

RESEARCH ARTICLE

Engineering while Black: An interpretative phenomenological analysis of Black males' construction and negotiation of engineering identity

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Abstract

Background: Despite ongoing efforts to broaden the participation of Black males in engineering, historical data point to a stagnation in their engineering bachelor's degree attainment. Furthermore, the relative dearth of literature that centers the voices of Black male engineering students has limited the propagation of positive change in producing more Black engineers.

Purpose: Given links between engineering identity and educational outcomes, such as persistence in engineering, we engaged engineering role identity to sensitize ourselves to themes that might emerge during the study of how Black male undergraduate engineering students constructed and negotiated their identities as engineers.

Design/Method: Guided by interpretative phenomenological analysis (IPA), we conducted semi-structured interviews with seven Black male engineering undergraduates to explore the following question: How do Black males construct and negotiate their engineering identities?

Results: We inductively developed three themes, namely "Identity as Others," "Identity as Validators," and "Identity as Representatives for All."

Conclusions: Findings highlight the psychological costs that these Black males experienced and how their racial and engineering identities were inseparable—what we describe as "Engineering While Black." At the same time, navigating engineering classrooms and workspaces demanded ongoing negotiation that cultivated a sense of agency and empowered participants to define and assert their identities on their own terms.

KEY WORDS

agency, Black male engineering students, engineering identity, interpretative phenomenological analysis, persistence in engineering

1 | INTRODUCTION

The persistent underrepresentation of Black males in engineering, other STEM disciplines, and professional fields speaks to the complexity of the challenges of broadening participation in engineering (Beddoes, 2011; London et al., 2020) and the need for interventions and scholarship that center the Black experience, identity development and negotiations, and agency toward improving engineering (Henderson et al., 2024; Holly & Lee, 2024). In part due to this underrepresentation, there is a scarcity of literature on the nuanced experiences and meaning-making of undergraduate Black males studying engineering (Benjamin & Henderson, 2024; Boyd-Sinkler et al., 2024; Rodriguez et al., 2018). By amplifying the voices of Black males in this study, we not only “amass” more successful accounts (Burt, 2020, p. 836; Nasir & Shah, 2011) but also aim to inform the development of data-driven interventions and strategies that can expand access, visibility, and voice for Black males within engineering spaces.

1.1 | Engineering while Black

The assets-based literature on Black males in engineering has shown that they are intrinsically motivated to persist in engineering despite many challenges (Burt et al., 2020; Moore et al., 2003; Tolbert Smith, 2022) that they might face, from access to quality early education to difficulties in the workplace. Instead of giving up, the literature shows, Black males develop mindsets and coping mechanisms to survive and thrive. These strategies include compartmentalizing academic versus personal experiences (Spencer, 2021) and adopting “prove them wrong” mindsets as a means of resistance (Brown et al., 2024; Moore et al., 2003). In addition to discussing the ways Black males respond to these experiences, scholars highlight the impact of familial (Burt et al., 2019; Fleming et al., 2013; Mobley & Brawner, 2018; Puccia et al., 2021; Tolbert Smith, 2022) and social networks such as peers and mentors (Brown et al., 2024; Dickerson & Zephirin, 2017; Fleming et al., 2013; Litzler & Samuelson, 2013; Revelo & Baber, 2018; Rangel et al., 2021) in the development of engineering identities of Black males.

1.2 | Black male engineering identity

The engineering identities of Black males are often seeded at an young age (Henderson, Snodgrass Rangel, et al., 2021; Henderson et al., 2024; Hines et al., 2024; Jett, 2023; Kyere et al., 2021). Along their journeys, they might experience constructive, detractive, and directional factors that impact their engineering identities (Morelock, 2017). Constructive factors are those that help students develop an engineering identity, while detractive factors weaken or inhibit engineering identity formation. On the other hand, directional factors help in shaping the nature (e.g., discipline, values, interests/motivation) of the engineering identity that forms (Henderson, Snodgrass Rangel, et al., 2021; Morelock, 2017). These factors might be experienced in or out of class, among faculty, staff, peers, within families, and in communities (Espino et al., 2024; Henderson, Hines, et al., 2021; Rodriguez et al., 2019). These factors and experiences have the power to push students toward or away from seeing themselves in the role of a professional engineer.

Recent engineering identity research on Black males, our work included, has focused on their experiences and identity in K-12 spaces (Henderson, Snodgrass Rangel, et al., 2021; Holly, 2020; Kyere et al., 2021) and at the graduate and professoriate levels (Burt et al., 2020; Henderson, Hines, et al., 2022; Henderson, Hines, et al., 2023; Slack et al., 2024). Less work has explored the engineering identities of Black males in undergraduate spaces (Henderson et al., 2024; Henderson, Benjamin, et al., 2022; Rodriguez et al., 2018). All of the studies that have specifically attempted to center Black male undergraduate student engineering and STEM identities (Berhane et al., 2020; Boyd-Sinkler et al., 2024; Brawner et al., 2024; Henderson et al., 2024; Henderson, Benjamin, et al., 2022; Spencer, 2024; White & Morton, 2024) point to the psychological costs of engineering while Black. Research suggests that Black males often contend with the ways they are recognized or not recognized in STEM (Henderson et al., 2024; Spencer, 2024; White & Morton, 2024; Wilson et al., 2024). Black males are also making sense of, navigating, and negotiating their places in engineering. Some have even described feelings that STEM was not created for them (White & Morton, 2024), while others find relationships through affinity groups, counterspace, religion, and family that create a sense of belonging (Brawner et al., 2024; McIntyre et al., 2024; White & Morton, 2024). The literature on Black male engineering identity further underscores the resilience and resistance of Black males (Henderson et al., 2024; White & Morton, 2024), as well as their ability to author their own identities despite detractive factors (Henderson et al., 2024; Henderson, Benjamin, et al., 2022).

