Received: 1 May 2022 | Revised: 11 June 2024 | Accepted: 12 June 2024

DOI: 10.1002/jee.20609

JEE Journal of Engineering Education

RESEARCH ARTICLE

Through their eyes: Understanding institutional factors that impact the transfer processes of Black engineering students

Bruk Berhane[1] | **Shannon Buenaflor**[2] | **Eunsil Lee**[3] | **Jingjing Liu**[1] | **Gabriel Najera**[4]

[1]School of Universal Computing, Construction, and Engineering Education & STEM Transformation Institute, Florida International University, Miami, Florida, USA

[2]Engineering Academic Services, A. James Clark School of Engineering, University of Maryland, College Park, Maryland, USA

[3]Department of Engineering Education, University at Buffalo, Buffalo, New York, USA

[4]Najera Consulting Group, Hinsdale, Illinois, USA

Correspondence
Bruk Berhane, School of Universal Computing, Construction, and Engineering Education & STEM Transformation Institute, Florida International University, 10555 West Flagler Street, Miami, FL, USA.
Email: bberhane@fiu.edu

Funding information
National Science Foundation, Grant/Award Numbers: 1828619, 2024081

Abstract

Background: The potential for broadening participation in engineering among Black undergraduates via transfer pathways is considerable, given their large share of the community college population. By understanding the opportunities and challenges presented within the context of transfer, this potential can be realized.

Purpose/hypothesis: The goal of this study is to explore ways in which Black students who transitioned from a community college to a 4-year engineering program describe the institutional factors affecting their transfer processes.

Design/method: Drawing from a 3-year qualitative research study involving approximately 27 Black engineering transfer students at a large, predominantly White, institution, we present data derived through interviews and focus groups with these undergraduates.

Results: Participants expressed that they benefited from supportive institutional agents who offered engineering transfer-related resources. These included both faculty and advisors in their mostly Minority Serving Community Colleges (MSCCs) as well as advisors from the engineering college at the 4-year institution. In addition, respondents described being part of a number of community college programs, including some for Black collegians, that offered resources for transfer. Nonetheless, some participants shared problems that emerged during the transfer process, including having to self-navigate confusing transfer websites or self-advocate to resolve erroneous admissions decisions.

Conclusions: We suggest a need to elevate MSCCs as learning environments that can produce future Black engineers. We also recommend a systems-level approach that brings together community colleges and 4-year institutions while also accounting for issues related to resources as well as power dynamics that students may encounter.

KEYWORDS

Black students, broadening participation in engineering, community colleges, race/ethnicity, transfer students

1 | INTRODUCTION

While the challenges of recruiting and retaining women as well as historically marginalized students of color in engineering have been well documented (Institute of Medicine, 2011; Seymour & Hunter, 2019), the percentages of Black enrolled engineering students and 4-year degree recipients in particular is alarming (American Society for Engineering Education or ASEE, 2019). From 2011 to 2020, Blacks consistently comprised only about 5% of all undergraduate engineering students and 4% of 4-year engineering degree recipients (50k Coalition Data Council, 2022a; 50k Coalition Data Council, 2022b). When compared to their nearly 14% share of the US population (United States Census Bureau, 2023), these numbers underscore the extent to which Blacks are underrepresented in undergraduate engineering degree programs and in engineering professions. At the same time, the statistics on Black students in community colleges offer a much more heartening narrative with respect to engineering.

First of all, community college enrollment rates for Black undergraduates are nearly at parity, around 12%, with respect to their share of the US population (American Association of Community Colleges, 2022). In addition, Black students earn 7% of associate degrees in engineering compared to just 4% of engineering degrees at the baccalaureate level. Nonetheless, vertical transfer rates for Black students are the lowest of any racial or ethnic group at under 9% (Espinosa et al., 2019). Thus, studies that attend to Black engineering student transfer from community colleges to 4-year institutions have the potential to significantly impact engineering diversity efforts.

Despite this potential, McPhail (2015) noted that research that examines Black engineering students who transfer from community college to 4-year institutions is scarce. This was confirmed in a recent systematic review on broadening participation in engineering (BPE) efforts to improve Black student engagement; the authors noted that none of the published research that they reviewed focused on community college/transfer students (Holloman et al., 2021). Given the potential that Black transfer students offer for increasing the number of Black engineers, the limited amount of scholarship on this subject, and national data noted here, vertical transfer (transfer from a community college to a 4-year institution) is an important topic to address.

Engineering transfer research studies tend to focus on all racial/ethnic groups as a whole (Lattuca et al., 2014; Reeping & Knight, 2021; Zhang & Ozuna, 2015), rather than on students of color from one racial or ethnic group. Where engineering or other STEM transfer studies do explore the experiences of students of color, the few that have been published tend to look at Latine students. A notable example is in Martin et al.'s (2019) systematic literature review, which looked at over 70 articles on Latine engineering and other STEM undergraduate transfer/community college student outcomes.

To our knowledge, no similar review or robust body of work has been published on Black engineering students. Thus, our purpose within this article is to draw attention to Black engineering transfer pathways in particular. It is precisely because Black transfer students are understudied and yet offer tremendous potential for increasing engineering diversity that we specifically illuminate their transfer experiences in this article. Our work is also timely given recent calls to challenge anti-Blackness (Holly, 2020) and stereotyping (McGee & Martin, 2011). With these as motivating factors, in this article we explore the institutional factors that impacted the transfer processes of Black engineering undergraduates who transitioned from different community colleges to a 4-year institution.

2 | LITERATURE REVIEW

The transfer process lacks a clear definition of when students begin to transfer and when the transfer process comes to an end. For our broader study, we adopted the concepts of pre-transfer, transfer, and post-transfer that were used to frame well-known models and theories on transfer pathways, including the STEM transfer model (Wang, 2016), which we discuss in Section 3. We also reviewed the Transfer Student Capital (TSC) model (Laanan, 1998; Laanan et al., 2010; Laanan & Jain, 2016) and work that has emerged alongside TSC. TSC focuses on ways in which community college learners "acquire skills and resources that allow them to be academically successful" in transferring (Starobin et al., 2016, p. 1045).

While exceptionally valuable in understanding the transfer space, this theory and related scholarship (Laanan & Jain, 2016; Moser, 2012) emphasizes what the student understands and is able to do, rather than on what the institution is able to do *for* the student. Given our emphasis on institutional factors, we draw on research emphasizing the latter (what the institution does for the student) rather than the former. With this as background, this section is organized into three subsections focused on (i) institutional agents (faculty and advisors), (ii) campus programs, and (iii) engineering admissions and transfer-related policies.

2.1 | The role of institutional agents

Support received from institutional agents, especially faculty and advisors, impact transfer student pathways. As it relates to faculty, community college professors who are supportive of students' transfer intentions and knowledgeable of transfer processes are known to contribute to successful transfer trajectories for engineering and other STEM undergraduates (Packard et al., 2011; Wang et al., 2017a; Winterer et al., 2020). Zhang and Ozuna (2015) reported that quality interactions with faculty can facilitate transfer pathways by providing students with academic validation. These exchanges can have positive impacts on the self-efficacy of historically marginalized students of color in engineering in particular (Zhang & Ozuna, 2015).

Other scholarship has shown that faculty members' encouragement can enhance learners' engineering or other STEM identities, which, in turn, helps facilitate transfer (Bauer, 2014; Dowd et al., 2013). Beyond traditional classroom interactions, reliable transfer information provided by faculty is also regarded as critical for Black (Granger, 2011; Lundberg & Schreiner, 2004) and STEM students (Packard & Jeffers, 2013). This information is especially useful given the complex curricular requirements of these degree programs (Packard & Jeffers, 2013; Reeping & Knight, 2021; Slim et al., 2014).

Despite the positive impacts that community college faculty can have on Black engineering undergraduates, scholars have identified a number of challenges. For example, Coley and Vallas (2015) state that the limited population of engineering faculty in community colleges prevents students from building quality relationships with them. The lack of these relationships thereby minimizes the number of students who have access to critical information for engineering study, as well as the number that ultimately transfer (Coley & Vallas, 2015). For Black community college students in particular, racialized stereotypes can cause difficulties in their faculty interactions, including particular challenges in their interactions with non-Black engineering faculty (Bush & Lawson Bush, 2010; Smith, 2016; Wilson, 2014).

In addition to faculty interactions, academic advisors have been described as critical factors that can contribute to a "seamless transfer" process for students (Hayes et al., 2020; Townsend & Wilson, 2006). Smith and Van Aken's (2020) literature review on engineering transfer students supports this claim by reporting that specialized advising (e.g., transfer-focused advisors, a transfer center, and transfer orientation) is the most cited institutional factor that influences engineering students' transfer. Ogilvie and Knight (2020) emphasize the added significance of advising for underrepresented students in engineering due to the highly sequenced coursework. These courses have restrictive prerequisites that can impede the transfer process without adequate advising (Grote et al., 2020a; Grote et al., 2020b). Particularly for Black and other historically marginalized students of color in engineering, transfer advising has been considered as a particularly useful support mechanism (Arteaga, 2015). Knowledgeable advisors and faculty have the ability to provide students with tailored information that can support their overall transfer process when advising is effective (Hayes et al., 2020; Wang et al., 2020).

2.2 | The role of interactions with campus programs and peers, and their effects on campus engagement

Research suggests that participating in student organizations and the resulting peer networks, particularly those with similar academic goals (e.g., transfer, engineering, etc.), leads to positive outcomes for historically marginalized students of color in in engineering and other STEM disciplines. For example, Wade (2012) found that students who shared challenges or advice with other students of color in engineering were able to resolve concerns regarding the transfer process. Similarly, Granger's (2011) study of Black engineering undergraduates' transfer experiences underscored the significance of having a peer support network (e.g., National Society for Black Engineers). Their study noted that connecting with other Black peers in engineering mattered "more than anything else" for students considering

transitioning to a 4-year institution (p. 65). However, historically marginalized students of color in engineering are often unfamiliar with programmatic support and networks and may find that there are a small number of peers with shared racial backgrounds (Henderson et al., 2023). Moreover, scholarship has revealed that Black engineering students' experiences of being marginalized can cause them to feel uncomfortable interacting with peers (Johnson, 2019). More broadly, other studies suggest that students from marginalized groups may not have equal access to institutional resources that might help them along their academic trajectory (Johnson, 2022).

