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RESEARCH ARTICLE

# Circle of success—An interpretative phenomenological analysis of how Black engineering students experience success

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## Abstract

**Background:** Though minoritized undergraduate engineering students earn less than 25% of engineering bachelor's degrees, minority-serving institutions (MSIs) are leading the way in producing a large percentage of those underrepresented engineering bachelor's degree holders. However, much of the published research about the experiences of underrepresented engineering students occurs within the context of predominantly White institutions. Upon deeper inspection into the apparent success of some MSIs, graduation rates of specific minoritized populations (e.g., Black students) remain critically low. This suggests that there is more to be learned about how to better support Black engineering students' success.

**Purpose:** We explored the experiences of Black undergraduate engineering students at a large public doctoral university with very high research activity.

**Design/Method:** We used interpretative phenomenological analysis to understand the experiences of eight participants.

**Findings:** We inductively developed two themes to describe how Black engineering students experience success at a Hispanic-serving institution, which include building success networks and implementing rules of engagement.

**Conclusion:** Participants enacted their cultural capital to construct their circles of success through the intentional engagement of others, resources, and themselves to realize success. This work sheds light on how Black students describe what it means to be successful in their engineering environment.

KEYWORDS

Black, broadening participation, engineering education, inclusivity, IPA, student diversity, underrepresentation

# 1 | INTRODUCTION

It is well-documented and understood that the participation, graduation, and retention rates of Black students in engineering undergraduate programs are alarmingly low (Barbara et al., 2020; Chen et al., 2018; Roy, 2018). Understanding how Black undergraduate engineering students persist to degree completion holds the potential for informing the development of programs and learning experiences that appropriately support them. Though for decades, a significant amount of literature has looked at factors that account for the lack of persistence of Black and other underrepresented students in engineering and science, technology, engineering and mathematics (STEM) more broadly (Busch-Vishniac & Jarosz, 2004; Cabrera et al., 1992; Seymour & Hewitt, 1997), much work has either intentionally or unintentionally used deficit framing (Schmidt, 2008; Valencia, 1997) and has been situated in the context of predominantly White institutions (Espinosa et al., 2019; Fleming et al., 2013). Thus, challenges such as low academic aspiration, poor academic preparation, and low self-efficacy (Ramos-Sánchez & Nichols, 2007; Terenzini et al., 1996) have been illuminated. Deficit thinking places the onus for failure and departure solely on the individual student rather than examining institutional barriers (Harper, 2010). Furthermore, deficit-framed studies do not foreground successful students' strategies to persist and complete their degrees.

As such, researchers have called for assets-based approaches to examining students' experiences in STEM (Castro, 2014; Harper, 2010; Mejia et al., 2018; Pawley, 2019). Recent studies have pointed to myriad reasons for low retention and completion rates among students of color, such as hostile environments (E. O. McGee, 2016, 2020), an underdeveloped sense of belonging in formal education spaces (Camacho & Lord, 2011), racial microaggressions (D. Solorzano et al., 2000), feelings of isolation, nonsupport, and inadequate/unfamiliar forms of encouragement (Fries-Britt & Kelly, 2005; E. O. McGee, 2016), and identity interference (Archer et al., 2014; Collins, 2018; Henderson et al., 2021). Though work that has sought to center the voices of students of color has provided key insights, they leave us wanting to know more about how we can increase the participation of Black students in engineering (Cokley, 2000; Palmer et al., 2010; Rodgers & Summers, 2008).

Contributing to the conversation, this study aimed to gather and share the experiences of Black undergraduate engineering students who persisted to upper-level status in their respective majors at a Hispanic-serving institution. As we designed this study with assets-based perspectives such as community cultural wealth (CCW) in mind, we present students' strategies for ultimately achieving success. In the next section, we synthesize select literature that informed the development of this study and data analysis.

# 2 | LITERATURE REVIEW

Because of the dearth of studies solely centering the voices of Black students, this literature review includes work centralizing factors that promote success for students from historically marginalized populations, such as internal motivation and social networks. In sharing this project, we attempt to "amass" more accounts of the success of Black students specifically (Burt, 2020; Nasir & Shah, 2011).

## 2.1 | Internal motivation

To begin, we drew from the literature calling attention to students' commitment to their own success. Students' success is driven by their aspirations (Mobley & Brawner, 2019; Samuelson & Litzler, 2016), persistence (Dika et al., 2018; Garriott et al., 2019), and academic self-efficacy/motivation (L. Huang et al., 2021; Mobley & Brawner, 2019). For example, in their study of 31 engineering students (11 Black and 20 Latino/a) at 11 universities, two of which were minority-serving institutions (MSIs), Samuelson and Litzler (2016) demonstrated that students' success was driven by aspirations such as a desire for a balanced life or having a career with enjoyable work. Students also describe succeeding because of their drive to actualize their dream of excelling and becoming an engineer (Dika et al., 2018; Garriott et al., 2019).