1.3 | Research question and scholarly contributions

Research question: In this study, we seek to answer the question: “How do Black males construct and negotiate their engineering identities?” **Contributions:** This project is part of an ongoing study. Highlighting both research and methodological contributions, we specifically contribute to the literature by expanding research on Black males in engineering, focusing on engineering identity, and through our use of interpretative phenomenological analysis (IPA). First, the project exclusively centers the engineering identities of Black males. Data for this work were collected from participants who identify as Black, male, and enrolled in an engineering undergraduate program. In doing so, we disaggregate the voices of Black males from other minoritized racial groups as well as Black males in other STEM disciplines (Priddie, 2020). Next, although research on engineering identity has often been conceptualized as independent of racial identity (Berhane et al., 2020), studies show that, “how students are socially positioned and how they position themselves as engineers are gendered and racialized as students interact with external structures and internal ideations of what and who an engineer is (McIntyre et al., 2024, p. 1267).” Therefore, we aim to advance the conversation by examining how participants construct and negotiate their identities at the interface of being Black in engineering. Lastly, given the gravity and timeliness of this topic, our use of IPA is an intentional means to anchor our attention on the richness of individuals’ personal lived experiences before moving to larger cross-case analysis (Eatough & Smith, 2006; Smith & Nizza, 2021). It was also our way of “doing justice” (Sochacka et al., 2018, p. 371) to the participants.

2 | FRAMEWORK

2.1 | Engineering role identity

Researchers have long examined the concept of identity and how individuals experience and understand it (Erikson, 1968; Gee, 2001; Josselson, 1987; Kroger, 2007). Gee (2001) provided a notable contribution by equating identity with an understanding of what it means to be a “certain kind of person.” More recently, researchers (e.g., Godwin & Lee, 2017; Varelas et al., 2012; Carbone & Johnson, 2007; Hazari et al., 2010) have built upon the identity work of Gee (2001) and identified useful constructs for understanding engineering identity.

Engineering role identity is a useful construct for understanding engineering identity development further and its implications for the development of professional engineers (Morelock, 2017; Rodriguez et al., 2018). Engineering role identity encompasses both how students position themselves and are positioned by others to be the kind of individuals who engage in engineering (Godwin, 2016; Godwin & Lee, 2017; Henderson et al., 2024; Matusovich et al., 2011; Tonso, 2006). Role identity builds on prior qualitative work around STEM identity (Carbone & Johnson, 2007; Gee, 2001; Hazari et al., 2010). Engineering role identity consists of three dimensions: interest, recognition, and competence beliefs (Carbone & Johnson, 2007; Godwin, 2016; Hazari et al., 2010). For women and students of color (Pierrakos et al., 2009; Ross & Godwin, 2016), engineering role identity has been linked to several educational outcomes (Pierrakos et al., 2009; Ross & Godwin, 2016), such as choice of engineering major (Godwin, Kirn, et al., 2016; Godwin, Potvin, et al., 2016) and persistence in engineering or the lack thereof (Matusovich et al., 2011; Tonso, 2006).

2.2 | The use of theory in this study

Given the theoretical underpinnings of IPA, which involve recognizing participants as experiential experts and employing an inductive data analysis approach (Smith & Nizza, 2021), we carefully considered how to incorporate theory into this work. For example, we constructed the interview protocol by drawing on engineering role identity. For instance, we asked, “Tell me what comes to mind when you think about your identity/ies,” and “What is it like being a Black man studying engineering?” Because identity is both a theoretical construct and an experience near (Geertz, 1974) term used in everyday language, we explicitly, as other researchers have done, asked participants questions about identity but ensured that we left space for their own sense-making (Henderson et al., 2024). No participants requested clarification on what we meant by identity during interviews. The engineering role identity framework was also useful for helping the team to expand its interpretations beyond the experiential to the conceptual level of abstractions, while remaining grounded in the evidence and interview transcripts (Henderson et al., 2024).

3 | METHODS

IPA is a qualitative research approach that orients researchers to understand personal lived experience as interpreted by the individual and the researcher (Smith & Nizza, 2021; Smith & Osborn, 2008). The dual interpretation that characterizes IPA requires the researcher to employ the method to integrate empathy into their inquiry (Smith & Osborn, 2008). In our implementation of IPA, we allocated significant time to understand participants' experiences, focusing on an idiographic first, and then within the context of the entire group (Huff, Okai, et al., 2021; Huff, Walther, et al., 2021; Smith et al., 2009). A more detailed description of our application of IPA is provided in the following subsections.

3.1 | Protocol development

Our open-ended interview protocol was developed by the research team and refined with feedback from nationally recognized IPA scholars and qualitative research experts. The feedback was used to develop the final version that we employed in the study. We began interviews by asking an initial question to open up questions of experiences (McAdams, 2008). We used the first question to help participants to begin to organize their holistic experiences; it also allowed us to delve into the relevant experiential features of their experiences in greater depth (Huff & Brooks, 2024). We also encouraged participants not to be concerned with censoring their responses, which sometimes elicited colorful, thick, and rich responses (Geertz, 1974).

3.2 | Participant recruitment

We obtained Institutional Review Board (IRB) approval from the corresponding author's home institution to conduct this study. Our IRB-approved recruitment email was then shared with potential participants by engineering communications offices and colleagues. The email distribution list included all students within the college database whose gender was listed as male and whose race was Black or African American. We also requested that the local chapters of student groups, such as the National Society of Black Engineers (NSBE), share our recruitment email with their members.

3.3 | Meet the participants

The recruiting efforts for the larger grant-funded study yielded a total of 14 participants. Of these participants, seven identified as third-year students or above, Black, and male, and we designated them as the focus of this analysis. Table 1 highlights participants, their self-selected pseudonyms, and selected demographics that they shared with the study team. We provide short vignettes for each participant for additional context and to highlight a focus on the idiographic.

TABLE 1 Participant demographics.

Pseudonym	Year	Self-identified race/ethnicity	Engineering major	First-generation college student
Black Jesus	Third	Black	Mechanical	No
Mensa	Third	Black	Petroleum	Yes
Joe	Third	Black	Chemical	No
Tomas	Third	African American (Nigerian)	Chemical	Yes
Abo	Fifth	Black, African American (born Ethiopian)	Industrial	Yes
LeBron	Fifth	Black, African American	Mechanical	No
Amir	Fifth	Black	Mechanical	Yes

3.3.1 | Black Jesus

A product of Nairobi, Kenya, Black Jesus (BJ) is a 25-year-old, third-year mechanical engineering student who appreciates hip-hop music and his family history. In his interview, he detailed his family lineage, the origins of his name, and the associated context concerning his early life experiences growing up in Africa and his time in the Midwest United States, where he attempted to understand his new environment as a 10-year-old Black kid from Africa. Through the struggles of coming to the United States during an economic downturn and witnessing his father look for work for months, BJ discusses how his faith, religion, family, and community helped him to survive and thrive in his constantly changing new environment. BJ connects his early experiences as a youth in Kenya and later his time living in the Midwest United States to where he is today and where he hopes to go in the future. He associates the discipline required of his practice of Islam with the discipline required to be an engineer and contributes all the above to his ability to thrive as a Black male.