The evidence collectively suggests that historically marginalized engineering students may not be able to participate as readily in the campus environment as more privileged students do. For Black engineering students attempting to transition to a 4-year campus, they must navigate heavily racialized systems in higher education while also encountering potential prejudices associated with being transfer students (Minichiello, 2018). Such prejudices might include instructors who seem "uncaring" and "rude" instructors who seem to have low expectations of transfer students (Minichiello, 2018, p. 275).

2.3 | Navigating engineering-transfer requirements and overall transfer admissions policies

Admission policies both for engineering-specific transfer requirements and the general transfer process also impact a student's transfer outcomes. Like other academic disciplines, engineering has its own course sequencing (Lattuca & Stark, 2011) that is designed to support students by preparing them for a career. Yet, the lack of ability to take prerequisites at community colleges and the complexity of engineering curricula at 4-year universities are known challenges for students (Glynn, 2019). For example, some community colleges are unable to offer all the prerequisites necessary for transfer in engineering due to limited resources, expertise, or budget constraints (Dunmire et al., 2016; Enriquez et al., 2013). When students are not able to complete prerequisite courses at a community college, they are less likely to pursue engineering degrees at the 4-year university (Glynn, 2019).

Additional studies further highlight the significance of course sequencing, particularly for Black and other historically marginalized students of color in engineering. Bahr et al.'s (2017) study on STEM transfer success found that students of color in engineering and other STEM fields showed relatively low rates of advancement, especially in STEM courses, despite their large proportion in entry-level courses in math, chemistry, and physics at a community college. The study also indicated that students of color in engineering/STEM were less likely to transfer after graduating from community college than their majority counterparts. This suggests the need to focus more attention on improving community college to 4-year pathways for Black and other students of color in engineering.

Other challenges include the extent to which information on the general transfer policies (e.g., articulation agreements or other state-, institutional-, or programmatic-level policies) are either accessible or comprehensible to prospective transfer students (Taylor, 2019). For example, Fincher et al.'s (2014) analysis of online materials for transfer articulation provided by 14 community colleges in Arkansas found that most colleges placed articulation agreements or other transfer opportunities in obscure places on their websites. Furthermore, Taylor's (2019) examination of the readability of a random sample of 100 articulation agreements indicated that most of the current materials were written at levels incomprehensible to first-year community college students, suggesting additional challenges that transfer students face in navigating the policies on the general transfer process.

3 | THEORETICAL FRAMEWORK

Our theoretical framework draws from Wang's (2016) STEM transfer model and Jain et al.'s (2011) framework on transfer receptive culture (TRC). Wang's model (2016) was developed on the basis of her prior research, which focuses on transfer and community college students in STEM majors with an overarching aim of improving transfer success. Her body of research unpacks different aspects of transfer pathways such as students' transfer experiences and trajectories (Wang et al., 2019), inequities in transfer (Wang et al., 2017a), and evaluation of teaching practices and faculty development (Wang et al., 2017b). Wang's model (2016) suggests that STEM transfer is directly connected to *person inputs* such as demographics, socioeconomic status, and prior academic abilities. As Wang (2016) notes, these inputs, which can include students' race or ethnicity, are correlated with the likelihood of transfer. Furthermore, she asserts

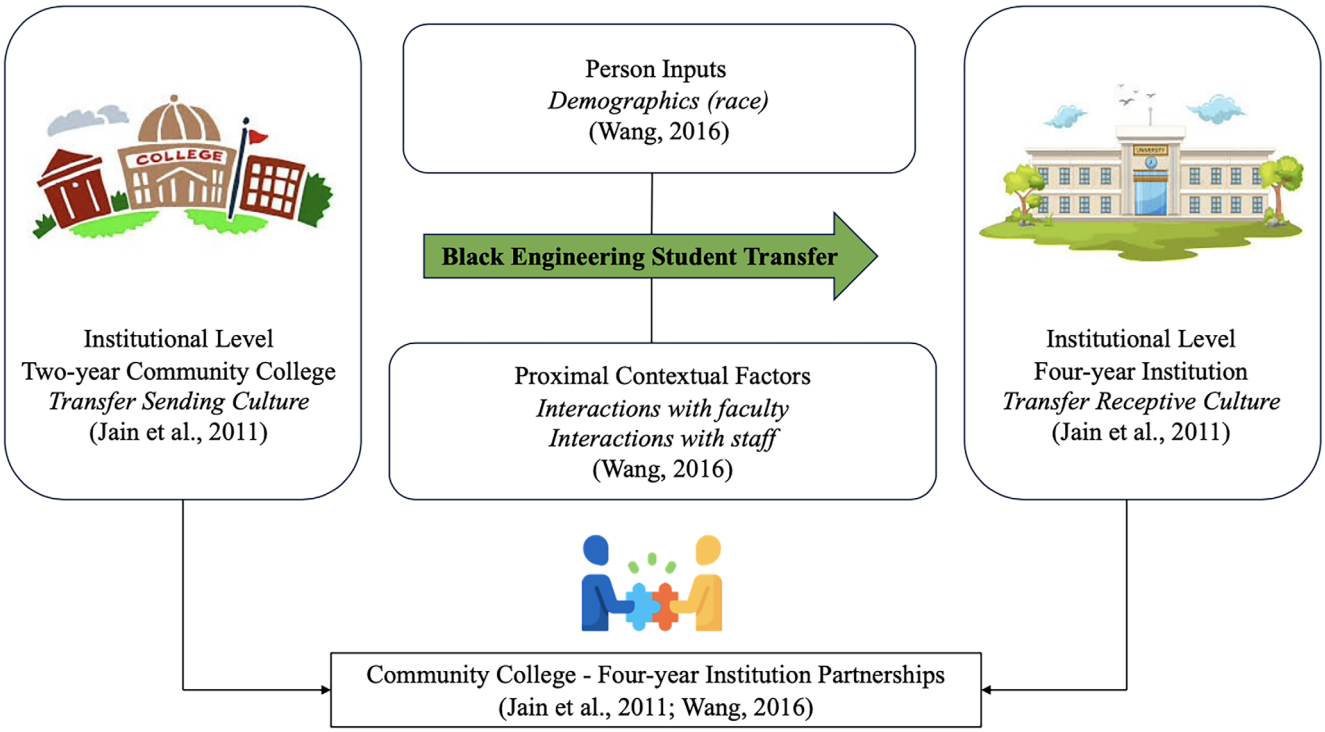

FIGURE 1 Integration of the STEM transfer model with a transfer sending culture and transfer receptive culture in the engineering transfer pathway.

that "race- ... disparities in transfer rates are even more salient within STEM fields and must be accounted for when investigating factors shaping STEM transfer" (Wang, 2016, p. 51).

Wang's (2016) model also suggests that "proximal contextual" factors that are situated at the institutional level, such as student interactions with faculty and advisors, contribute to STEM transfer. Wang (2016) also cites the importance of student-facing units within post-secondary institutions as well as partnerships between community colleges and 4-year institutions. Drawing from her other work, our perspective also considers the degree to which transfer pathways are clearly defined at the institutional level for students, and the extent to which they have to self-navigate these pathways (Wang et al., 2020). Additionally, we note that Wang's model (2016) has been used as a robust tool for understanding different stakeholders within the engineering and broader STEM transfer context. Not only does it name these stakeholders but it helps unpack their different motivations and the contexts that define their placement within the transfer ecosystem. However, Wang's model (Wang, 2016) does not examine challenges related to power and inter-group challenges across the STEM transfer domain within or across campuses. Thus, it is unclear from Wang's model (2016) how or to what extent issues related to institutional culture marginalize certain populations within engineering/STEM fields.

To complement Wang's model (2016) and to explore these and other campus-related issues that might impact Black engineering students, we also employed Jain et al.'s (2011, 2016) TRC framework in this article. With an examination of the critical relationship between community colleges and 4-year institutions, Jain et al. (2011, 2016) highlight the importance of both transfer-sending culture in community colleges and transfer-receptive culture in 4-year institutions for facilitating student transfer. Transfer-sending culture refers to certain norms within community colleges that promote transfer to 4-year schools (Jain et al., 2011, 2016). Within the 4-year institution, TRC is defined as "an institutional commitment ... to provide the support needed for students to transfer successfully" (Jain et al., 2011, p. 252). Additionally, TRC is important in creating welcoming transfer environments for students transitioning into 4-year campuses (Jain et al., 2011, 2016). TRC draws from Critical Race Theory to examine ways in which many 4-year institutions have operated within a racist and elitist space to overlook largely underserved community college students. While not explicitly stated, TRC is most likely appropriate for 4-year predominantly White institutions (PWIs). Given that State University (a public PWI) is the receiving institution for the student participants in this study, we consider TRC as an appropriate framework for analyzing our data.

Combined, both Wang's (2016) STEM transfer model and Jain et al.'s (2011) work on TSC and TRC allowed us a unique perspective with respect to this study. Integrated together, their work informed our understanding of what components impact engineering transfer, and the institutional cultures in which these components are situated. Figure 1 provides a visual representation of how we integrated these two frameworks for this study.

4 | RESEARCHER POSITIONALITIES

A positionality statement ensures trustworthiness, removes bias, and offers insights into the academic and even personal backgrounds of the author (Secules et al., 2021). Consistent with this approach, we acknowledge that both the primary and secondary authors for this paper have experience working as practitioners supporting transfer students. The primary author (Bruk) of this paper is an electrical engineer by training and was a transfer engineering student himself. He was also employed for over a decade as a recruitment director and coordinator in an engineering college. The second author (Shannon) currently serves as program director for transfer student advising and admissions, supporting students interested in transferring to a 4-year engineering college. Given their backgrounds, these authors share a scholar-practitioner lens that informs their overall understanding of this work.

The third author on this paper (Eunsil) is a materials science engineer by training, and pursues engineering education research that focuses primarily on how international engineering students maneuver through graduate school. The fourth author (Jingjing) is a postdoctoral scholar with educational backgrounds in mechanical engineering and higher education, and has research interests in community college access and engineering students' transfer pathways. Finally, the fifth author (Gabriel) is a civil engineer by training and first became involved in engineering diversity work over 50 years ago with the Society of Hispanic Professional Engineers. Gabriel also works with the 50k Coalition to develop strategies to address key objectives associated with engineering diversity, including engineering transfer-related objectives. Collectively, our research team brings a broad array of disciplinary engineering expertise, experience working with engineering transfer stakeholders, and interest in supporting diverse student populations.