The literature has also shown that students learn to lean upon themselves for success through their ability to find and use resources and are often motivated to figure things out on their own (Mobley & Brawner, 2019). For example, Samuelson and Litzler (2016) highlight that minoritized students had an array of interpersonal skill sets that they leaned upon to succeed, such as the value of asking questions, managing time, building relationships, and having a solid work ethic. Students also attributed their success to self-initiated finding and connecting to campus resources such as tutoring, peer, or other social networks (L. Huang et al., 2021; Mobley & Brawner, 2019).

## 2.2 | Social networks

People such as family (Fleming et al., 2013; Mobley & Brawner, 2019; Puccia et al., 2021), peers (Dickerson & Zephirin, 2017; Litzler & Samuelson, 2013; Meador, 2018; Mobley & Brawner, 2019; Revelo & Baber, 2018), and professors (Fleming et al., 2013; Meador, 2018) have been highlighted as having a significant impact on the success of underrepresented students in STEM. Family support has been shown to manifest in several ways, such as financial and emotional support. For example, Puccia et al. (2021), in their investigation of how social capital provided by parents contributed to 55 students' (17 of whom were Black) decisions to pursue and persist in engineering, demonstrated the significance of crucial emotionally supportive and encouraging conversations. They call this out as a form of expressive social capital that students draw upon to succeed.

Research highlighting the significance of peer support has shown that students depend on their peers as academic supporters (Litzler & Samuelson, 2013) and as role models (Revelo & Baber, 2018), to name a few. Role model peers have enacted their roles in interesting ways. For example, Revelo and Baber (2018) demonstrated that role modeling has been used to combat notions of engineering incompetence and celebrate competence among Latina/o students. Engagement of peers through participation in student organizations has also been shown to be crucial to students developing a sense of belonging (Litzler & Samuelson, 2013), and at least in one single public Predominantly White Institution (PWI) setting (Dickerson & Zephirin, 2017) has been linked to more equitable student success outcomes for Black students (i.e., higher graduation rates and lower departure rates).

Last, existing literature has also shown that positive faculty interaction and mentorship in and out of class enhances student academic success, career preparation (Fleming et al., 2013), and self-efficacy beliefs (Dika et al., 2015; Litzler & Samuelson, 2013). For example, Allen et al. (2022) found that faculty helped first-generation Latinx students connect to campus, which is vital to their academic success. Likewise, Cole and Espinoza (2013) demonstrated that a positive student–faculty mentoring relationship improves engineering students' academic performance and degree attainment for minoritized students. In a multiple-method evaluation of an engineering enrichment program, Nguyen (2022) found that meaningful interaction with faculty prevented minoritized and women students from leaving engineering and kept them persisting to graduation.

In summary, we identified a need for this study as indicated by the fact that little work is focused on translating the experiences of Black undergraduate engineering students into institutionalized-supported systems. Further, existing literature shows attempts to address the need for more nuanced understandings of historically marginalized students in engineering. Still, it stops short of work focused on the nuanced needs of Black engineering undergraduate students, especially. Last, we build from work that employs assets-based perspectives such as CCW.

# 3 | ASSETS-BASED APPROACH

In implementing this project, it was important for the team to understand the participants' experience through an assets-based framing (Harper, 2010). One example, CCW, extends Bourdieu's notion of social reproduction via various forms of capital (Bourdieu, 1986; Bourdieu & Passeron, 1977) to move beyond the focus on dominant group values (Yosso, 2005). The CCW framework draws from critical race theory to demonstrate the need to understand and articulate cultural attributes and families and communities as assets that students build upon (Villalpando & Solórzano, 2005; Yosso, 2005). Yosso's CCW categories are described next (Denton et al., 2020; Villalpando & Solórzano, 2005; Yosso, 2005).

CCW posits that students bring "cultural wealth" to educational environments: in this case, undergraduate engineering education in a large public, Hispanic-serving institution in an urban setting. Yosso puts forward six forms of capital that students of color engage to navigate and succeed in educational settings. They are aspirational, linguistic, familial, navigational, social, and resistant capitals. Table 1 provides a summary.

