perceive that U.S. institutions uphold equality. One must recognize inequity to respond to it, a perception that requires a certain positional lens, which needs to be developed. As Fries-Britt, Mwangi, Chrystal, and Peralta (2014) found, due to their phenotypical presentation as African American, Black international students who come to the United States untroubled by race "learn race in a U.S. context" (p. 1) by experiencing racialized encounters. Therefore, as international students spend more time in the United States, they may become more invested in racial and other inequities and develop an equity ethic.

To address our second research question (see Figure 1), we found a relationship between expressions of an equity ethic and interest in academia. Students who reported direct experiences of social suffering in the academy were motivated to return in hopes of improving the experience for future underrepresented students. However, numerous factors affected how their equity ethic influenced their career interests. The participants most interested in academia were passionate about teaching and did not feel that academia conflicted with their equity ethic. Moreover, students who developed a passion for effecting social justice after witnessing inequity outside the academy had a more tenuous interest in academia. In this group, only Lindsey was definitively interested in academia (who explained that her research would be better funded in academia).

The positive relationship we found between equity ethic and interest in academia can be explained by recent research showing that STEM college graduates who entered graduate school rather than the workforce were more likely to believe that socio-political activism could improve society (Garibay, 2018). Furthermore, research has shown that science PhD students who preferred academia over industry were more interested in research independence than high salaries (Roach & Sauermann, 2010). Engineers doing social justice work and motivated to help others are often less motivated by the chance to earn a higher

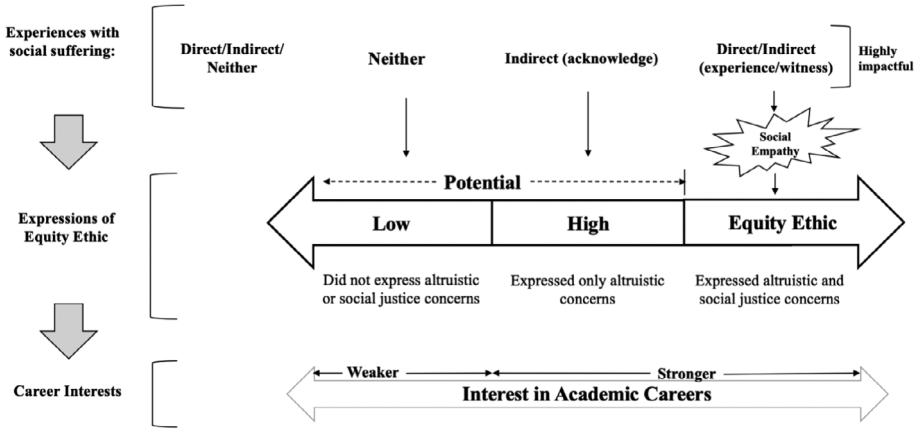

FIGURE 1 Experiences with social suffering, expressions of an equity ethic, and career interests

salary in industry (according to the 2015 Survey of Earned Doctorates, the median salaries for engineers who earned their PhDs since 2010 in industry and academia are $100,000, and $62,000, respectively; National Science Foundation, National Center for Science and Engineering Statistics, 2018). It is noteworthy that many of our participants with an equity ethic were interested in academic careers to pursue their altruistic and/or social justice goals through teaching and mentoring. They were not as attracted to academic research, possibly due to the rise of academic capitalism, competition for research funding, and the commercialization of scientific discoveries (Szelényi & Bresonis, 2016).

8 | IMPLICATIONS

The study findings have several implications for engineering departments and faculty. Many of our participants underrepresented by race and/or gender were interested in academia, but many were dissuaded by an environment in which they experienced racial and gendered microaggressions, tokenism, and overt racism and sexism. Allocating resources for interventions to reduce bias at the individual level may be ineffective in creating more inclusive academic spaces if there are no structural changes, particularly if members of the community feel these activities do not serve their interests (Baber, 2015). Meta-analytic research of more than 500 studies on Intergroup Contact Theory found that intergroup prejudice is reduced when different groups can mix and not feel threatened (Pettigrew & Tropp, 2006). Our finding that majority group students can develop social empathy and an equity ethic when they witness and understand others' social suffering supports this theory and suggests that administration policies should promote cooperation rather than competition in engineering courses (Godfrey & Parker, 2010).

Ashley, a Black woman, perceived that academia's lack of emphasis on teaching and mentoring clashed with her desire to broaden participation in engineering. Because a majority of engineering and computing PhD students attend R1 institutions (National Science Foundation, National Science Board, 2018), it is important that these institutions expose students to a broad range of academic career paths, such as minority-serving institutions and primarily undergraduate institutions. Broadening the possibilities in academia may encourage historically marginalized students to remain in the academy and broaden participation in engineering.