Our collective backgrounds, particularly for Bruk and Shannon as scholar-practitioners, frame our ontology and epistemology. Our ontological and epistemological worldview draws from pragmatism, which emphasizes "real-world ... educational phenomena" (Weaver, 2018, p. 3). Pragmatism also emphasizes the connection between "thought and action," draws from "human experience, and [is] oriented toward solving practical problems" (Weaver, 2018, p. 2 and 3). We are largely informed by our positions, in which both Bruk and Shannon have regularly interacted with engineering transfer students. These interactions guide our overall worldview.

5 | METHODS

Our approach to this work was initially motivated by a desire to understand the experiences and perspectives of Black engineering students regarding the transfer process. Our primary research question is, *What do the experiences and perspectives of Black engineering transfer students reveal about the transfer process?* In thinking through how we would make meaning of and analyze the data, we added the following secondary research question: *To what extent do these experiences and perspectives align with literature within the domain of engineering, STEM, or higher education research?*

As noted above, our ontological and epistemological worldview draws from pragmatism. Both Bruk and Shannon are qualitative researchers by training and place emphasis on the lived experience of participants within the study. Eunsil and Jingjing follow a mixed-methods approach in their work but similarly place emphasis on the human experience when approaching research. Gabriel seeks to make meaning of the lived experiences of participants within particular systems (economic systems, educational systems, etc.) that are not always explicitly defined.

Data for this study were drawn from a 3-year project funded by the National Science Foundation (NSF), which explores factors that lead to transfer, persistence, and graduation (with a 4-year degree) in engineering for African diasporic students. We note here that our broader project explores within-group differences between Black engineering students born in sub-Saharan Africa and those born and raised in the United States. In a forthcoming article, we attend to these differences in detail and use specific descriptors when referencing the racial demographics of each of our participants (e.g., Black, African, Black American, Nigerian). This article, however, does not explore these differences and as such uses the term "Black" as a general descriptor for all participants.

The study's dataset includes 27 Black engineering students who were at various points of the transfer process. Data collection involved both individual interviews and focus groups and took place in two phases—in spring 2019 and in fall 2020. Therefore, findings from our study reflect student experiences prior to the COVID-19 pandemic as well as during the pandemic.

It is important to note that the experiences of our participants vary based on when their interview or focus group took place. For those students who were interviewed in spring 2019, the data collection process took place in person. However, our second phase of data collection was conducted via Zoom due to the nature of the pandemic. Students who were interviewed in fall 2020 reflected on their experiences with online course learning and challenges that were specific to the COVID-19 pandemic. The central theme of this article focuses on the transfer process. While students transferred at different points of the pandemic, COVID-19 did not arise as a critical theme impacting transfer. Rather, students tended to reflect on how the pandemic impacted their social engagement on the college campus as well as their classroom experiences. Therefore, given the scope of this article, we do not unpack the nuanced experiences of students as it relates to the pandemic. We plan to explore these themes in a future article.

All the participants in our study either already transferred or planned to transfer. Each one of the students who already transferred attended one large public, research-intensive PWI on the east coast of the United States, which we refer to as "State University" (a pseudonym). The prospective transfer students attended community colleges that serve as sending institutions to this university. In the section that follows, we provide details regarding the institutional context of these community colleges. Following this description, we elaborate on the data collection and analysis process.

5.1 | Institutional context

The three community colleges selected for this study are geographically central to State University and serve as feeder institutions to the 4-year school. Each of the three community colleges has been assigned a pseudonym: Central Community College (CCC), Southern Community College (SCC), and Northeastern Community College (NCC). In order to provide contextual information about each community college, our team spoke with institutional agents at each school to learn more about the campus profile. It is worth noting that some of our participants were recruited directly from State University; four of these participants attended three other community colleges that were not part of our initial study design. In Table 1, these community colleges are labeled "Other A," "Other B," and "Other C."

Owing to the nature of our study, we did not conduct informational interviews on these other campuses. However, we were able to review institutional websites in order to provide additional context for this article. It is important to note that the state where these community colleges reside has a systemwide articulation agreement that allows associate degrees to waive students of general education requirements. There are then specific engineering degrees offered at each school that provide a pathway for students to complete some, if not all, freshman- and sophomore-level degree requirements while enrolled at the community college. In Table 1, we provide contextual information about the three main community colleges in our study.

Comparatively, State University is a PWI. In Fall 2019, nearly 50% of students at State University identified as White and only 12% identified as Black. It is worth noting that these demographics are not representative of the larger geographic area where the university is situated. The State University campus is located just a few miles from an urban city center where Black residents make up the largest majority of people in the city. While this article does not focus on the students' experiences while at State University, it is important to note the demographics of the campus, as this can impact how students perceive and interact with the campus during the transfer process.

TABLE 1 Demographic information on three community colleges selected for inclusion in the study.

	Central Community College	Southern Community College	Northeastern Community College
Institutional size	>20,000 students	~14,000 students	>14,000 students
Demographics	Over 50% of students identify as either Black or Latine	40% of students identify as Black	30% of students identify as Black
Engineering faculty	Employs 8–9 faculty, (1 identifies as Black)	Employs two faculty (both identify as White)	Faculty data unavailable

TABLE 2 Background information on study participants.

Pseudonym	Gender	Year of birth	Community college attended	Stage in transfer process (pre- or post-transfer)	Major
Aman	Man	1990	CCC	Post	Electrical engineering
Paul	Man	–	CCC	Post	Aerospace engineering
Evie	Woman	1999	NCC	Post	Bioengineering
Mike J.	Man	1998	Other A	Post	Mechanical engineering
Will	Man	1997	CCC	Post	Chemical engineering
Debbie	Woman	1994	Other B	Post	Chemical engineering
Homa	Man	1997	CCC	Post	Electrical engineering
Yonas	Man	–	CCC	Pre	Computer engineering
Mira	Woman	1998	CCC	Post	Mechanical engineering
Jake T.	Man	1991	Other A	Post	Civil engineering
Mike E.	Man	1996	CCC	Post	Electrical engineering
Leila	Woman	1989	CCC	Post	Bioengineering
Douglas	Man	1997	SCC	Post	Electrical engineering
Thomas	Man	2002	NCC	Pre	Civil engineering
Charles	Man	1995	SCC	Pre	Mechanical engineering
Marcel	Man	1999	SCC	Pre	Civil engineering, fire protection
Jackson	Man	2001	SCC	Post	Aerospace engineering
Xavier	Man	2000	SCC	Post	Civil engineering
Lauren	Woman	2001	NCC	Pre	Computer engineering, mechanical engineering
Uchie	Man	2000	SCC	Post	Mechanical engineering
Jake A.	Man	1999	SCC	Pre	Electrical engineering
Ricardo	Man	1994	CCC	Post	Chemical engineering
Alex	Man	2000	SCC	Post	Computer engineering
Adisa	Man	2002	SCC	Post	Mechanical engineering
Kam	Man	–	Other C	Post	Mechanical engineering
Solange	Woman	2002	NCC	Pre	Bioengineering, civil engineering, materials science and engineering
Mbarka	Man	2002	NCC	Pre	Mechanical engineering

Note: All dashes (–) in the chart indicate that the student did not provide the requested information.
Abbreviations: CCC, Central Community College; NCC, Northeastern Community College; SCC, Southern Community College.

5.2 | Data collection

In order to recruit participants and solicit demographic and other background information, our team partnered with academic advisors at State University and the three community colleges selected for this study. To be eligible for this study, students needed to either (i) be enrolled in an engineering program and have completed specific gateway course requirements that would make them eligible to transfer to the 4-year school, or (ii) have already transferred to State University from a local community college. Eligible participants were sent an email inviting them to participate in either an interview or focus group. Table 2 includes details regarding each participant, their transfer status, and the community college that they attended. Each community college was assigned a pseudonym, which is represented in the table. The vast majority of our participants transferred from one of these three community colleges with a few exceptions that are noted in our participant table.

Advisors, in collaboration with the registrar's office at the community colleges and State University, downloaded lists of eligible students and sent them an email inviting them to participate in our study. Those students who indicated

interest in the study were then asked to complete a demographic questionnaire in order to confirm their eligibility. The research team collected the information (presented in Table 2) through the questionnaires that respondents completed before each interview. As noted in the table, dashes (—) in the chart indicate that the student did not provide the requested information.

Once students completed the questionnaire, they were then invited to meet with us for either an individual interview or focus group. We offered all students the opportunity to attend a focus group, but, due to some scheduling conflicts or low attendance at the scheduled focus group session, some data collection was done through individual interviews. Interviews are useful in providing an in-depth understanding of student experiences and the way in which students make meaning of these experiences (Creswell & Poth, 2016). The interviews for this study were semi-structured. This allowed the researchers the opportunity to ask a planned series of questions, while also offering the flexibility to seek further clarification.

We relied on Wang's (2016) STEM Transfer Model to develop our interview protocol. In particular, we paid particular attention to Wang's (2016) definition of "proximal contextual" factors in order to ask students about institutional-level factors such as student interactions with faculty and advisors. We did not draw from Jain et al.'s (2011) TRC or TSC frameworks initially because our focus was much more on the student experience than institutional transfer culture. However, in order to make meaning of the data as students interacted with their community colleges and State University, we ultimately drew from the STEM Transfer Model, TRC, and TSC in our analysis. We found that, although it was useful to think about these proximal contextual factors in developing this protocol, we realized that the factors that Wang (2016) describe are situated in very significant TSC and TRC. We discuss our use of both the STEM Transfer Model and these two frameworks in Section 8.

When we began this project, we developed a protocol that was used for the first phase of data collection in 2019. However, following the start of COVID-19, we amended our protocol to include questions about the student experience during the pandemic. Both interview/focus group protocols were developed with the STEM Transfer Model and broader literature in mind. These protocols both asked about the transfer process specifically and included questions such as the following: *How knowledgeable were you about the transfer process? What did you hear from your peers about the transfer process? How were you able to navigate the transfer process?* The interview/focus group protocols are included in Online Appendix A (pre-pandemic) and Online Appendix B (peri-pandemic), respectively. As noted above, student responses regarding the transfer process did not elicit themes related to the pandemic. As such, we do not explore the impact of the pandemic on the student experience in this article.

We note that we were not able to ask the full list of questions presented to each student, as we ran out of time during a few of the interviews/focus groups. However, we did ask the specific questions about transfer to all of our participants. In addition, we note that we received Institutional Review Board approval from Bruk's institution prior to administering these questions as well as other research instruments.