We were guided by the inductive theoretical underpinnings of interpretative phenomenological analysis (IPA) (J. A. Smith & Nizza, 2021; J. Smith & Osborn, 2008). Thus, CCW was brought into the study to hone our sensitivity (Huff et al., 2021), that is to say, to help raise our awareness and sensitivity to participant responses. In this study, CCW was not used to design the interview protocol or deductively analyze data. CCW was, however, a useful assets-based frame to inform how we connected findings to existing knowledge and dissemination of this work. CCW also provided a vocabulary for articulating emergent findings among research team members that the team members of various experience levels were familiar with.

TABLE 1 Descriptions of Yosso's (2005) forms of capital.

| Capital | Definition |
|---|---|
| Aspirational | The ability of students to persist in the face of actual or perceived barriers |
| Linguistic | Communication skills that students possess in multiple languages or styles |
| Familial | Intersectionality of familial and cultural knowledge with an emphasis on the creation of community and the well-being of that community |
| Navigational | The array of skills that students learn to use to help them maneuver through educational institutions with dominant cultural norms and conditions that put them at risk of doing poorly or dropping out of school |
| Social | Networks of people and community resources that enable students to achieve their goals |
| Resistance | The skills and networks students use to challenge inequality |

## 4 | THE STUDY

An Institutional Review Board approved this study at the first author's institution. In this work, we aimed to understand the experiences of Black undergraduate engineering students at a large public doctoral university with very high research activity (Carnegie Classification of Institutions of Higher Education, 2021). To achieve this goal, we were guided by the following research question: How do Black engineering students experience academic success?

### 4.1 | Methods

For this study, we employed an IPA approach. We determined this method to be ideal as it allowed us to use our meaning-making perspective to explore how participants made meaning of significant life experiences (J. A. Smith & Nizza, 2021; J. Smith & Osborn, 2008). The dual interpretation that characterizes IPA is compelling and requires the analyst to employ the method to integrate empathy into their inquiry (J. Smith & Osborn, 2008). Given IPA's requirement for researchers to situate themselves within the richness of participants' data, we allocated significant time to understanding the research phenomenon within individual cases and across the collective participants' experiences. A more detailed description of our application of IPA is provided in the following subsections.

### 4.2 | Research design

We developed a semistructured interview protocol, as we were keenly interested in the experiential details of each participant. We therefore prioritized flexibility in our questioning and were willing to disregard rigidity for the opportunity to probe for rich context, as J. A. Smith and Nizza (2021) suggested. The protocol included open-ended interview questions inspired by the literature on underrepresentation in engineering and student persistence (e.g., Henderson et al., 2022; Ross et al., 2021; Yosso, 2005). Our interview questions probed students' understanding of their experiences with academic successes, engagement, and barriers. To illustrate our line of questioning, we offer the following examples: (a) Can you describe the experiences you have had while pursuing your engineering degree (both positive and negative)? (b) What barriers have you faced while pursuing your engineering degree? (c) What factors have helped you achieve success as an engineering student?

### 4.3 | Institutional context

Curtis College (pseudonym) is designated as a Hispanic-serving institution and an Asian American and Native American Pacific Islander-Serving Institution (AANAPISI). Although Hispanic Serving Institution (HSI)s represent a relatively small percentage of higher education institutions, they enroll 39% of all Hispanic students in the United States (Burbage & Glass, 2022).

The undergraduate population of Curtis College (Table 2) is generally composed of 10.2% Black students, 23.0% Asian American students, 36.5% Hispanic, 3.8% International, 5.3% Other, and 21.2% White students at the time of this study. Further, Table 2 provides a profile by ethnicity/race for the college of engineering and 4-year and 6-year graduation rates by race/ethnicity.

**TABLE 2** College of engineering enrollment, 4- and 6-year graduation percentages by race/ethnicity of enrolled students.

| Ethnicity | Campus enrollment (%) | Engineering college enrollment (%) | 4-Year graduation (%) | 6-Year graduation (%) |
|---|---|---|---|---|
| Black | 10.2 | 4.87 | 11.0 | 47.0 |
| Asian American | 23.0 | 20.93 | 18.0 | 64.0 |
| Hispanic | 36.5 | 27.62 | 13.0 | 51.0 |
| International | 3.8 | 20.44 | 11.0 | 62.0 |
| Other | 5.3 | 5.56 | 12.0 | 64.0 |
| White | 21.2 | 20.58 | 15.0 | 50.0 |

The student population of the college of engineering is comprised of 27.4% women and 72.6% men. Among faculty within the college of engineering, there are 3 (2.1%) Black faculty members, 62 (43.1%) Asian American faculty members, four (2.8%) Hispanic faculty members, 10 (6.9%) international faculty members, 64 (44.4%) White faculty members, and 1 (0.7%) faculty member who identified as "other," of which 15.3% are women and 84.7% are men. Although Black engineering students are likely to graduate having few, if any, Black students in their classes or without having a same-race professor or professor of color, the institution's college of engineering has implemented support structures for students. For example, a student success program (Success Project, pseudonym) is open to all students within the college. Success Project was initially founded as a "Minority Engineering Program." The college annually hosts a back-to-school exposition in which student organizations (including affinity group organizations such as the National Society of Black Engineers or Society of Hispanic Professional Engineers) within the college can recruit new members.