3.3.2 | Mensa

Mensa selected a pseudonym that had special meaning and connected him to others who had invested in his development and success. In describing his experiences, Mensa was open in recognizing and acknowledging those who had poured into his development as a person, husband, and engineer. Mensa, a name given to him by his mentor, is a show of respect for his intelligence, a desire to see him succeed, and, ultimately, an encouragement for him to take an intelligence test to see if he qualifies for membership in the international organization with the same name. Born in Atlanta, Georgia, Mensa is a 27-year-old, third-year petroleum engineering major. He described his early years in Atlanta, growing up in a close-knit household with his mother, father, and five siblings, which included both biological and step-siblings. Mensa described being the middle child, seeing his siblings chart their own paths, and feeling that there was still so much more for him to accomplish and milestones to reach. He described many experiences and events that not only led him to engineering but also motivated him to return to college after taking a 4-year break from his studies due to significant financial debts accumulated after his initial year in college. As a self-described tenacious and driven chameleon, Mensa shared how he uses painful experiences and setbacks as motivation to improve his future and ensure that his family and those he loves have a better future than he did in his past. As he described, when his self-motivation is lacking, he thinks of his family and his future to break through difficult seasons.

3.3.3 | Joe

Joe is a self-proclaimed, confident, and competent third-year chemical engineering student who stresses the importance of family, faith, discipline, and dependence on God for the strength he needs to live. As a child of two parents from East Africa, Joe learned about hard work and discipline from his parents and brother and has adopted these principles in his journey to complete his own engineering degree. For Joe, he did not have to go too far to find examples of what engineers do or what characteristics and actions are required to succeed. As an immigrant from East Africa, his dad came to the United States to earn a PhD in physical chemistry. His brother earned an engineering degree. In his own words, Joe strives to be the light to those around him, especially when things are tough. For Joe, the greatest compliment is when someone says he has made them smile.

3.3.4 | Tomas

Tomas is a third-year chemical engineering student with a Nigerian heritage. As an inquisitive adolescent, he was infatuated with solving math problems and understanding how things around him worked. For Tomas, the early years, especially his early academic successes and ability to break things and repair them before getting in trouble, proved to be the introduction to his growing interest in engineering. Even as a young child, around kindergarten age, he recalls exploring new things and enjoying and engaging with learning. Tomas describes himself as sweet, timid, and funny.

3.3.5 | Abo

Although born in Africa, Abo was raised in a single-parent home by his mother in the United States with his two older siblings. He described how times were hard during his early years growing up in Section 8 housing. Abo's mother brought the family to the United States from Ethiopia when Abo was around 8 years old. His mother worked to support his family on an annual income of around \$30,000 a year, nearly \$40,000 less than the median household income during that time (U.S. Census Bureau). Both Abo and his brother attended college to study engineering, and both earned their degrees. Abo referred to the early years of his life as a time when he was exploring what engineering was and how he could find his place in the profession. In describing his entry into engineering, he described going from following to seeking and exploring, and ultimately taking ownership of his future goals in engineering. When discussing the most important aspects of himself, he shared, "... My religion being very important, my family being also very important, and then career coming in next." He strongly depends on these three things to ensure that in the future his family will never be without shelter, food, and a safety net.

3.3.6 | LeBron

At the time of the interview, LeBron was a fifth-year senior studying mechanical engineering and planning to graduate in the upcoming spring term. He described himself as an adventurous, caring, sarcastic jokester who operates in one of two gears regularly – either "I do care, or I don't care. There is no in-between". As an adolescent, he and his family moved often because of his father's job as a border agent. These moves took him to places where seeing other Black people was uncommon, such as border towns in the Southwest United States. LeBron also spent time in the Air Force Reserves as an undergraduate student. Being in the Reserves provided him with resources to attend college and the motivation to succeed in the classroom, if for no other reason than not having to repay the Air Force for failing a class. As a senior in high school, he started exploring careers in engineering. Following high school graduation, he took a year to work and "earn bread" before beginning his undergraduate studies. Upon arriving at his current institution, he found what he considers his calling as an engineer and overcame many obstacles to get to the finish line.

3.3.7 | Amir

Amir is a fifth-year mechanical engineering student from St. Louis, MO. He describes himself as an introspective thinker who is laser-focused on his future self and how he is going to financially change his and his family's life because of engineering. Amir sees himself as the person who can change the trajectory of his family's future generations, which comes with joy in being chosen and pressure to be the one that everyone depends on to succeed. Many times, he stated, "it's all on me ... I got to go get it." He lives by the idea that if you really want it and work hard, you can make it happen. "All you need is one yes," Amir says. For him, leaving his family home to attend college was his opportunity to reinvent himself and become who he wants to be. Amir understands that the journey is never eventless and without problems. For him, he has bills to pay, his check engine light comes on too, and he does not always want to wake up when the alarm goes off at 4:30 am, especially after having to stay up late to study for an exam he had to pass the class. But it is all about focusing on "whatever it takes," according to Amir. His words conveyed this deep calling to do what has not been done before. Amir earned his engineering degree in 2024.

3.4 | Data collection

Prior to their interview, participants completed a pre-survey in which they shared their race/ethnic identity, engineering major, classification, and gender identity. Each Black male engineering student participated in a semi-structured interview, which we conducted via Zoom. On average, each interview lasted 75 min. Participants were eager to talk, which allowed researchers to quickly build rapport with them, making the interaction function more like a conversation than an interview. Several participants thanked us for making space for them to share their experiences, and some followed up by asking for career and academic advice and resources. After completing their interviews, we compensated each participant with a \$25 Visa gift card. We audio- and video-recorded all interviews. We posed follow-up

questions as necessary to obtain thorough and thoughtful responses (Breakwell & Rose, 1995). After each interview, authors 3 and 4 participated in a reflective meeting to capture real-time thoughts about what we learned from the interviews. This was our way of bracketing, so that our excitement and prior experiences would enhance rather than dominate data analysis (Maxwell, 2012). Authors 3 and 4 collaboratively conducted all interviews.