5.3 | Data analysis

Data were transcribed using Verbalink.com and transcriptions were shared with participants for member-checking. The research team then used Dedoose, a qualitative research software, to code the data and to begin data analysis (SocioCultural Research Consultants, LLC, 2023). Additional data analysis was done manually; the manual process involved hand-coding focus group transcripts for themes. Our analysis process (whether done via Dedoose or by hand) involved deductive coding, relying on themes drawn from the literature as well as themes that emerged from the data. The resulting themes, as well as the number and examples of responses that were classified within each theme, are provided in Table 3.

Each transcript was reviewed by at least two members of the research team, and all themes were discussed by the team to ensure that we were actively reflecting on emergent patterns within the data. To ensure that our methods were robust, our team engaged in a combination of analytic memoing, individual and group reflections, and member-checking (Tracy, 2010). The following is an example of an analytic memo from November 2020: "[Alex] shared his efforts to reach out/seek to find resources, such as research opportunities, on his own." This memo was drafted immediately following our interview with Alex and contributed to our understanding of how students navigate the transfer process on their own. Our process also involved reviewing and checking the coding of different team members and ensuring agreement on which code(s) were most appropriate for the data.

TABLE 3 Emergent themes, number of relevant quotes, and sample quotes.

Theme	Number of quotes	Sample quote
Theme 1: Faculty in community colleges	10	"Mr. [Samuel Tenley, a computer science professor], at the time. He was very helpful for me [with respect to transfer]. Also, two of my professors have been super helpful for me [in preparing for transfer], also, with just giving me general life advice and what not ...."
Theme 2: Advisors in community colleges and in the 4-year university	14	"I was able to email the transfer advisor at [State University], that really helped me a lot because I just kept emailing her all the time. Almost any time I had a question, she was the first person I emailed. And so ... it just helped me be more comfortable ...."
Theme 3: Campus support programs	14	"Since the first day I joined the [Diverse Male Student Initiative] club, there they were talking about transferring, transferring every day."
Theme 4: Navigating the engineering transfer requirements and the overall admission process	15	"Some people didn't get into the engineering school when they had a 4.0. And it was kind of like—it just didn't make any sense."

6 | LIMITATIONS

Our larger project criteria specified that participants have either already transferred or have completed one of three STEM courses that State University requires for engineering transfers. As we note later in this article, including this criterion limited our participants to students who demonstrated some success in early STEM courses like calculus. As a result, we did not include community college undergraduates who would have been deemed ineligible for engineering at the time because they did not meet the prerequisite mathematics. Indeed, for many community college students, including those who are Black or from other historically marginalized communities of color in engineering, moving through courses like developmental mathematics to Calculus 1 is difficult (Wolfe & Williams, 2014). Data reveals that just 11% of community college collegians who begin in developmental mathematics courses will eventually pass gatekeeper courses like Calculus 1 (Jaggars & Stacey, 2014). We plan to further investigate the trajectories of prospective Black engineering students who start in these more foundational mathematics courses in future projects.

7 | FINDINGS

The participants described experiences and perspectives that revealed a number of factors that impacted their transfer processes. These factors were mostly *institutional* components that shaped their engineering transfer pathways. Among these components were faculty at the community college, as well as advisors at both community colleges and State University. Other institutional factors included campus programs that exclusively focused on providing transfer assistance along with programs that offered other forms of co-curricular support.

In addition, numerous participants talked about how they navigated the engineering transfer requirements and the overall admission process. We focus on what seemed to be a complex, and at times even arduous, process for some participants. In addition, we provide data that highlights how several students managed this process with little to no assistance from campus staff.

7.1 | Faculty in community colleges

Participants from multiple institutions, including both students who had already transferred and those who intended to transfer, referred to specific faculty at their previous or current community colleges who offered valuable assistance. In most cases, the respondents indicated that these faculty were from different community college STEM departments. We reference those faculty using pseudonyms. Interestingly, no participants described these faculty or student–faculty interactions in a racial or ethnic context. Respondents described their experiences with these instructors in terms of what the faculty *did* rather than who they (or who the students) *were* demographically.

A number of students who previously or currently attended SCC consistently talked about Professor Eric Schmidt and how he helped them prepare for transfer. Marcel, a current SCC student, said, "we have our teachers ... like Professor Eric Schmidt. He teach[es] us physics and engineering ... and he always talk[s] to us about the classes that we need [to transfer]." Similarly, Jackson, a student who already transferred to State University, described how both Professor Schmidt and other STEM faculty offered valuable assistance:

> Mr. [Samuel Tenley, a computer science professor] ... He was very helpful for me [with respect to transfer]. Also, two of my professors have been super helpful for me [in preparing for transfer], also, Dr. [Anne Nichols]. She's my math teacher.

Students who attended Other A Community College also described faculty who were knowledgeable about transfer. Jake T., who attended Other A Community College before transferring to State University, said:

> At [Other A], in the basement of one of the engineering buildings there were professors who taught during the day but they'd stay at night and tutor students ... one of the teachers wasn't even like my professor, but she gave me like so much good advice just about everything, the whole school, the transfer process, everything ....

Mike J., another former Other A student now at State University, talked about how faculty at the community college were knowledgeable and "explained everything that I would need ... to transfer."

Louis, a pre-transfer student at NCC also shared the following about NCC: "In physics, our professor, he put on the board the requirements to transfer to [State University] and certain other schools, you know, what courses you had to take ...." Similarly, students who were previously or currently enrolled at CCC consistently talked about how Dr. Robert Winters provided them tremendous guidance. Leila, who transferred from CCC to State University, explained that Dr. Winters provided "guidelines about who to talk to" about engineering transfer. Aman, another former CCC engineering student now at State University, also had a positive impression of Dr. Winters:

> [Dr. Winters] said, "Where do you want to transfer?" I was like, "I have a question about where I should transfer." He was like, "Anywhere. Where do you want to go?" And then, that sort of things coming from people like Dr. [Winters] who went to the good schools who know, who have been at the college for a long time, it motivates you to work hard. And then, he was like, "Why are you even—if you want to go to Cornell, you should go to Cornell. That's your dream school."

From the collective responses of both Leila and Aman, not only was Dr. Winters aware of the "guidelines" for engineering transfer, but Dr. Winters also was able to "motivate" students to think about *multiple* transfer destinations.

7.2 | Advisors in community colleges and in the 4-year university

As in the case of faculty, students shared experiences that were almost exclusively positive with respect to advisors. Participants described how both community college and engineering advisors at State University impacted their transfer journey. Once more, while respondents talked about what these advisors did, they offered no evidence of racial or ethnic factors that were associated with the role that they played. We unpack the lack of attention to these factors in our data in Section 8.

7.2.1 | Advisors in community colleges

Comments from students suggested that the advisors across several community colleges played a key role in helping them transfer or prepare to transfer in the future. Students did not indicate that these advisors were associated with particular majors, so they may have been generalists who support students across all fields.

For students who attended SCC, engineering transfer-related advising appeared to be available from a broad range of sources. Adisa, a former SCC student who transferred to State University, shared, "I got most of the information I needed from my [community college] advisors, either from academic advisors or even other advisors in other clubs ...." Kam, who

attended the Other C Community College and also transferred, similarly remarked about receiving considerable advising help at his community college. Kam talked about receiving help from "a bunch of advisors" who "laid out a plan" for transfer. Finally, Thomas, a student from NCC who intended to transfer, similarly shared that while "talking to advisors when ... plan [ning] ... classes, they usually [would] bring up the [4-year] school website and they check the requirements for the different fields." As with Adisa and Kam, Thomas' campus appeared to provide the resources to make the transfer process clear.

7.2.2 | Advisors at State University

While the data shared earlier in this section referenced community college advisors in general, students referenced specific advisors when referring to the staff from State University. Again, we refer to specific advisors in the data using pseudonyms. One of these advisors was Dr. Lauren Phillips, director of transfer advising in the engineering college at State University. Several interviewees spoke extensively about how Dr. Phillips offered various forms of support maneuvering through transfer and their very positive perceptions of their advising sessions. For instance, Jackson, an engineering transfer student from SCC, said that: "I'd send [Dr. Phillips] lots of e-mails double checking that different things would transfer as they said it would. Because sometimes the websites aren't up to date or something like that, and so she was super helpful with that."

Alex, another transfer from SCC spoke about the safe space that Dr. Phillips provided:

> ... I was able to email the transfer advisor at [State University], that really helped me a lot because I just kept emailing her all the time. Almost any time I had a question, she was the first person I emailed. And so ... it just helped me be more comfortable with asking for help, because if not, I probably would not have spoken up about certain questions or things to find more about deadlines and when to apply and stuff like that.

Alex appeared to appreciate both the knowledge that Dr. Phillips provided, and the more "comfortable" environment for asking questions that Dr. Phillips offered.

In addition to Dr. Phillips, there were other specific advisors that students described. One of these advisors was Dr. Michelle Fare, who works in aerospace engineering at State University as an advising lead. According to Jackson, "[Dr. Fare] was also someone who I would sometimes go to about asking questions about stuff in aerospace, would this count for aerospace. And she introduced me actually to the [Special Program for Aerospace Engineering Transfers]." Dr. Fare provided a connection that proved very useful by way of this special program. We share more about this engineering transfer program and other transfer support programs in the following section.

Finally, outside of the college of engineering, students found Mr. Gerald Thomas to be crucial for transfer. Mr. Thomas is one of several university advisors at State University whose primary offices are based at regional community colleges; Gerald is based at SCC. Marcel, a pre-transfer student at SCC, shared that Mr. Thomas provided "all the list of classes that I had to take to transfer to State University." Overall, the experiences shared by the students about advising staff were very positive, both with respect to community college advisors and State University advisors. One exception to this was Kam, who, despite positive comments about his community college, described a difficult situation involving an advisor at State University. We share Alex's feedback later in Navigating the Engineering Transfer Requirements and the Overall Admission Process. Next, though, we describe a final set of institutional resources that assisted participants in transfer: campus support programs.

7.3 | Campus support programs

A number of participants described being a part of programs in their community colleges with a particular focus on achievement or co-curricular support. While these programs were not engineering/STEM-focused and did not all have an explicit transfer emphasis, they seemed to play a considerable role.