### 4.4 | Participants

Our selection criteria were informed by Harper (2010), who contended that it is best to learn about student success from successful students. To be eligible for the study, participants were required to be:

1. 18 years or older;
2. an undergraduate engineering major at the junior level or above;
3. in good academic standing (i.e., current Grade Point Average (GPA) score of 2.8 or higher);
4. and a self-identified member of a minoritized group in engineering.

We report findings from eight Black participants. In accordance with IPA guidelines (J. A. Smith, 1996; J. Smith & Osborn, 2008), we sought to construct a homogeneous sample based on race/ethnicity and academic discipline. Due to the relatively low percentage of Black students within the college of engineering and the willingness of the students to participate, we decided to retain and include data collected from two participants who graduated during the data collection process; their experiences enhanced the quality of the insights formed and the overall richness of the study. The impact of this design decision is addressed further in the limitations section.

We engaged participants in a single-individual semistructured interview that lasted approximately 60 min. Table 3 presents a selective participant demographic profile that includes participant-selected pseudonyms.

The academic majors of the participants represented six of the eight undergraduate engineering majors offered at the institution. Five participants identified as women and three as men. At the commencement of the study, four students were juniors, and four were seniors (two of whom graduated during the course of the study).

## 5 | PROCEDURES

### 5.1 | Participant recruitment

To populate our participant sample, the Engineering College's Communications Office and engineering student organizations such as the National Society of Black Engineers, Society of Women Engineers, and Society of Hispanic

TABLE 3 Interview participants' pseudonyms and selected demographics.

| Pseudonym | Gender | Classification | Engineering major |
|---|---|---|---|
| Brenda | Woman | Junior | Civil |
| Cindy | Woman | Recent Alum | Chemical |
| Hemi | Woman | Junior | Industrial |
| Jessica | Woman | Senior | Chemical |
| Jordan | Man | Junior | Electrical |
| Magda | Woman | Senior | Chemical |
| Morgan | Man | Junior | Electrical |
| Paul | Man | Recent Alum | Mechanical |

Professional Engineers distributed an Institutional Review Board (IRB)-approved recruitment email. Snowball sampling was found to be most beneficial to the advancement of this study since, as J. A. Smith and Nizza (2021) noted, it may sometimes be challenging to find participants who meet the recruitment criteria. Students forwarded the recruitment email to peers whom they assumed would be interested in participating in the study, which augmented our recruitment efforts.

## 5.2 | Data collection

Before interviews, participants completed an online demographic form that requested information on their personal and professional backgrounds. Since this project represents a subunit of a larger ongoing study, it should be noted that participants were also invited to complete a survey instrument (not described in this manuscript), which sought to understand their classroom experience, experiences with faculty, peers, professors, and diversity, equity, and inclusion at their institution. Each participant selected a pseudonym (also used in the findings section). To maintain consistency and trustworthiness across interview sessions, two specific team members were charged with either individually or collaboratively conducting all semistructured interviews. Undergraduate team members knew several study participants from class and personal interaction. We view this as an asset, and they were likely able to develop a rapport that could have led to participants being more willing and comfortable with sharing their experiences (Prosek & Gibson, 2021). Though viewed as an asset, during data analysis, we were reflective about ensuring that findings were based on data, not personal relationships. All interviews were recorded and transcribed by an external transcription service, after which we identified and corrected minor transcription mistakes to ensure we conducted accurate analyses and presented trustworthy findings (Creswell & Creswell, 2017). Participants' verbatim quotes were reported throughout this work (Corden & Sainsbury, 2006). Doing so ensured that the authenticity of participants' "languaged" perceptions could be honored (Bhattacharya, 2017, p. 60).

## 5.3 | Data analysis

The first and second authors initiated and were guided by IPA procedures (J. Smith & Osborn, 2008). These researchers completed independent transcript reviews, which involved several passes of reading each transcript in detail. Following their review, these authors recorded hand-written descriptive and linguistic notes across the margins of each transcript (J. A. Smith et al., 2009; J. A. Smith & Nizza, 2021). As an adaptation to the traditional IPA design, we concurrently examined the description of the experiences participants recounted while examining their choice of language (Ross et al., 2021).