3.5 | Data analysis

Our analysis was guided by IPA procedures (J. Smith & Osborn, 2008). The first step in our iterative analysis process was to individually listen to interview recordings to reposition ourselves (authors 1, 3, and 4) as analysts (Smith & Nizza, 2021). Then, after several passes at transcript review, we annotated each transcript, making hand-written descriptive and linguistic notes in the page margins adjacent to key quotes (Smith et al., 2021; Smith & Nizza, 2021). We also developed individual electronic “codebooks,” which consisted of experiential statements (Smith et al., 2021) and clustered experiential statements (Smith et al., 2021). After reviewing the first transcript, we held a team meeting to discuss the emergent findings. At this convening, we posed general and conceptual questions (e.g., how do findings relate to participants’ identity development) to each other, which helped us interrogate and examine the credibility of our findings. Author 2 was instrumental in leading these discussions. The process of directing conceptual questions to one another regarding the formation and meaning associated with earlier annotations allowed us to examine these data within the context of our interpretations of the phenomenon (Ross et al., 2021; Smith et al., 2009; Smith & Nizza, 2021). We refer to this part of the analysis process as a time of calibration (Henderson, Hines, et al., 2022), as it provides an opportunity for the team to reconcile differing views and interrogate emergent findings. Led by authors 1 and 4, we then clustered the experiential statements into themes, developing themes supported by the experiential statements of the participants.

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 developed practical adaptations that suited our team. One such example involved integrating descriptive, linguistic, and conceptual notes into a whiteboard (PowerPoint in our case) conceptual cluster matrix (Miles & Huberman, 1994) and a shared Microsoft Excel spreadsheet for development into varying levels of themes (Henderson et al., 2024).

We repeated this process for each participant. After each individual transcript had been analyzed as a case (Smith & Nizza, 2021), we examined the entire dataset and our analysis of each case to generate themes that captured the shared experience of participants.

Next, the second author, serving as a research auditor, conducted an independent audit. This audit involved “check [ing] the validity” of data analysis and developing a summary of themes based on the findings of the first and fourth authors (Smith et al., 2009, p. 183). Finally, all research team members reached a consensus on the final themes, as suggested by the auditor, and made significant contributions to the preparation of the final manuscript.

4 | QUALITY

We engaged Walther et al. (2013) Qualifying Qualitative Research Quality (Q3) framework to ensure quality throughout this project. Adherence to this framework is a recognized measure of quality in STEM education research. We focused on theoretical, procedural, communicative, and pragmatic validation, as well as process reliability, during both *making data* and *handling data* (Walther et al., 2013, 2015). In *making data* to enhance quality, we implemented several steps. For instance, we gathered a team of varying levels of experience and positionalities and took a team approach to collecting data (e.g., multiple team members participated in interviews). We also had two researchers in the interview at all times. We believe that having two researchers involved in interviews who identified as Black and male, and whom participants perceived could relate to their experiences, helped elicit thick and rich conversations. Although the interviewers shared these two characteristics with participants, our divergent backgrounds also allowed different aspects of the conversation to resonate uniquely with each of us. We, therefore, collaborated in the interview process, supporting each other in asking follow-up questions as needed. We also assured participants that, when needed, they should use their own language, not struggle to use “fancy” or formal words, and be as authentic as possible. Finally, some participants requested more time to think about responses or asked for clarity on questions, and we provided that.

In *handling data*, first, we used a professional transcription service to transcribe the audio recordings of the interviews verbatim. Author 4 updated interview transcriptions to remove mistakes (process reliability). The team also spent considerable time with the data and repeatedly referred to and discussed the theoretical underpinnings of engaging IPA to maintain our methodological commitments to the research approach (Smith et al., 2021; Smith & Nizza, 2021). Lastly, we collectively situated ourselves in this research via a positionality statement to ensure that we were aware of aspects of our experiences that might influence the research process in positive and limiting ways (Jones et al., 2014).

5 | POSITIONALITY

The identities and positionalities of the researchers in this study are essential considerations. When employing interpretative qualitative methods, it is recommended that researchers acknowledge and bracket their biases, perspectives, and lived experiences (Maxwell, 2012; Smith & Nizza, 2021) as they explore the experiences of participants. In the following paragraphs, we describe aspects of our identities and positionalities that we judged relevant to this study.

The first author is a Black male in his third year of study as an undergraduate civil and environmental engineering major. As a third-year student, he has a unique insider perspective on the participants' experiences as he is living them himself. He has several leadership roles on campus. His dual role as a student and researcher enhances his insights and contribution to the research. He co-led data analysis. The second author is a Black male in his third year of study as a doctoral student in the Biomedical Engineering Department. He is also an instructor of engineering and engineering technology at a local community college. He holds an undergraduate and graduate degree in engineering. His insider status stems from past experiences as both a student and instructor, which also provides a unique perspective on the research, as he currently occupies both student and instructor roles simultaneously. He served as a peer debriefer and auditor in this stage of the project. The third author identifies as a Black male and is a research assistant professor at a College of Engineering. He holds an undergraduate and graduate degree in history and a doctorate in higher education administration. His work as a university faculty and researcher, whose scholarly and service interests center on Black male excellence, and his identity as a Black male and college degree holder contributes to his insider status. The author's two older brothers completed engineering degrees and worked in the industry for many years. His insider status provides a relatedness and vested interest in the topic. Although author 3 started his academic career as an engineering major, he never completed this major, thus giving him outsider status as having a non-engineering academic and professional background. These insider and outsider experiences assisted him in developing interview protocols, conducting interviews, analyzing data, and disseminating project findings.

The fourth author is an assistant professor of engineering who initiated the study. He identifies as a Black man. He has earned a bachelor's, master's, and Ph.D. degrees in engineering and often mentors Black male engineering students. He seeks to understand his students' experiences with empathy and spends countless hours mentoring them. In his approach to qualitative research, he seeks to lower barriers between the researcher and participant by employing methods that empower participants. He co-led data collection, analysis, and manuscript development.