Several interviewees referenced minority-focused achievement groups that they were a part of in their community colleges. For example, when asked about support that he received in order to transfer to State University, Xavier talked about being part of a program at SCC for men of color. Xavier explained how the program functioned in this way:

> Basically what happened [in this program] was we had a motivational speaker was the head of the program and once a week or so, maybe for an hour or two, or something like that, he would I guess speak to us about kind of reaching our goals, and just filling us up with positive energy, and I liked it a lot.

Charles also joined this program and shared that it focused extensively on transfer, noting:

> Since the first day I joined [this program for men of color], there they were talking about transferring, transferring every day. I was kind of like, "What is this kind of meeting, every day we just remind people about transferring?" I say, "What? Change the subject. Talk about something new. Talk about something interesting." Don't every day say, "Take like 15 or 20 minutes to spend time and say, 'Oh, transfer—have you applied to this?'"

For Charles, there was in fact so much information shared about transferring that it seemed to become almost overwhelming.

Thomas similarly talked about a program for underrepresented men that helped them transfer from NCC to a 4-year institution. Thomas remarked:

> The [Black Male Program] is a cohort at [NCC] for black minority males ... Basically, they help students try to—they usually help them, their students, know the resources available at HCC. They also help them with their process of transferring, making sure they get the right courses done.

Thomas perceived that this program benefited students by helping them with both the overall transfer process and the specific courses that they needed to do so.

In addition, a number of students were part of other community-college-sponsored scholarship programs that offered transfer support. Paul, another transfer from NCC, was accepted into a scholarship program while at the community college which Paul called "pretty nice, because it's for people trying to transfer to [State University]." Paul also thought it was "pretty nice" that this program transitioned to [State University], "which also guaranteed ... some funding" after transferring. Like Paul, Mike E., who was currently enrolled in NCC, was part of a scholarship community college program. Mike E. talked about receiving multi-semester financial support and was "introduced [to] people [who presented] opportunities [for] transfer." In addition, Xavier from SCC talked about joining a scholarship program that also offered "step by step" guidance. Xavier also shared that "even when ... doing the [transfer] application, [program staff] were sitting right there."

Finally, students referenced programs based at State University. As noted earlier, Dr. Fare introduced Jackson to a transfer program specific to aerospace engineering students. This program offers funding to take a course in the summer that can reduce the time to degree by as much as 1 year post transfer. Another program that students referred to was the State University Guaranteed Admission Initiative, or GAI. Xavier explained that GAI "is just this seamless way of getting to [State University] when you have your associate's." Unfortunately, for both Xavier and Jackson, information on GAI was not readily available. Xavier noted:

> One thing I noticed about SCC was that, for example, with the nursing program, they make it so cut and so clear, "This is what you do and if you want to transfer, you can do this." 'Cause I feel at SCC, they took a lot more emphasis on other majors, but with engineering, it wasn't that much emphasis. So it was really just word of mouth. The only way I found [GAI and the scholarship program he was admitted to] was through word of mouth from somebody else, one of my classmates. So definitely it wasn't, "Okay, this is what you do to get here."

The fact that Xavier was able to navigate the engineering transfer pathway from SCC potentially had more to do with informal interactions with peers than with the formal infrastructure of the campus. Jackson likewise commented:

> I didn't find out about [GAI] until my last semester at [SCC], so I wasn't able to do anything with that. And then some of the biggest reasons that my time at [SCC] was so great for me graduating early and what not, it's because I definitely went out of my way to find out stuff, and ask certain people, and stuff, and what not. So I guess I don't know who needs to hear this, but if a lot of that information was more accessible to

> people, I think that would help a lot of people at the community colleges, if they didn't have to work so hard to find certain information out.

While these students were able to find valuable transfer-related information from faculty and advisors as evidenced by their earlier comments, they did not seem to know of all of the programmatic resources available to them early on. This lack of information on transfer, combined with some of the confusion that they encountered in the transfer process, as described in the next section, reveals some of the most salient challenges that this population faced.

7.4 | Navigating the engineering transfer requirements and the overall admission process

Another theme that arose among our participants was the experience of navigating engineering admission requirements. Many engineering degrees, including those at State University, have specific course requirements that students need to complete prior to submitting a transfer application. These requirements were often confusing for students. At times, students expressed that they were not aware of these requirements until they spoke with an advisor or faculty member. Other respondents talked about navigating the overall transfer admission process, describing it often as ambiguous and confusing. A number of respondents discussed having to maneuver through this part of the journey on their own, with little assistance from the types of institutional agents referred to earlier.

Several students' transfer journeys were impacted by the pressure of having to pass core STEM courses with minimum grades. Kam described these requirements, and the emotions associated with meeting these requirements, as follows:

> So one of the requirements to get into the [engineering college at State University] is that you have to pass Calculus 2 with a B. And when I took Calculus 2 in my community college, I had a C, and the requirement was that you can't do Calculus 2 more than two times. And I did Calculus 2 twice, and I got a C both times. So, when I talked to ... the advisor, the [State University] advisor that was stationed at Other C Community College, my community college, she told me, she basically flat out told me that I could never get into the engineering program again. That's what she told me. So, that was like a discouragement because she told me that this is the requirement and you knew about this, but you can't get into, you can't do anything about it.

After describing what this denial into the engineering college, Kam learned that one could appeal the decision. However, Kam noted that the campus advisor "did not know that you could appeal" and "was looking for resources" without the help of the advising office. Kam experienced both "discouragement" and had to single-handedly manage the burden of finding ways to mitigate this situation.

Other students experienced distress related to the grades in certain courses or the overall GPA required in order to transfer. Michel, a transfer student from NCC, explained that not passing physics with a minimum grade caused some angst:

> I almost failed two classes. Like Physics I is my most difficult class ... Physics I and Physics II, I was about to fail, you know. And the professor curved the grade. So that one, I know those were the only classes I was worried about. I think I had like, I was supposed to have like a C but the professor curved it so I had a B. I was like, thank you.

Similar to the way in which Michel felt "worried," Jake, who earlier transitioned from SCC, had to manage the stress associated with the GPA requirement for transfer:

> ... The biggest barrier I had was not knowing that my prior institution GPA would factor into my current GPA. I understand why, but—it's very inconvenient ... I mean, I did relatively okay, but I think I had, like, a 2.5, 2.7, something like that. And to transfer to [State University], you need, like, a [3.0], which I was not there, so I had to play catch-up a little bit.

While Jake "understood" why this relatively low GPA might present a "barrier," it was created a large "inconvenien[ce]."

On the other hand, Douglas, another former SCC engineering student now at State University, applied—along with other undergraduates—with relatively high GPAs. Douglas described the situation in this way:

> Some people didn't get into the engineering school when they had a 4.0. And it was kind of like—it just didn't make any sense. [Laughter] And I understand a lot of other stuff has to do with being accepted into [State University] but what, y'know? And I think that's also the whole point of [SU]; I feel like there's no key. If they told everybody the key, then it wouldn't be like—you wouldn't choose the best people. It wouldn't be natural. But, yeah, I think just that whole thing was weird. A bunch of my friends went to the [SU] office, and they just went back and were like, "Well, okay, yeah, no, you were supposed to be in the engineering school, sorry." And then they put them in the engineering school. And I'm just like, "I don't understand this school. How do you make these mistakes like that?" Stuff like that. But that was difficult. That was ridiculous.

This "weird" and "difficult" problem was resolved only when Douglas and several friends traveled to State University. It is likely, however, that although this particular group of undergraduates successfully resolved these issues, these very same roadblocks may have prevented other students from being admitted to the engineering program at SU. We speak to the broader implications for these types of problems from a systems-level later in this article.

8 | DISCUSSION

In this section, we review our findings in the context of both extant literature and the STEM Transfer Model, as well as the TRC and transfer-sending culture frameworks. In reviewing these findings, we foreground this section by representing our two research questions: (i) *What do the experiences and perspectives of Black engineering transfer students reveal about the transfer process?* and (ii) *To what extent do these experiences and perspectives align with literature within the domain of engineering, STEM, or higher education research?* Our discussion below collectively answers both of these questions.

With respect to faculty, data from our study reaffirms the importance of encouraging community college professors who support students' transfer intentions. Interactions with these faculty buoyed students en route to transfer and underscore the importance of these interactions as proximal contextual factors (Wang, 2016). Students received a "roadmap" for transfer from the faculty, which included minimum grade requirements and other procedural guidance. As an example, Dr. Winters not only knew about this "roadmap," but "motivate[d]" Aman to "dream" about top-ranked engineering programs. As noted in previous studies, community college faculty who share this kind of knowledge with prospective engineering transfers can positively impact students' transfer pathways (Wang et al., 2017a; Winterer et al., 2020). Moreover, the motivation that Aman gained from exchanges with Dr. Winters aligns well with Bauer (2014) and Dowd et al.'s (2013) earlier work on the importance of faculty encouragement.

Students appeared not to be impacted by the lack of diversity among the mostly non-Black engineering and other STEM faculty. Whereas prior research (Coley & Vallas, 2015) references racial stereotyping that can impede Black community-college students, our population as a whole appeared to thrive with supportive and accessible professors across multiple campuses. While some earlier work suggests that Black faculty are better suited to serve Black community collegians in engineering (Coley & Vallas, 2015), the sense that these instructors were caring may have mitigated the need for them to be of the same race as the target population. As Fox et al. (2017) discuss in their research on Minority Serving Community Colleges (MSCCs), faculty and other institutional agents within these campuses often develop close relationships with Black and other underrepresented students. These relationships appear to facilitate engineering transfer regardless of the demographic backgrounds of the professors. This finding is consistent with prior research that finds professors and other instructors from multiple demographic backgrounds can have a similarly positive effect on students of color (Butz et al., 2019; May et al., 2024; Robnett et al., 2018). Our study and these previous investigations suggest that the race/ethnicity of faculty, particularly those who demonstrate care for their students, does not affect student outcomes in engineering fields.

Similarly, advisors—including program advisors for other units in community colleges and engineering advisors at State University—offered a breadth of valuable information about transfer. Participants received transfer advice both

from generalists at their sending institutions and from discipline-specific advisors in the engineering college at State University. As prior work suggests, the combination of advice from generalists and from advisors with a specialization in engineering can offer tremendous benefits for Black and other prospective transfer students (Berhane et al., 2023; Grote, 2020).