After identifying significant words and phrases, we reconvened to compare and discuss descriptive and linguistic notes. During these sessions, we developed conceptual-level annotations to interrogate these data within the context of our pre-understandings of the phenomenon (Ross et al., 2021; J. A. Smith et al., 2009; J. A. Smith & Nizza, 2021). These convenings, which we later coined "times of calibration" (Henderson et al., 2022), gave rise to conceptual questions that would ultimately inform "experiential theme development," formerly referred to as emergent theme development in earlier IPA literature (Martin et al., 2020; J. A. Smith & Nizza, 2021, p. 32).

By proceeding through these iterative stages of analysis, we could focus on the idiographic nuances of individual cases before engaging with cross-case levels of abstraction. Additionally, IPA's affordances for methodological flexibility allowed us to, as noted by J. A. Smith and Nizza (2021), avoid strict adherence to a "particularly prescriptive method" (p. 10). Instead, we attuned ourselves, where necessary, to practical considerations. One such example involved the integration of the descriptive, linguistic, and conceptual notes into a whiteboard conceptual cluster matrix (Miles & Huberman, 1994) and a shared Microsoft Excel spreadsheet for development into varying levels of themes.

Next, the fourth author, serving as a research auditor, conducted an independent audit. This audit involved "check [ing] the validity" of previous data analysis completed and developing a summary of themes based upon the findings of the first and second authors (J. A. Smith et al., 2009, p. 183). All research team members then came to a consensus on the final themes, as suggested by the auditor, and proceeded to make significant contributions to the preparation of the final manuscript.

## 6 | LIMITATIONS

Some limitations impacted the design of this study. While the authors delimited the study sample to Black undergraduate engineering students, an intentional decision was made to sustain the participation of two students who graduated while the study was in progress. This delimitation was justifiable on two pertinent grounds. First, limited prospective participants were available for recruitment within the student population at the institution (J. A. Smith & Nizza, 2021). This meant that if they were removed, fewer participants would be available to understand the phenomenon under investigation fully. While their inclusion may be perceived as a limitation, as it can be argued that the experiences of the recent graduates may have reduced the standard of homogeneity required in IPA, we felt sufficiently justified that any reduction in homogeneity was unlikely given that students held registered student status for the majority of the study. An additional limitation to the homogeneity of the sample was the inclusion of participants from diverse engineering specializations as opposed to, for example, one single discipline. The first author/study designer's research agenda primarily focuses on Black males' experiences in engineering. Given that the majority of this study sample consisted of women, it is possible that the interpretative perspective of the first author may have been less au courant with the intersectional nuances associated with the experiences of Black women in engineering. Two women researchers were a part of the research team to help lessen the effect of this limitation. Last, because we knew the research participants, we convened "times of calibration" to ensure that findings were grounded in data and not in our pre-established understanding of the social reality under investigation or our prior relationships with participants.

## 7 | POSITIONALITY

The positionality of the first author—a Black male assistant professor of engineering—served as a catalyst for the early conceptualization of the study. Having experienced and observed the reality of engineering education for Black students, he was inspired to conduct a study that would provide evidence-based recommendations for programmatic improvements for institutions seeking to support Black engineering students better. Other components of his research agenda include Black and Latino male engineering identity development and their persistence in engineering. In addition to his early contribution to the study design, the first author assisted with data collection, analysis, project guidance, and dissemination of results. The second and sixth authors are both Black male undergraduate engineering research assistants who are currently living their own engineering experiences. The second author identifies as Black Angolan, and the sixth author is Black American. They both assisted with data collection and analysis, having a unique "insider status." The fourth author is a Black male and an associate professor in school counseling. His research interests revolve around Black male academic and career outcomes and recruiting students of color in STEM careers. He served as the external auditor for this study (described above). Another of our authors included a female higher education researcher of Afro-Caribbean immigrant identity who explores minoritized learner experiences in various settings. This author contributed to the theme and manuscript development. Additional authors assisted with manuscript development and revisions and contributed to critique and "times of calibration."

# 8 | FINDINGS

Inspired by one of the participant's responses, "I've been around a circle of people that are also looking for those opportunities," our interpretation of participants' individual and collective experiences suggests that the success of Black students at this Hispanic-serving institution is grounded in their "circle" of success. Their circles of success consist of themselves and others in their social networks and resources. As they used their capital to determine how and when to use these resources, they ensured the completeness of their circles (i.e., ensured that their circles were unbroken). Two themes emerged describing how Black students at a Hispanic-serving institution experience success, including building success networks and implementing rules of engagement. Participants emphasize these factors as pivotal to their success. Table 4 summarizes and defines these themes.