6 | LIMITATIONS

As with other studies, some limitations may have impacted the study. For example, although part of a more extensive longitudinal study including first- through fifth-year students, we made a pragmatic decision to include only participants from the third year (e.g., juniors) or higher (e.g., seniors) in this analysis. Although the longitudinal study targeted first- and second-year engineering students, several third- and fifth-year students also responded. Owing to the small population of Black male engineering majors at the study site, and recognizing the value they bring to the broader discussion, we decided not to turn them away. Thus, we cannot address early college engineering identity constructions and negotiations. In addition, we included participants from several different engineering disciplines, but the sample did not reflect all of the engineering disciplines at the study site. There may be discipline-specific challenges and encounters that we did not capture. Lastly, because authors 1 and 4 knew the research participants, we convened "time [s] of calibration" to ensure that findings were grounded in data and not in our prior relationships with the participants. Authors 2 and 3 were especially helpful in that regard.

7 | FINDINGS

This study sought to understand how undergraduate Black males' engineering identities were constructed and negotiated. Using IPA, we developed three themes. The first two themes highlight the psychological factors involved in the construction of engineering identities as Black males. We discuss how feelings of being seen as "other" and the pressure to represent all were influencers of their identity. We then discuss how these Black males fought for their existence and recognition as Black males with engineering identities. Within this last theme, we illustrate how they successfully navigated engineering spaces.

7.1 | Identity as others

This first theme describes how participants felt their experiences in engineering as Black males caused them to have identities of "other" and how they navigated these identities. Othering is a concept which suggests that, in society, racism is connected to hierarchy and power. The concept of othering refers to the within-group similarities and connections, as well as between-group differences that create conflict in society. Grell-Brisk et al. (2020) wrote, "What 'they' are depends on, and is related to, what 'we' are and what 'I' am" (pp. 3–4). Ultimately, these ideas and perceptions can and often do influence expectations, behaviors, and the evaluations of others, from both within groups and between groups.

7.1.1 | Typecast as other than engineer

One example of how participants experienced being othered in settings both in and out of school was through feeling typecast based on their appearances or preconceived notions of who they are. Although they had identities as engineers, they were typecast as anything but engineers. For example, Abo said, "A lot of times, like when I was 19, 20 [years old], people [would] see me, and they would assume that I'm an artist or an athlete. Whenever I say I'm an engineer, it kind of catches them by surprise." The surprise element has persisted in Abo's life. For example, he described an experience from his summer internship. He said:

When I went to my internship in [City], [State], this was the summer of '22, most people didn't think I was an engineer. Actually, this happens quite frequently. It's not just during my internship. It happens quite frequently where people kind of guess my career or guess what I do for a living. It's not too often that people would guess that I'm an engineer.

Though Abo is wrapping up his college career, he already refers to himself as an engineer. He also attributes othering he experiences as a human occurrence. He said:

You may be just as smart or even smarter than the individual next to you, but just because humans psychologically like people who mirror them and who look similar to them, it feels like you don't have that advantage that the man next to you does, because the leader of that environment may be a Caucasian male.

When it comes down to it, Abo perceives that there may be certain advantages that come along with having leaders who look like you in engineering environments. Abo also makes sense of this experience by suggesting that the advantage might be based on something other than competence or being "just as smart" as his White counterparts.

The default assumption of others toward several of these young men is not to believe or identify them by the roles they believe themselves to be (i.e., engineers). Because of typecasting based on his appearance, Mensa navigates his experience by "trying to go the extra mile to make sure that I'm not looked at as this gangbanger or this thug or whatever." He said:

Just waking up and not knowing that you're going to make it back. To me, every day, that is one of the first things that's on my mind, me making it back home to my family, and it's sad. It is sad, but we are misunderstood a lot of the time.

He also points out the psychological stress and the grave consequences of not being believed for who he says he is.

LeBron also attributed the othering he had experienced to being typecast based on appearance. He said, “But I think when people see me sometimes, they’re like, ‘Oh, yes. That is a n****.’ [Laughter] I mean, that happens when you’re a Black male.” Though LeBron calls out the experience, his laughter is striking, as it appears to help him process the discomfort that he feels. He demonstrates that he has normalized the experience when he says, “I mean, that happens when you’re a Black male.”

On the other hand, Joe believes that the typecasting he has experienced has come from the projections of others. He said, “I’ve had an image put on me. I definitely have experienced someone’s preconceived notions of something they may have experienced or may have been told. I’ve seen how that can affect relationships before they even come to fruition.”

Here, Joe attributes some of his experiences to people not getting to know him, but from experiences they have had with others and, even worse, what they have been told, as if to say they have not taken the time to understand the experiences or backgrounds of others before making assumptions. Joe also describes his experience as a Black male in engineering as an extremely difficult fight. He said:

I think going more into that is like, I feel like—it’s [an] uphill battle. I feel like it’s not the same thing as not being a Black male engineering student ... I feel like for me personally, it may not just be something that is actually real, but you just feel like.

Several important points emerge from Joe’s experience. He first describes his experience as a Black male in engineering as a fight. Moreover, the fight is different. It seems to be fixed as it is an uphill battle—perhaps requiring more strength, energy, and effort. The additional layer of Joe’s battle is that he cannot seem to put his finger on the source of the challenge, but he perceives that his experience is different from the experience of those who are non-Black male engineering students.

Further, BJ described:

So realizing that, it’s really changed my perspective as who I am as an individual, because it doesn’t matter the type of person you are or the character of your—the principles that you carry, you’re Black. Those positive and/or negative connotations that come with that are bestowed upon me.

BJ highlights that the typecasting he feels is real, and he connects it to both positive and negative perceptions about his blackness. He cannot separate himself from those perceptions or his blackness that were “bestowed” upon him. They permeate his identity.

7.1.2 | Feeling isolated

This subsection highlights how participants describe experiencing isolation because they are different from the norm, do not look or fit the part of who others believe can be engineers, or do not feel that they belong entirely. Abo describes the pain. He said:

I’m also a sore thumb poking out because there’s only two or three of us ... my classes, there [are] two other Black men, but we don’t look at it that way because I guess, the school I’m at is Hispanic-serving as well. It’s pretty diverse, but once we leave the school, and we go into these work environments that aren’t too diverse, then it truly feels like we’re really sticking out, or I’m really sticking out.