Overall, these comments and others, including students' references to campus support programs, suggest that students benefited from a transfer-sending culture at their respective community colleges (Jain et al., 2011). Our findings not only underscore the value of a transfer-sending culture for prospective Black engineering transfer students but also suggest the specific components that might define such a culture for this population. Indeed, data from this study suggest that not only are faculty and advisors crucial for promoting Black engineering transfer student pathways, but also are community college diversity efforts. Moreover, our results suggest that some MSCCs may be especially well equipped to create a transfer-sending culture for Black or even other historically marginalized students of color in engineering.

Furthermore, the presence of a 4-year university advisor on a community college campus, as in the case with Mr. Thomas—effectively a generalist at SCC employed by State University—reinforces the significance of partnerships between community college and 4-year within Wang's (2016) STEM Transfer Model. Additionally, Dr. Fare's capacity to both offer information on course acceptance *and* connect Jackson to the Special Program for Aerospace Engineering Transfers fits within Stanton-Salazar's (2011) social capital framework for institutional support. Stanton-Salazar (2011) illustrates how advisors like Dr. Fare offer two forms of support: (i) direct support, which encompasses the "provision ... of various funds of knowledge associated with ascension within an exclusionary education system" (in this case, within a specific engineering major within a large, PWI) and (ii) system linkage and networking support, which entails "recruiting students ... in [a] program, department, etc." (Stanton-Salazar, 2011, p. 1099 and 1101). Collectively, the access to knowledge and programs that people like Dr. Fare, Mr. Thomas, and Dr. Phillips provided suggests what a TRC might look like for Black engineering students.

In fact, the programmatic supports that students described both at the community colleges and at State University underscore their importance in the transfer process. These programs, combined with faculty/staff interactions, map well onto the model of co-curricular support for engineering (Lee & Matusovich, 2016). More specifically, our study illustrates the importance of community college programs that targeted Black males or other historically marginalized students of color in engineering.

Furthermore, while data from past work suggest that racial affinity programs *in engineering* are especially helpful (Granger, 2011), Xavier, Charles, and Thomas described campus offerings that targeted community college students who are Black or are from other historically marginalized communities of color, from all disciplines. This suggests that, at least in the case of African diasporic students, institutions that offer engaging opportunities for Black undergraduates can further promote engineering transfer. When considered alongside the other named initiatives that were more explicitly transfer- or engineering-focused, our results suggest that it is beneficial to provide *both* transfer/engineering programs and opportunities specific to Black undergraduates.

Despite the availability of all these campus resources, comments related to the grades and GPA that they earned versus those that they needed to transfer suggest that several of the participants found the process to be difficult. While prior literature has focused on the lack of available engineering prerequisite courses and course sequencing (Dunmire et al., 2016; Enriquez et al., 2013), the challenge for some of the participants was simply in passing these courses with a minimum grade or GPA. In Kam's case, earning a "C" two times in Calculus 2 nearly blocked further academic advancement beyond community college. In another instance, Jake's overall GPA posed a considerable "barrier." This suggests that the criteria required for persistence within community colleges may differ from the criteria required for transfer. At least in the case of Black students, this may further explain why despite community college enrollment being on par with their share of the US population, Black transfer is the lowest of any racial/ethnic group (Espinosa et al., 2019).

Finally, in navigating the engineering transfer requirements and the overall admissions process, the confusion in the process and specifically around websites mirrors past scholarship (Fincher et al., 2014; Taylor, 2019). Further complicating the issue was that students had to figure out issues like appeals and incorrect admissions decisions on their own. This suggests that students operated "on their own" and that State University did not offer the type of TRC that they needed for a seamless transition. Fortunately, as noted earlier, the engineering college within State University seemed to have a TRC within itself that may have buffered the broader lack of a TRC.

9 | IMPLICATIONS

For the participants in this study, it is encouraging that they found institutional agents and other campus resources that could help them in the engineering transfer process. It is also laudable that some of these resources were established entities that would help not only Black engineering students but also other students of color and even majority students intending to transfer. As an example, people like Dr. Phillips have a full-time position that is entirely focused on engineering. Generalist advisors at community colleges as well as the faculty at those campuses are also in direct service positions that are fundamentally focused on engineering transfer. In this way, an engineering transfer infrastructure seems somewhat established within the State University context, as well as in its feeder institutions. By extension, it is foreseeable that within these campuses, future prospective Black engineering transfer students will continue to find these kinds of resources available to them within these colleges and State University.

Yet, there is a certain randomness to the way that these students engaged with at least some of these "proximal" entities. By implication, there may not be as robust of an infrastructure to ensure that future Black engineering transfer students have similar—if not better—experiences. For example, Xavier's and Jackson's comments about finding out about a transfer-specific program only through word of mouth implies that there is a potential for students to miss out on key information.

One means of ensuring that students do not miss this type of information is to develop a consistent list of transfer resources that advisors are regularly encouraged to share with students. This type of resource sharing can and should become part of a broader engineering transfer infrastructure, which can include all of the elements that students recognized as being beneficial in this study. For Black engineering students not only planning to transfer to State University but also in other parts of the country with a limited focus on engineering transfer, we suggest a systems approach to create this type of infrastructure. Such an approach can ensure that regardless of the institutional type or history, elements that emerged as salient within this study can be replicated and firmly established.

Systems thinking approaches involve bringing together "groups or combinations of interrelated, interdependent, or interacting elements forming collective entities" in a "synergistic" way (Arnold & Wade, 2015, p. 675).

To provide guidance on how to move toward systems thinking for engineering transfer, we reference the Six Conditions of Systems Change framework developed by Kania et al. (2018). This framework identifies six conditions that impact the extent to which educational or social challenges are likely to change. We note that this framework was not discussed in Section 3 because it did not drive our research design. However, in considering the implications of our data, we came to understand that a systems approach can ensure that better engineering transfer processes are in place at increasingly more post-secondary schools.

Kania et al. (2018) categorize each of the six conditions of systems change in the following way: (i) Conditions that, when addressed, can lead to *structural change*. These are often referred to as explicit conditions. Conditions related to structural change include policies, practices, and resource flows, as discussed below. (ii) Conditions associated with making *relational change*, also known as semi-explicit conditions. These include relationships/connections and power dynamics. (iii) Finally, conditions that can lead to *transformative change*, or implicit conditions, include mental models. We explain all of these conditions below. In presenting them, we also reference themes identified in our study to show where these themes fit within the engineering transfer "system," with attention in several instances to Black learners in particular.

A. *Policies* are defined as the written rules and regulations that govern activity within the system. From our findings, we see that admissions policies for engineering transfer are critical for undergraduates to both understand and navigate. When unclear, policies can reduce the number of Black engineering students who are able to successfully transition to schools like State University.
B. *Practices* refer to activities and behaviors that occur within the system. These are unwritten rules or habits that guide actions within the system. Our data indicate that advisors and faculty can exhibit certain habits that guide Black and other engineering transfer students, such as regularly sharing useful information about transfer. However, as noted above, institutionalizing these types of behaviors is critical for removing the randomness that can define the transfer process.
C. *Resource flows* are the ways that money, information, and other resources move through the system. In the context of this study, there were resource-related challenges related to the accessibility of information on general transfer policies on campus websites. We consider implications to be the degree to which Black and other marginalized students of color in engineering have access to that information.

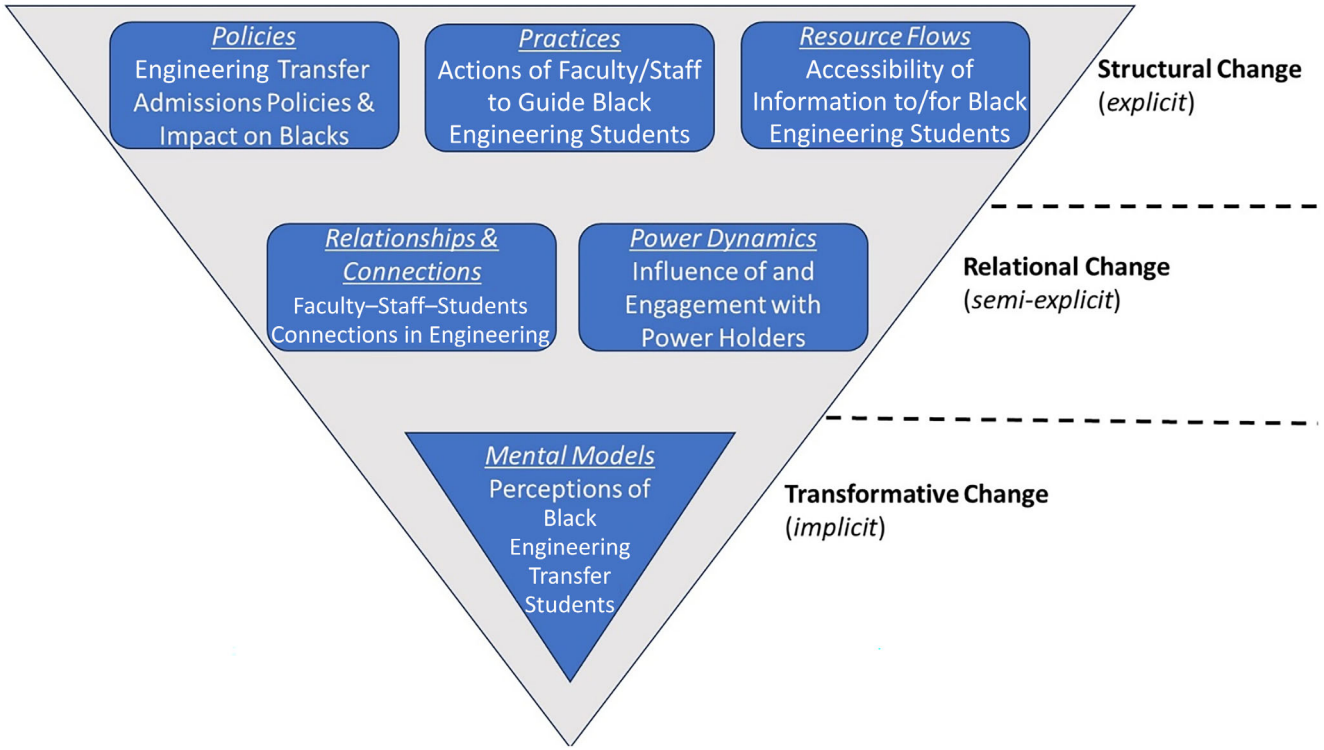

FIGURE 2 Six conditions of systems change for improving Black engineering transfer student pathways (Kania et al., 2018).