## 8.1 | Building success networks

Participants emphasized that finding and engaging the right people was a crucial contribution to their success. Jordan described, "Oh yes, 100%. If I didn't have those people around me, there's no way I would have been able to do this." He does not believe that he would be able to complete his education without the support of his peers. Morgan also describes his success as a collaborative experience with his peers. He stated, "I feel like I'm at the school where I'm supposed to be. With my fellow students, I can make it through. I feel really confident in that." Morgan has found his people, and he points out that he feels that he is at the right institution. Jordan went further and said:

> If I wasn't in [the National Society of Black Engineers] NSBE, I wouldn't be as successful as I am right now just because there's a lot of opportunities that I am aware of now that I wasn't aware of before just because I've been around a circle of people that are also looking for those opportunities. Also, people that are older than me that had been able to tell me what exactly they would have done differently.

We learn from Jordan how he engages his peer network. First, he acknowledges and hinges his success on the people he has found and engaged through participation in the NSBE chapter. Not only that, he highlights senior peers or aspirant role models, who have gone where he hopes to go, to offer experiential-level advice. Next, the language Jordan used, "circle of people," reflects the continuum of support that he believed was crucial for his success. Jordan's network has been able to band together around this notion of "also looking for opportunities." Further, participants describe the function of their circle of connections. Magda said:

> I relied on senior students, so I started making connections which are really important. This is what I felt helped me the most, just making connections with senior students or whomever I can find. It was really, really helpful for me, and it did work for me to kind of change my perspective, change my studying methods and actually get to the point I am today.

When Magda made her connections, these connections challenged her to change, for example, her study methods. Magda also flat-out asked her peers for direction. She indicated, "I usually sought, or I was always seeking, someone to ask questions. I got to someone and asked how can I succeed in this class or succeed in this and that." She experienced success by finding peers and engaging them in critical conversation. As with others, these relationships were crucial to her success.

In contrast, though most participants had positive experiences finding and engaging their peers, Hemi said:

**TABLE 4** Themes and definitions of those themes.

| Theme | Definition |
|---|---|
| Building success networks | Intentionally developing a network of "selves" (interpersonal) and "self" (intrapersonal) that results in success |
| Implementing rules of engagement | The process of learning how and in what ways to use resources that contribute to success |

> Studying with other people has been very hard. People often clique up with people, not necessarily because you don't look like them, they don't want to study with you, but as humans, that's something—we like to be around people who look like us, and we can more closely relate to, so it's hard getting people to study with me because I don't look like them or we don't have similar backgrounds or upbringing.

Hemi's experience may very well be the experience of other students and is essential to note. She believed that cultural differences inhibited the enactment of these crucial relationships with peers in her classes. Hemi's experience also speaks to the importance of representation. If it is hard to find peers with "similar backgrounds or upbringing," it may be hard for some students to complete their "circle" of success. Though Hemi had this particular experience, it should also be noted that she found her people through her engagement with student organizations.

> There was never a sense of, "I'm here to support you. I'm here to help, and I want to see you do well." I didn't get that until, again, outside resources like NSBE, [National Action Counsel for Minorities in Engineering] NACME, [Success Project], the faculty in those kinds of orgs is what continued to push me to do well and just deal with it, the cards that I've been dealt with.

Hemi not only points out the impact of the organizations on her, but she also makes mention of the faculty who were engaged in these student organizations. Describing that the faculty she had found helped push her to success, Jessica (a senior chemical engineering major) also pointed out that her "circle of people," including a professor, was necessary for her success. She said, "and I ended up failing and I had to retake [the course], but thanks to all of the support and comfort like my friends, my family, but then also people like Dr. Graves (pseudonym)." These people provided the emotional support that she needed to persist.

Lastly, the participants also saw themselves as a part of this "circle." In this way, they helped us understand how they built agency and ownership of their own success. For example, Jessica explained:

> That was something I had found out early, and I just learned to study myself. Even as a senior now, I go to class, just to buy and read the textbook. I take note of whatever textbook we have to use. I just buy it and read it because I feel like a lot of the professors, some of them don't even want to explain how—some of them that do want to explain, I feel like they are so much in their heads that they don't understand that they have to bring it down to the average person's level.