He acknowledges that, because there are so few people who look like him, he feels out of place in some settings and not just out of place but “sore,” as if it is painful to exist in certain spaces. This effect appears to be mitigated but not entirely eliminated in his academic environment, which is more culturally diverse. This is evidenced by him bringing it up. It indicates that one could be in a diverse place (e.g., his university) but not feel entirely represented. This raises questions about what a critical mass of Black engineering students would be needed for Abo not to feel isolated at all. Furthermore, the sore thumb idiom carries the meaning of being significantly different in a noticeable way. The reason the thumb is initially sore is because of previous trauma it has experienced, as if, for example, it was hit by a hammer. There is an aspect of vulnerability here, where being the standout or “sore thumb” comes with a vulnerability that the

other fingers do not experience. Since the thumb is sore and swollen, it is now more vulnerable and has a higher chance of being hit again. This is an interesting parallel to how this participant experiences being recognized (or not) as an engineer. That is to say, to stand out based on physical character, yet to feel often isolated from other engineers whose identities may not be questioned or misrecognized.

Joe relates to being isolated because he does not see many other Black engineers. He describes his experience in a list. He first said, “So, I think from my perspective, when you’re a Black male engineer, the number one thing is you’re rare … there’s not many people like you.” He went on to say, “From what I’ve seen, oftentimes—I feel like you also may feel, I think, isolation.” As Joe shared his list and his use of the words “you” and “I think” at the linguistic level of analysis, we highlighted how this might have reflected his active meaning-making of the layers of his experience. Simply, his existence in engineering as someone not commonly seen yields isolation. Unfortunately, Joe, has experienced this for a long time. He said:

Even when I was younger taking AP and honors classes, it’s just the same common theme. It could just be like where I grew up, but you just don’t see many Black people in those types of classes.

Joe recognizes his experience as a “common theme.” He seems to have navigated this experience by normalizing the isolation associated with his engineering identity. This theme highlights how these young men made sense of their existence as Black men in engineering, how they experienced feeling othered, and how they navigated it.

7.2 | Identity as validators

This section describes how participants felt they had to validate their identities as Black male engineers. While many participants expressed pride in their accomplishments, they also described the emotional labor required to constantly validate their engineering identities.

First, participants described how they felt compelled to reassure, teach, show, or make visible to others who they were. For instance, Abo described typical interactions he has had. He stated:

Some people will say, “Wow, there’s no way,” or, “Are you sure?” things like that. Like, “What kind of engineer?” It almost seems like people aren’t truly understanding I’m an engineer until I break it down, explain to them, and reassure them that I am an engineer.

Abo illustrates the extra work required for him to be recognized as an engineer by others. For example, he had to “break it down,” “explain,” and “reassure” others that he is actually who he says he is. Breaking something down requires being confident and competent in the subject matter. In that, Abo has demonstrated confidence in his identity as an engineer. He also exhibits a willingness to engage others in this identity by teaching and reassuring them.

Similarly, Mensa feels he must go out of his way to dispel stereotypes and validate his identity. He explained that he often has to lead with assuring words such as “Don’t let my background fool you. I’m well-educated as well.” He expounded, “And then once people see, Oh, this is not a regular guy … they kind of, Oh, you’re cool people. Oh, you’re fine because … my personality is going to speak.” This calls to question who is the judge on or who gets to say that Mensa is “cool people” or “fine.” Is there a certain way that individuals must show up? What if he does not feel like working to dispel myths?

Joe describes how he validates who he is in classroom settings by carefully curating how he wants others to see him. He said:

I always try to make sure that people know I’m serious about what I’m doing, I’m not just here to mess around, like people know when I see Joe, I know that he’s serious about his school, his work. He tries to get everything done. He’s disciplined. He’s diligent.

Here, Joe describes how he attempts to manage people’s experiences and thoughts about him. His process is filled with the pressure of always having to be on. For example, he said, “I always make sure that before I enter a room like that, I’m coming in informed on the material, studying up so that—that’s one way people see me.”

LeBron, however, described that he weaves in and out of the necessity to validate who he is as an engineer. First, he said he felt compelled to “play the part” during his engineering internship. He said:

I'm probably the youngest, and there's not a lot of Black folks, I'm going to have the common sense to stay under the radar, kind of dress more the part to fit the scene that you're supposed to be in, and that's not to suck up to anyone else, but that's more so like to protect myself from something I could have avoided.

This raises the question: Why does LeBron feel he needs to stay “under the radar” to be protected? Is there a way to “dress more the part?” Who decides what “the part” is? Why does he feel he needs to hide to feel safe? One example of why LeBron might have decided that he needs to fly under the radar is given in this encounter, as in the one he experienced after class. He described it as a “microaggression.” He said:

I went to the professor ... I was just talking to him about my exam ... I was just thoroughly explaining why I didn't deserve this grade, and he told me to calm down. “Calm down. You don't have to get aggressive.” I was like, “What? What are you talking about?” I looked to the audience to see my friend, and he was just laughing. [Laughter] I was like, there's no way this is happening right now. I tried explaining it again as the same thing, and I was just like, “Okay. Let me just leave. I see where this is going, obviously.” I just walked out.

LeBron described feeling helpless in the presence of someone who should have been there to help him, and how his presence and questioning were perceived as aggression. This also highlights the ways people of color experience being both hyper-visible and yet invisible (O’Meara et al., 2018; Solórzano et al., 2000). In other words, his professor sees him, but does not see him. His active identity negotiation is exhibited here. He said:

Hey, man. I'm going to just do me ... I don't really care what you think. I think that attitude has continued until today like I don't really care what anyone thinks because I know that I'm competent in what I do. Who are they to me for me, like, why would I care about their opinion is kind of the approach that I take to it. You're definitely not my boss, but in saying that, I definitely do realize that perception is a lot.

He leans into his feeling of competence to protect himself from others' opinions. Lastly, LeBron exhibits that he might still be negotiating this stance, because he says that he understands that perceptions matter.

Another interesting way some participants used to construct their identities was by proving others wrong. For example, Amir described, “Whatever they may think I'm [majoring in]. I love proving to people that I deserve my spot at the table.” One example Amir shared was when his professor doubted him. He said, “Just this past semester, when my own professor told me to drop the class, and I passed.” He expounded:

I wanted to prove to her that I will never give up that win. I might be at rock bottom, which she made it seem. It felt like rock bottom and she couldn't look at me and told me I need to drop the class.