D. *Relationships and connections* are defined as the quality and connections between actors within the system. For our purposes, students' relationships with faculty or advisors with knowledge of engineering-specific majors can have a positive impact on them. At the same time, inter-institutional connections between community college and 4-year faculty/staff, such as those that participants had with Dr. Winters and Dr. Phillips, are likely to have immediate benefits on undergraduates transferring from one campus to another. A systems-approach to ensuring that all students, especially Black and other historically marginalized students of color, have connections to these types of faculty/staff, is critical for their engineering transfer success (Ogilvie et al., 2015). We also note that in our study, while several participants named diversity programs and transfer units on campus, none named the National Society of Black Engineers (NSBE). Given NSBE's commitment to serving Black engineering undergraduates (Ross & McGrade, 2016), it is key that NSBE become integrated well within the engineering transfer landscape. Relationships between NSBE and 2-year schools (MSCCs in particular) seem a logical, appropriate step to move toward systems-level change.

E. *Power dynamics* can be thought of as how influence is distributed and exercised within the system. Understanding this condition allows us to describe both those who make decisions and the impact of those decisions on others. In our context, Black engineering students like Douglas might face especially challenging situations when having to engage with power holders like senior staff in enrollment management. Providing students with the agency to advocate for themselves and educating admissions staff on the importance of supporting diverse transfer students can improve transfer processes for Black engineering students.

F. *Mental models* are the assumptions, beliefs, and values that people have about how systems function. While implicit and not expressly communicated, one might be able to deduce from a 4-year institution's TRC, or the lack thereof, the mental models that exist for Black engineering students. Poor perceptions of engineering transfer students within 4-year schools can be problematic (Minichiello, 2018), and so one might expect that for *Black* engineering transfer students, these perceptions can be layered with even more challenges. Part of addressing these models might involve a strategic approach to professional development on campus or even state-wide. Helping campuses or state systems to have a more welcoming TRC can be key to changing these mental models.

Figure 2 can aid in visualizing these conditions. Drawing from Kania et al.'s (2018) systems change framework, the figure shows the three aforementioned categories and the six conditions outlined above. Within each condition listed, we again reference themes specific to engineering transfer and, as appropriate, implications for Black students in particular. By addressing these six conditions constructively, we can expect positive change at a systems level for this population of students and potentially other engineering transfer students. We advocate for a new research agenda using systems-based approaches that elevate engineering transfer to a national level. We expect that this approach will not only introduce new scholarship but also fundamentally improve the number of Black engineering undergraduates nationwide.

10 | CONCLUSION

As Bragg (2021) noted in the recent report, *Reimagining Transfer for Student Success*, "the increased focus on racial injustice and widening socioeconomic gaps ... demand that higher education reduce the barriers for ... students of color to enable them to transfer, persist, and complete their degree" (p. v). Given the tendency for engineering to push away Black undergraduates, it is critical that transfer *within engineering* be straightforward and not become an additional barrier. We suggest that transfer in fact can be much more of an opportunity than a barrier when institutionalized and prioritized at a systems level. For example, in the context of the recent Supreme Court ruling on race-conscious admissions, transfer can become an opportunity for 4-year schools to diversify their campuses. By recruiting community college students, especially from MSCCs, 4-year engineering programs can find legal ways to increase the number of Black engineering students within their schools. We look forward to working with engineering education partners not only to test new strategies for increasing these numbers but also to implement systems-level components to ensure that these students graduate.

ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation under Award Nos. 1828619 and 2024081. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

ORCID

Bruk Berhane https://orcid.org/0000-0001-8164-1835
Shannon Buenaflor https://orcid.org/0000-0002-4023-8799
Eunsil Lee https://orcid.org/0000-0002-1200-2412
Jingjing Liu https://orcid.org/0000-0001-5485-1896

REFERENCES

50k Coalition Data Council. (2022a). *Undergraduate engineering enrollments*. [Data file]. Prepared by Yoder Yamashita Group.

50k Coalition Data Council. (2022b). *Number of students who received an engineering bachelor's degree*. [Data file]. Prepared by Yoder Yamashita Group.

American Association of Community Colleges. (2022). *Fast facts*. https://www.aacc.nche.edu/2022/02/28/42888/

American Society for Engineering Education. (2019). *Total U.S. engineering enrollment* [Data file]. https://www.asee.org

Arnold, R. D., & Wade, J. P. (2015). A definition of systems thinking: A systems approach. *Procedia Computer Science*, *44*(2015), 669–678.

Arteaga, B. E. (2015). Applying culture in the community college counseling practice. *Community College Journal of Research and Practice*, *39*(8), 708–726.

Bahr, P. R., Jackson, G., McNaughtan, J., Oster, M., & Gross, J. (2017). Unrealized potential: Community college pathways to STEM baccalaureate degrees. *The Journal of Higher Education*, *88*(3), 430–478.

Bauer, K. (2014). Black male community college students and faculty–student engagement: Differences in faculty validation and time status. *Journal of Progressive Policy & Practice*, *2*(2), 157–164.

Berhane, B., Onuma, F., Buenaflor, S., Fries-Britt, S., & Ogwo, A. (2023). "They helped me to get through": Investigating institutional sources of support at two-year colleges that facilitate the transfer and persistence of Black engineering students. *Community College Review*, *51*(1), 103–127.

Bragg, D. D. (2021). *A portrait of student transfer and the awarding of credit toward degree completion*. American Council on Education.

Bush, E. C., & Lawson Bush, V. (2010). Calling out the elephant: An examination of African American male achievement in community colleges. *Journal of African American Males in Education (JAAME)*, *1*(1), 40–62.

Butz, A. R., Spencer, K., Thayer-Hart, N., Cabrera, I. E., & Byars-Winston, A. (2019). Mentors' motivation to address race/ethnicity in research mentoring relationships. *Journal of Diversity in Higher Education*, *12*(3), 242–254.

Coley, B. C., & Vallas, C. A. (2015). *Tapping into the talent: Exploring the barriers of the engineering transfer pathway*. Paper presented at the ASEE Annual Conference and Exposition. https://peer.asee.org/24795

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Dowd, A. C., Pak, J. H., & Bensimon, E. M. (2013). The role of institutional agents in promoting transfer access. *Education Policy Analysis Archives*, *21*(15), 1–40.

Dunmire, E. N., Enriquez, A. G., Langhoff, N. P., Montere, T. R., & Schiorring, E. (2016). *Developing resources to support comprehensive transfer engineering curricula: Assessing the effectiveness of a hybrid materials science course*. Paper presented at the ASEE Annual Conference and Exposition. https://peer.asee.org/26769

Enriquez, A. G., Cheung, E. P., & Reardon, T. (2013). *Strengthening community college engineering education through collaboration and technology*. Paper presented at the ASEE Annual Conference and Exposition. https://peer.asee.org/22475

Espinosa, L. L., Turk, J. M., Taylor, M., & Chessman, H. M. (2019). *Race and ethnicity in higher education: A status report* [Executive summary]. American Council on Education.

Fincher, M., Sharp, L., Burks, J., Lyon, K., Parker, M., Ward, J., Hall, A., Wilson, V., & Washington, B. (2014). Articulation visibility at two-year colleges. *Community College Journal of Research and Practice*, *38*(7), 684–692.

Fox, H. L., Thrill, C. R., & Zamani-Gallaher, E. M. (2017). *Serving racial minority students in STEM at minority-serving community colleges*. Office of Community College Research and Leadership.

Glynn, J. (2019). *Persistence: The success of students who transfer from community colleges to selective four-year institutions*. Jack Kent Cooke Foundation. https://www.jkcf.org/wpcontent/uploads/2019/01/Persistance-Jack-Kent-CookeFoundation.pdf

Granger, K. T. (2011). *African American engineering students at river city community college: Factors that improve transfer to four-year engineering degree programs*. University of Southern California.

Grote, D. M. (2020). *Enhancing the community college transfer pathway: Exploring aspects of transfer receptivity at 4-year institutions in engineering* [Unpublished doctoral dissertation]. Virginia Tech.

Grote, D. M., Knight, D. B., Lee, W. C., & Watford, B. A. (2020a). Exploring influences of policy collisions on transfer student access: Perspectives from street-level bureaucrats. *Educational Evaluation and Policy Analysis*, *42*(4), 576–602.

Grote, D. M., Knight, D. B., Lee, W. C., & Watford, B. A. (2020b). Navigating the curricular maze: Examining the complexities of articulated pathways for transfer students in engineering. *Community College Journal of Research and Practice*, *45*, 1–30.

Hayes, S., Lindeman, L., & Lukszo, C. (2020). The role of academic advisors in the development of transfer student capital. *NACADA Journal*, *40*(1), 49–63.

Henderson, J. A., Junqueira, W., Benjamin, L. S. S., Hines, E. M., Alarcón, J. D., Davis, J. L., & Cavazos, S. (2023). Circle of success—An interpretative phenomenological analysis of how Black engineering students experience success. *Journal of Engineering Education*, *112*(1), 403–417.

Holloman, T. K., Lee, W. C., London, J. S., Hawkins Ash, C. D., & Watford, B. A. (2021). The assessment cycle: Insights from a systematic literature review on broadening participation in engineering and computer science. *Journal of Engineering Education*, *110*(4), 1027–1048.

Holly, J., Jr. (2020). Disentangling engineering education research's anti-Blackness. *Journal of Engineering Education*, *109*(4), 629–635.

Institute of Medicine. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. The National Academies Press.

Jaggars, S. S., & Stacey, G. W. (2014). *What we know about developmental education outcomes. Research overview*. Community College Research Center, Teachers College, Columbia University. http://ccrc.tc.columbia.edu/media/k2/attachments/what-we-know-about-developmental-education-outcomes.pdf

Jain, D., Bernal, S., Lucero, I., Herrera, A., & Solorzano, D. (2016). Toward a critical race perspective of transfer: An exploration of a transfer receptive culture. *Community College Journal of Research and Practice*, *40*(12), 1013–1024.

Jain, D., Herrera, A., Bernal, S., & Solorzano, D. (2011). Critical race theory and the transfer function: Introducing a transfer receptive culture. *Community College Journal of Research and Practice*, *35*(3), 252–266.

Johnson, A. M. (2019). "I can turn it on when I need to": Pre-college integration, culture, and peer academic engagement among Black and Latino/a engineering students. *Sociology of Education*, *92*(1), 1–20.