Jessica explains that her success depends upon her being a self-directed learner. Unfortunately, she came to this realization because of experiences with professors, as she described, not wanting to explain course material to her. She has ultimately discovered the power of teaching herself. The implications of how Jessica arrived at this conclusion may also be relevant to other students in this setting. Brenda's lived experiences have brought her to a similar understanding. For example, being a successful student was an optimization process of self-discovery (i.e., discovering what worked best for her):

> You can't be successful unless you actually put in work. So regardless of if you have a team behind you, it's still up to you to put in the work. But I never ever felt like everyone didn't want me to succeed if that makes sense. So, it wasn't like I was doing this because I'm the only person that wants me to succeed. I know my professors care about me, and they actually want me to pass the class, so I can go to them if so, be it. I know the people around me want me to do well as well as these organizations, etcetera.

Though she admits to having social support, Brenda believes that hard work must be the driving force for success whether one has a team of support or not. She proudly exclaims, "I'm not going to get an A unless I work for an A."

In building networks, we see the cultural capital that participants employ to ensure their own success. For example, they were using their aspirations to fuel their interaction with their social networks and navigating to people who were also pursuing success while also resisting environments where they did not feel welcome.

## 8.2 | Rules of engaging resources

Participants' experiences of becoming successful engineering students are also centered in their ability to recognize and engage resources. This process often involved learning the rules of engagement at their institution, whether independently or through interaction with peers. In one practical example, Jessica shared how she learned to fund her education: "I learned to apply for ... scholarships ... one of the main barriers I initially faced was finances." This example of learning surfaced as Jessica shared the challenges she faced in funding her education. Through social networks and institutional support structures, she learned the skills needed to access financial resources that helped to alleviate stress, thereby contributing to her academic success.

Cindy spoke about the application of her capital for classroom resources and beyond:

> Go to office hours. I think not a lot of people go to office hours. I didn't go to office hours a lot, but I think those office hours are definitely very helpful. Talk to TAs if you have problems, ask questions.

Here Cindy names traditional forms of student support, such as attending office hours, interacting with teaching assistants, and networking with her peers, as crucial to her success. In addition, she has acquired additional capital in her higher learning process. She found value in looking for other spaces where help may be available. For example, she said, "Network in the classroom; I mean, I also had crossed to other classrooms [different sections of the same course] too because you don't know who knows what that can help you." Though nontraditional, she found that attending another section of the course was helpful for her.

Participants also described other resources that were important to their success. For example, Jessica highlighted the importance of her resource for success. She said,

> I felt like I just had to read the textbook and form my own study groups, so for all of my classes, I have my friends I text, and we take classes together, and we do the homework together.

Jessica demonstrates ownership of her academic success by reading the textbook and forming study groups. These are no new strategies; in fact, most professors recommend that students read textbooks and form study groups, but seeing a student take hold of these strategies and describe them as such might be what other students need to hear early on in their engineering journeys. Jessica elaborated, "I found out that the extra things I was doing were what was really helping me in most of my classes." Jessica described how she navigated to this strategy by saying, "I found out." This suggests that she had been in a process of discovery.

Cindy also highlighted the value of study groups as a resource. Interestingly, she emphasized how she was forced to find her study group. She said:

> I think—in my opinion, from my graduating [class], I felt when I came into that group, that set of classmates, I felt that they were very cliquey. They had their cliques like you see people in their groups, and I think when I started out, I think I was the only—was I the only Black girl in my class.

In trying to access other study groups that "felt cliquey," Cindy became more aware of her onliness within her cohort. This forced her not to give up but to be more persistent. She said, "I did meet some incredible people. A few of them, we would work together, we would study together, and we were able to help each other out throughout the program." Unlike Hemi, she emphasized the importance of her study group resource eventually being comprised of same-race peers. "Oh, there were like four or five other Black girls." Cindy's study group enabled not only her but also other members to get through the program, which was her measure of success. In a concluding statement, Cindy offered an additional reason why finding a study group was a vital resource. "I don't think anybody can make it by themselves. I mean, even if you make it, you're not going to make it so well." Cindy's comment offers a perspective for Black students who might feel isolated or as if they have to do it on their own. Her experience has led her to believe they do not have to do it alone.

In this section, we illustrated how participants experienced success by understanding the rules of engagement of resources, some traditional and some more innovative. As the field continues to grapple with increasing diverse representation in STEM, we offer assets-based insights for addressing this need.

## 9 | DISCUSSION AND RECOMMENDATIONS

This study continues to shed light on the ways Black students tap into their cultural assets to realize success in engineering. Our contribution adds to the body of work that situates student success within culturally relevant experiences and epistemologies. We also contribute to the knowledge base for an area that has been less explored: Black engineering students' experiences in non-PWI settings (Fleming et al., 2013). We observed that successful Black engineering students at an HSI engage in circles of success. Students engage their capital to determine what/who comprises their circles, but completing these circles yields success. This calls to question in what ways we can contribute to students completing their circles and in what ways institutional stakeholders are disrupting students' circles of success.