Though Amir was doing poorly in the class, he felt the impact of his professor not even being able to “look at” him. He described his exchange as an opportunity to thrive rather than be demoralized. He ended by saying, “This woman doesn't know me, know my capabilities. I will go to great lengths to prove it, and I did.” He ultimately completed the course. We note the linguistic transition in tone in Amir’s description of his professor from “my own professor” to “this woman.” This transition might indicate some distancing and disappointment.

LeBron described the outcome of proving others wrong. He said, “You're going to see the chapter where I'm just balling, just, Man, how did you do that, man?” For LeBron, thriving is connected to reaching a stage in his life where he is financially free and recognized as such. His baller status will indeed prove the naysayers wrong and perhaps convince them that he is a competent engineer.

7.3 | Identity as a representative for all

Last, participants constructed their identities as Black men in engineering as representatives for all. This representation often meant that their individual actions, performance, and behavior were not seen as personal, but rather as reflective of all Black males in engineering.

Joe describes how he represents all in his institutional setting. He said:

I guess you could say, kind of like leave a long-lasting stamp so when they see someone else that looks like me, they're like, "I know Joe and I know he's like this." I'm going to start with an assumption that someone else that looks like Joe is like this. Even though Joe may have [an] unpicked afro or Joe may have some cool earrings, Joe is still working this way.

Joe sees it as a necessity, based on his past experiences, to leave others with a good impression of those who look like him in engineering. He describes the pressure that comes along with this necessity to navigate in this way. He said:

Let me make sure that I'm on point. I don't know if that make sense. Because right here, right now, I'm a representative. I'm not just here as Joe. I'm here as representing a group of people that I want to represent in redeeming light and represent well, if that makes any sense.

Joe has taken ownership of this role and has consciously chosen to be a "redeeming light." As if to say he is that source of hope or positive change. This is a heavy responsibility for a 20-something-year-old, yet Joe has taken it on almost seamlessly. He then went on to explain why he took on this role. He said, "I feel like if I just coasted and I didn't do that, I'm doing a disservice because, especially even now, like I told you guys, there's not many people that look like me." Where others might be able to coast, as the representative, Joe believes that he cannot. Joe gave some insight into where this obligation came from. He said, "I don't think it's from anywhere else, but I feel like it's my job."

On the other hand, Amir, when describing his internship experience, views being a representative as a privilege. He said:

I get to let people see what a Black engineer is really about because I'll be the only one in there. That's even better because now I get to represent everybody. So being a Black man in engineering is, of course, not easy, but I love it.

Amir admits that being a Black male in engineering is not an easy experience, but he gladly takes on this role. Amir went on to describe the joy of having the privilege of setting the tone for others who might come after him. He explained:

It's lovely like when I go to these internships, it's like, yes, they see this kid at the table, but when I open my mouth and I express myself to what I need to say, it's like, "Oh." I catch people off guard. "This kid knows what he's talking about. This kid knows what he's doing." I love doing that because, one, I'm setting the tone for myself and two, I get to add on to changing the effects of the one who is coming behind me. So now, I represent Black engineering and I think that's great.

In this way, Amir believes he serves as a representative who actively breaks stereotypes. Tomas also describes how he negotiates his role as a representative. He said:

I should keep going because I'm an African American ... 7.2% of all chemical engineers are African American. Those are very small numbers, so we're trying to bump those up ... I don't want to say I'm making history, but [Laughter] I am making a difference by trying hard. I'm doing my part to improve the African American community.

He views his role as one of trying hard, and his work toward becoming an engineer will ultimately improve an entire community.

In closing, we end with a quote from Joe, who said, "So, we're all representatives of each other—Black male engineers are representatives of each other." Whatever the tensions these young men felt, they approached their interviews with clarity about their engineering identities and their desire to enact change for those coming after them so that perhaps those coming after them will not have to go through the same experiences.

8 | DISCUSSION

To address and support the needs of Black males in engineering, scholars, educators, and policymakers must understand their cultural backgrounds and identity constructions and negotiations. In this study, we highlight what researchers have called the complicated processes of identity production (Tonso, 2006). For example, although participants identified themselves as engineers and had confidence in their abilities and identities as engineers, they also grappled with and were impacted by how they were rarely recognized as engineers.

First, we demonstrated how participants navigated being positioned as others. Similar to previously published research that describes the experiences of students of color in engineering, our work uncovers some of those same challenges, such as loneliness, isolation (Malone & Barabino, 2009; McGee & Martin, 2011; Moore et al., 2003), and marginalization (Brooms, 2023; Pirtle et al., 2024). While our work starts there, using IPA allowed us to illustrate further the psychological implications of having engineering identities. Participants did so using colorful language to describe their identities as Black males in engineering, such as feeling like a “sore thumb,” and this invisible battle that they cannot seem to pinpoint. Some have described this as a microaggression (Pierce, 1974; Williams et al., 2003). Findings also highlight how participants construct their identities and demonstrate who is considered an engineer, especially when they are perceived as undeserving or unworthy of that identity (Brooms, 2024) or labeled by stereotypes (Cross & Paretti, 2020; McGee & Martin, 2011).

Similar to previous studies, our second theme demonstrates that although they have identities as engineers, these Black males grapple with not being recognized in STEM/engineering (Henderson et al., 2024; White & Morton, 2024). We also found that they responded with resilience. Rather than give in, participants curated how they are recognized and engage others through reassurance and teaching. Some researchers have named this as resilient identity: “the consistent view of oneself in spite of context that threaten the congruence of multiple identities” (Ross et al., 2021, p. 106). This clarity about who they are helps solidify their own engineering identities. Yet, we as researchers wonder, resilience at what cost? Black males may become exhausted from developing coping strategies (Smith, 2004).