Johnson, A. M. (2022). Collaborating in class: Social class context and peer help-seeking and help-giving in an elite engineering school. *American Sociological Review*, *87*(6), 981–1006.

Kania, J., Kramer, M., & Senge, P. (2018). *The water of systems change*. FSG. https://policycommons.net/artifacts/1847266/the-water-of-systems-change/2593518/

Laanan, F. S. (1998). *Beyond transfer shock: A study of students' college experiences and adjustment process at UCLA* [Unpublished doctoral dissertation]. University of California.

Laanan, F. S., & Jain, D. (2016). Advancing a new critical framework for transfer student research: Implications for institutional research. *New Directions for Institutional Research*, *2016*(170), 9–21.

Laanan, F. S., Starobin, S. S., & Eggleston, L. E. (2010). Adjustment of community college students at a four-year university: Role and relevance of transfer student capital for student retention. *Journal of College Student Retention: Research, Theory & Practice*, *12*(2), 175–209.

Lattuca, L. R., & Stark, J. S. (2011). *Shaping the college curriculum: Academic plans in context*. John Wiley & Sons.

Lattuca, L. R., Terenzini, P., Ro, H. K., & Knight, D. B. (2014). *America's overlooked engineers: Community colleges and diversity in undergraduate education*. Deep Blue. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/107460/Americas%20Overlooked%20Engineers%20FINAL.pdf?sequence=8&isAllowed=y

Lee, W. C., & Matusovich, H. M. (2016). A model of co-curricular support for undergraduate engineering students. *Journal of Engineering Education*, *105*(3), 406–430.

Lundberg, C. A., & Schreiner, L. A. (2004). Quality and frequency of faculty–student interaction as predictors of learning: An analysis by student race/ethnicity. *Journal of College Student Development*, *45*(5), 549–565.

Martin, J. P., Choe, N. H., Halter, J., Foster, M., Froyd, J., Borrego, M., & Winterer, E. R. (2019). Interventions supporting baccalaureate achievement of Latinx STEM students matriculating at 2-year institutions: A systematic review. *Journal of Research in Science Teaching*, *56*(4), 440–464.

May, R., Stanley, C., Soto-Arzat, A., & Ackerman, J. (2024). Does race, ethnicity or gender of the mentor affect whether they will be a "good mentor"? A qualitative analysis of students' perceptions. *Journal of Women and Minorities in Science and Engineering*, *30*(6), 85–107.

McGee, E. O., & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful Black mathematics and engineering students. *American Educational Research Journal*, *48*(6), 1347–1389. https://doi.org/10.3102/0002831211423972

McPhail, I. P. (2015). Enhancing the community college pathway to engineering careers for African American students. In J. B. Slaughter, Y. Tao, & W. Pearson, Jr. (Eds.), *Changing the face of engineering: The African American experience* (pp. 305–334). Johns Hopkins University Press.

Minichiello, A. (2018). From deficit thinking to counter storying: A narrative inquiry of nontraditional student experience within undergraduate engineering education. *International Journal of Education in Mathematics, Science and Technology*, *6*(3), 266–284.

Moser, K. (2012). *Redefining transfer student success: Transfer capital and the Laanan transfer students' questionnaire (L-TSQ) revisited* [Unpublished doctoral dissertation]. Iowa State University.

Ogilvie, A. M., & Knight, D. B. (2020). Engineering transfer students' reasons for starting at another institution and variation across subpopulations. *Journal of Hispanic Higher Education*, *19*(1), 69–83.

Ogilvie, A. M., Knight, D. B., Fuentes, A. A., Borrego, M., Nava, P. A., & Taylor, V. E. (2015). *Transfer student pathways to engineering degrees: A multi-institutional study based in Texas*. Paper presented at the IEEE Frontiers in Education Conference. https://peer.asee.org/27074

Packard, B. W. L., Gagnon, J. L., LaBelle, O., Jeffers, K., & Lynn, E. (2011). Women's experiences in the STEM community college transfer pathway. *Journal of Women and Minorities in Science and Engineering*, *17*(2), 129–147.

Packard, B. W. L., & Jeffers, K. C. (2013). Advising and progress in the community college STEM transfer pathway. *NACADA Journal*, *33*(2), 65–76.

Reeping, D., & Knight, D. B. (2021). Information asymmetries in web-based information for engineering transfer students. *Journal of Engineering Education*, *110*(2), 318–342.

Robnett, R. D., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M. M. (2018). The form and function of STEM research mentoring: A mixed-methods analysis focusing on ethnically diverse undergraduates and their mentors. *Emerging Adulthood*, *7*(3), 180–193.

Ross, M. S., & McGrade, S. (2016). *An exploration into the impacts of the National Society of Black Engineers (NSBE) on student persistence*. Paper presented at the ASEE Annual Conference and Exposition. https://peer.asee.org/27280

Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., L. Sánchez-Peña, M., & Svyantek, M. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, *110*(1), 19–43.

Seymour, E., & Hunter, A. (2019). *Talking about leaving revisited: Persistence, relocation, and loss in undergraduate STEM education*. Springer.

Slim, A., Kozlick, J., Heileman, G. L., & Abdallah, C. T. (2014). *The complexity of university curricula according to course cruciality*. Paper presented at the Eighth International Conference on Complex, Intelligent and Software Intensive Systems. https://doi.org/10.1109/CISIS.2014.34

Smith, L. M. (2016). *Effects of a support program on retention rates for African-American male community college students: An action research study* [Unpublished doctoral dissertation]. Capella University.

Smith, N. L., & Van Aken, E. M. (2020). Systematic literature review of persistence of engineering transfer students. *Journal of Engineering Education*, *109*(4), 865–883.

SocioCultural Research Cosultants, LLC. (2023). *Dedoose (Version 9.0.107), cloud application for managing, analyzing, and presenting qualitative and mixed method research data* [Software]. http://www.dedoose.com

Stanton-Salazar, R. D. (2011). A social capital framework for the study of institutional agents and their role in the empowerment of low-status students and youth. *Youth & Society*, *43*(3), 1066–1109.

Starobin, S. S., Smith, D. J., & Laanan, F. S. (2016). Deconstructing the transfer student capital: Intersect between cultural and social capital among female transfer students in STEM disciplines. *Community College Journal of Research and Practice*, *40*(12), 1040–1057.

Taylor, Z. W. (2019). Inarticulate transfer: Do community college students understand articulation agreements? *Community College Journal of Research and Practice*, *43*(1), 65–69.

Townsend, B. K., & Wilson, K. (2006). "A hand hold for a little bit": Factors facilitating the success of community college transfer students to a large research university. *Journal of College Student Development*, *47*(4), 439–456.

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, *16*, 837–851.

United States Census Bureau. (2023). *QuickFacts*. https://www.census.gov/quickfacts/fact/table/US/PST045223

Wade, R. H. (2012). *Feeling different: An examination of underrepresented minority community college students' major persistence intentions through the lens of STEM identity* [Unpublished doctoral dissertation]. University of Washington.

Wang, X. (2016). Upward transfer in STEM fields of study: A new conceptual framework and survey instrument for institutional research. *New Directions for Institutional Research*, *2016*(170), 49–60.

Wang, X., Chan, H. Y., Soffa, S. J., & Nachman, B. R. (2017a). A nuanced look at women in STEM fields at two-year colleges: Factors that shape female students' transfer intent. *Frontiers in Psychology*, *8*(146), 1–15.

Wang, X., Lee, S. Y., & Prevost, A. (2017b). The role of aspirational experiences and behaviors in cultivating momentum for transfer access in STEM: Variations across gender and race. *Community College Review*, *45*(4), 311–330.

Wang, X., Lee, S. Y., Nachman, B. R., & Zhu, X. (2020). It matters long before: How early exposure to faculty and advisors at baccalaureate institutions relates to upward transfer. *Educational Researcher*, *50*(2), 105–114. 0013189X20956659.

Wang, X., Lee, Y., & Wickersham, K. (2019). Exploring the relationship between longitudinal course-taking patterns and in-state transfer into stem fields of study. *The Journal of Higher Education*, *90*(2), 272–297.

Weaver, K. (2018). *The SAGE encyclopedia of educational research, measurement, and evaluation*. SAGE Publications. https://doi.org/10.4135/9781506326139

Wilson, D. (2014). Follow me to the baccalaureate: Reflections and advice from African American community college transfer student journeys. *Community College Enterprise*, *20*(2), 72–84.

Winterer, E. R., Froyd, J. E., Borrego, M., Martin, J. P., & Foster, M. (2020). Factors influencing the academic success of Latinx students matriculating at 2-year and transferring to 4-year US institutions—Implications for STEM majors: A systematic review of the literature. *International Journal of STEM Education*, *7*(1), 1–23.

Wolfe, J. D., & Williams, M. R. (2014). The impact of developmental mathematics courses and age, gender, and race and ethnicity on persistence and academic performance in Virginia community colleges. *Community College Journal of Research and Practice*, *38*(2–3), 144–153.

Zhang, Y., & Ozuna, T. (2015). Pathways to engineering: The validation experiences of transfer students. *Community College Journal of Research and Practice*, *39*(4), 355–365.

AUTHOR BIOGRAPHIES

Bruk Berhane, School of Universal Computing, Construction, and Engineering Education & STEM Transformation Institute, Florida International University, 10555 West Flagler Street, Miami, FL 33174, USA; bberhane@fiu.edu.

Shannon Buenaflor, Engineering Academic Services, A. James Clark School of Engineering, University of Maryland, 4298 Campus Drive, College Park, MD 20742, USA; shayes@umd.edu.

Eunsil Lee, Department of Engineering Education, University at Buffalo, 140 Capen Hall, Buffalo, NY 14260, USA; eunsille@buffalo.edu.

Jingjing Liu, School of Universal Computing, Construction, and Engineering Education & STEM Transformation Institute, Florida International University, 10555 West Flagler Street, Miami, FL 33174, USA; jinliu@fiu.edu.

Gabriel Najera, Najera Consulting Group, Inc., 15 Spinning Wheel Road, Suite 420, Hinsdale, IL 60521, USA; gnajera@najeraconsulting.com.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Berhane, B., Buenaflor, S., Lee, E., Liu, J., & Najera, G. (2024). Through their eyes: Understanding institutional factors that impact the transfer processes of Black engineering students. *Journal of Engineering Education*, *113*(3), 695–716. https://doi.org/10.1002/jee.20609