Previous research has also suggested that the persistence of Black students, typically at PWIs, can be tied to their participation in the National Society of Black Engineers (Dickerson & Zephirin, 2017). Our current work showcases similar experiences for Black students at a Hispanic-serving institution. Participants sought the help and expertise of upper-level peers, which they often encountered during their involvement in student organizations. Like Martin et al. (2020), which explored persistence through social capital among first-generation students at five large institutions, participants engaged their peers as both social/emotional supports and in practical ways (e.g., study groups suggested coursework). A key finding of this study is that participants' responses demonstrated that they believed their success was closely tied to finding "like-minded people" who desire success regardless of the actual or perceived challenges or barriers they might face (e.g., aspirational capital). Though family influence in the traditional sense did not show up, embedded within these findings, participants' experiences with peers can be likened to kinship (Yosso, 2005). They illustrate how crucial their "circles of people" are and describe their kinship-like dependence and reliance upon their community.

We know that social capital plays a crucial role in academic and career success. Following this line of thinking, we assert that resources should be provided to promote interactions with aspirational peers and facilitate systematic peer-to-peer mentoring. For example, based on what we have learned from these participants' own student support experiences, as well as previous studies, we believe that institutions should ensure institutional support (e.g., budget line items, study, and networking spaces) for interventions and student organizations that help students engage their navigational and social capital (Martin et al., 2020). Such a strategy has the potential to be impactful since these nonpecuniary forms of capital are generally found to be crucial to student success but are often left for students to "fundraise" on their own (Knaphus-Soran et al., 2021).

In addition, since participants were upper-level students who have encountered and learned the rules of academic engagement, we foresee significant benefits for institutions that design and support interventions that promote such developmental outcomes sooner rather than later in students' college careers. One example might be implementing student-centered advising approaches such as proactive advising (E. L. Allen et al., 2013). Proactive advising has the potential to build from students' existing assets, thus ensuring they can plan for and avoid potential barriers to success.

The first author, who is an engineering faculty member, suggests that it would be beneficial for engineering faculty to use assets-based strategies to enhance the development of cultural capital and the overall success of Black engineering students. Examples include reflecting on how we can use the classroom to promote peer interaction, learning about resources, and empowering students. An example of how the latter can be achieved is by giving small amounts of classroom time for students to meet their peers or giving space for student organizations to introduce themselves to students. Other recommendations include encouraging faculty members to proactively reach out and introduce themselves to students, providing greater clarity to students on the benefits of attending office hours (Martin et al., 2020), and helping facilitate the development of peer study groups, especially for first- or sophomore-year students.

## 10 | IMPLICATIONS FOR FUTURE RESEARCH

The findings of this study contribute to the conversation about how Black students engage their cultural capital to successfully navigate undergraduate engineering programs at MSIs, in this case, a Hispanic-serving institution. At the conclusion of this project, additional project ideas and questions arose that would help push the conversation further. One might envision exploring the experiences of other homogenous groups of students (e.g., Black women, first-year engineering students, Black men, or students from a specific engineering discipline) at this institution and beyond. Researchers should conduct longitudinal studies, obtaining interviews at various points during students' undergraduate trajectories, to understand their real-time experiences. Longitudinal studies may provide deeper insights into students'

lived experiences in engineering undergraduate programs. Moreover, similar studies should be extended to Historically Black College & University (HBCU)s and Tribal Colleges and Universities. Also, in the context of the institution described in this study, the experiences of sophomore-year students are of particular interest: while first-year retention is 82%, sophomore-year retention is 69%. Though, in this study, our participants did not mention the impact of family on their success, researchers suggest further investigating the role of familial capital and extended definitions of family on student success.

## 11 | CONCLUSIONS

This work supports the growing body of work related to the experiences of students of color in engineering. This work uniquely contributes to the literature by highlighting the perspectives of Black students at a large public southwestern doctoral university with very high research activity (Carnegie Classification of Institutions of Higher Education, 2021). Highlighting their assets, participants used their cultural capital to construct their circles of success through the deliberate engagement of others, resources, and themselves to achieve success. Much work is needed to further elucidate the experiences of underrepresented students at MSIs. MSIs remain a fertile test bed for investigations and student support. If those at MSIs can better support the "circles" (i.e., systems and mechanisms) that students are using to succeed, perhaps we can better inform and enact broadening participation in engineering. As the body of literature grows, some of the lessons learned about the experiences of students of color at MSIs can be used to develop transferable interventions that enhance quality education and promote student success.

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