Additionally, Moore and colleagues in 2003 described “prove them wrong” and called for further investigations of this attitude. More than a decade later, participants in this study described a desire to prove the naysayers (aka “Haters”) wrong, illustrating further that some challenges may not ever go away, but individuals adapt to overcome them. This study uniquely shows positive and negative psychological implications of “prove them wrong” attitudes. Some participants took ownership of proving others wrong, and one participant, Amir, even said that he loved proving that he should be at the “table.” Although this exhibits confidence in his abilities right now, the question becomes, is this attitude time-dependent? Will Amir (and others) always love proving that they belong? What happens when the fire to prove wrong becomes a burden to carry? Some participants already discussed and demonstrated that they were exhausted and were experiencing Racial Battle Fatigue (Smith, 2004) that manifested as exhaustion, anger, avoidance, and resistance. For instance, LeBron describes his engineering identity as requiring him to “play a part” to “stay under the radar.” These environments are not conducive to supporting positive work experiences or to broadening participation.

Lastly, participants highlighted how isolation and little recognition left them leaning into hope for the future, which involved the joy and privilege of being a representative for all Black males in engineering on one hand and the obligation to be a representative on the other. Some researchers have described this notion as Black tax (Griffin, 2012; Griffin & Reddick, 2011). However, to highlight the agency these young men use in curating their engineering identities, we point to their equity ethic (McGee & Bentley, 2017). According to McGee and Bentley, an equity ethic manifests in STEM students and faculty of color through facets such as having first-hand experiences of racial marginalization, a desire to improve the experiences of others, and a collectivist cultural background. In describing their hopes to improve, Joe describes his engineering identity such that he is a representative of all Black men in engineering. Yet he, as well as other participants, fight to bring their whole selves to engineering. This has interesting implications for Joe: choosing to curate his engineering identity in engineering spaces to present symbols of Blackness (unpicked afro, earrings, etc.; Mercer, 2000) to engineering communities which have been cited as dehumanizing for Black people, as well as others of non-White male heteronormative backgrounds (MbiliShaka et al., 2020). Joe was essentially saying that his blackness was not a detriment to his ability to be an engineer, normalizing these symbols to represent and teach others.

9 | IMPLICATIONS FOR RESEARCH AND PRACTICE

9.1 | Implications for research

Learning from the meaning-making of participants, we share implications for research that might add to the broader body of knowledge and inform future methodological approaches used to examine Black male engineering identity constructions and negotiations. At the conclusion of this study, we identified additional future lines of inquiry that could further advance the conversation. First, we acknowledge that all engineering disciplines are not the same. Like other researchers, we posit that understanding the discipline-specific differences (e.g., chemical, mechanical, etc.) that inform Black males' identities would broaden researchers' understandings (Holloman et al., 2021). In addition, as participants were from one single institution, expanding studies to include Black males from multiple institutional types would greatly enhance our understanding of their experiences. Furthermore, although scholars have called for it for nearly a decade, more longitudinal studies are needed to investigate how engineering identity changes over time, particularly given its complexity and fluid nature (Henderson et al., 2024; Patrick & Borrego, 2016). Last, we acknowledge the need for multiperspective-based studies that engage faculty, staff, administrators, and students' families (Denton et al., 2020; Sellers et al., 2022).

9.2 | Implications for practice and policy

The implications we present for practice are not necessarily new. We argue that support designed for Black male students will benefit all students (Gurin et al., 2002). We therefore recommend that colleges of engineering institutionalize policies and programs that are tailored toward supporting students' success and make those supports accessible to all, so as not to put the onus solely on the students alone to find the support they might need (Ash et al., 2023; Elmouden et al., 2024; Henderson, Hines, et al., 2023; Hines et al., 2023; Wright et al., 2023). In addition, given the psychological implications of the findings shown here, institutions should ensure that there is approachable mental health support for all students (Wright et al., 2023).

This work also points to a need and calls for faculty to learn anti-deficit/assets-based strategies and promising practices, such as anti-bias and mentorship training, voluntarily if necessary, to better support the engineering identity development of Black male students (Kendi, 2019).

Furthermore, representation is key, as these young men describe feeling isolated and not seeing many individuals who look like themselves in engineering settings. This work supports scholarship that highlights the importance of representation to the success of Black male engineering students. The proposition is for a critical mass of representation not only among students but also among faculty and those in leadership roles to support the development of engineering identity among Black males, who, as Joe puts it, are "representatives of each other." This would involve institutions being strategic about hiring a critical mass of Black male engineering faculty, admitting a critical mass of Black male engineering graduate students, and developing targeted recruiting strategies. This does not necessarily suggest meeting specific diversity metrics. However, institutions can implement evidence-based strategies for recruiting and outreach (Henderson, Hines, et al., 2023) instead of resorting to common phrases like "there are no candidates" during searches. Until a critical mass is achieved, or if institutions are unable or unwilling to do so due to bans and restrictions, they can provide support for student organizations such as the National Society of Black Engineers or other student-led organizations on their campuses. As we know, significant amounts of mentorship occur between students themselves (Henderson, Junqueira, et al., 2023). Organizations like the National Science Foundation must recommit and remain steadfast in their commitment to supporting Broadening Participation in Engineering through programs like the Inclusive Mentoring Hub so that Black males have access to mentors.

10 | CONCLUSIONS

Although there is a growing body of work related to the experiences of Black males in engineering, little progress is being made in their representation. This work contributes not only to the growing conversation around broadening participation in engineering but also points to actionable steps to enhance the representation of Black males in engineering. In addition, IPA, in this case, served as a form of methodological activism (Sellers et al., 2022) in that the

theoretical underpinnings of IPA called for attention to the particular nuanced experiences of individuals (Smith & Nizza, 2021). In particular, by listening to and zooming in on the linguistic capital of these young men, they insightfully brought us into their engineering identities. They provided an insider's perspective on potential ways to better support Black males in engineering. Furthermore, we gain an understanding of the beauty and tension of their existence. They demonstrated the tension between their engineering identities and how they grappled with being recognized or not as engineers, especially in spaces where they were loved (e.g., among family) and in spaces that shunned them. Our findings stress the need for educational institutions to implement inclusive strategies that foster the engineering identities of Black males. More institutionalized efforts that consider the whole of who they are and how they navigate the world are crucial for transforming the engineering education landscape into one that is truly inclusive, such as supporting student-led Black male mentoring programs, even during times when federal and state policies complicate practices. Finally, for the Black men within this study, being Black and an engineer were two aspects of their identity that were permanent fixtures, integral to who they are. That means being an engineer while Black (Parnell et al., 2023) was part of their daily existence. Their existence within engineering classrooms and workspaces required continuous negotiations that produced resilience and repositioned them to be just who they said they were on their own terms.

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