Faculty should know that students should be encouraged to develop an equity ethic, even those distanced from social inequities due to their social positioning, and to think about how their work promotes equity and justice. It is critical that majority group students increase their sense of responsibility to help "level the playing field" and not leave it to those marginalized by systemic oppression. The narratives of students with an equity ethic who witnessed social suffering suggest that structured curriculum and programming, including activities such as service learning and cocurricular community engagement, could help students develop a passion for promoting equity. This could also help students like those we classified as having low potential for an equity ethic understand the systemic nature of social inequities.

We caution against pedagogy that takes a deficit-based approach and re-creates hierarchies between those who "help" and those who need help (Grusky, 2000; Nieusma & Riley, 2010). Furthermore, students need not go abroad to witness inequity; they can work to solve problems affecting marginalized groups within their local communities, such as residents of Flint, Michigan, devastated by lead poisoning, who are disproportionately Black (Agyeman, Schlosberg, Craven, & Matthews, 2016; Boyd, Ridgeway, & Nyachae, 2018). Such exposure could help students understand the contextual factors shaping the problem and their own contribution to it. Furthermore, having physical proximity to inequity could prompt an equity ethic and encourage more students to become involved.

While understanding an equity ethic is important in the United States, researchers must consider the international implications of this work. Our study is largely focused on the U.S. context as all of our participants were studying in U.S. institutions, but we recommend that future research consider the global impact of our findings, perhaps by examining the equity ethics of doctoral students studying in other countries.

Future research should also test the replicability of these findings, qualitatively, quantitatively, and longitudinally, and with larger samples. Such research might explore how the type of inequity and degree of social suffering individuals experience relate to an equity ethic, and the degree to which geographic proximity, closeness, and perceived similarity to individuals experiencing social suffering impact individuals' equity ethic. Another important next step would be understanding the specific social justice-related experiences within engineering and computing education that can help attract and retain underrepresented students and help well-represented students develop an equity ethic.

9 | CONCLUSION

Most participants in this research expressed concern for helping others, suggesting a nascent equity ethic that could grow if they learned about the possible applications of their disciplines through intentional programmatic efforts. Intentionally infusing equity

ethic in engineering and computing fields has the potential to attract historically marginalized students, improving their representation in these fields, and attract some of their majority allies. Increasing the diversity of identities, life experiences, and concerns in these fields should increase the likelihood that engineering and computing outputs are equitably distributed to social groups that are often devalued or ignored, thus increasing equity in society at large. Because engineers and computer scientists are well positioned to harness the power of technology, engineering, and computing programs should educate their students about the responsibility to use their skills to help underserved groups both locally and globally. We believe it is the responsibility of academic communities to ensure that they adopt and espouse these same values.

Although we found a strong relationship between the presence of social empathy and an equity ethic in this particular study, we recognize that social empathy for marginalized groups may not always lead to an equity ethic in which individuals align their values with behaviors that dismantle the structural inequalities that benefit majority groups. We are also cognizant that having an equity ethic may not actually result in meaningful structural change. Even when an equity ethic helps individual students develop a work ethic based on decreasing inequities, it may be insufficient to disarm the systemic and brute force of racism, sexism, and other systems of oppression in educational contexts and society at large. Nonetheless, although systemic problems need collective solutions, promoting an equity ethic in engineering and computing students is an important step in transforming society to be more equitable and just.

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AUTHOR BIOGRAPHIES

Dara E. Naphan-Kingery is an Assistant Professor of Sociology in the Department of Social Sciences and Cultural Studies at Western New Mexico University, Silver City, NM 88062; dara.naphan-kingery@wnmu.edu

Monica Miles is an Academic Pathways Postdoctoral Fellow in the Department of Teaching and Learning at Vanderbilt University, PMB Box 230 GPC, 230 Appleton Place, Nashville, TN 37203; m.ridgeway@vanderbilt.edu

Amanda J. Brockman is a doctoral student in the Department of Sociology at Vanderbilt University, PMB 351811, Nashville, TN 37235-1811; amanda.j.brockman@vanderbilt.edu

Rachel G. McKane is a Doctoral Candidate in the Department of Sociology at Vanderbilt University, PMB 351811, Nashville, TN 37235-1811; rachel.g.mckane@vanderbilt.edu

Portia K. Botchway is a Doctoral Candidate in the Department of Teaching and Learning at Peabody College, Vanderbilt University; PMB 2301930 South Drive Nashville, TN 37203; portia.k.botchway@vanderbilt.edu

Ebony O. McGee is an Associate Professor of Diversity and STEM Education in Vanderbilt University's Peabody College, PMB Box 230 GPC, 230 Appleton Place, Nashville, TN 37203; ebony.mcgee@vanderbilt.edu

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