

"Do I really belong here?": A single case Interpretative Phenomenological Analysis of How a Black Male Engineering Student Experiences Sense of Belonging (Research)

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He began his higher education pursuits at Morehouse College and North Carolina Agricultural & Technical State University, where he earned degrees in both Chemistry and Chemical Engineering as a part of the Atlanta University Center's Dual Degree in Engineering Program. While in college, he was a Ronald E. McNair Scholar, which afforded him the opportunity to intern at NASA's Langley Research Center. He also earned distinction as a Phi Beta Kappa member and an American Chemical Society Scholar. Dr. Henderson completed his Ph.D. in Chemical & Biomolecular Engineering at the University of Illinois at Urbana-Champaign. During his time as a graduate student, he was a NASA Harriet G. Jenkins Graduate Fellow.

Dr. Henderson has dedicated his career to increasing the number of students who are on pathways to pursue STEM careers. He believes that exposing students to STEM early will have a lasting impact on their lives and academic pursuits. He is the co-founder of the St. Elmo Brady STEM Academy (SEBA). SEBA is an educational intervention aimed at exposing fourth and fifth-grade students and their families to hands-on STEM experiences.

His research group aims to understand student engineering identity trajectories and success mechanisms, using interpretative qualitative, and action-based participatory research methods.

He was most recently recognized by INSIGHT Into Diversity Magazine as an Inspiring STEM Leader, by the University of Illinois at Urbana-Champaign with the College of Liberal Arts & Sciences (LAS) Outstanding Young Alumni Award, and with a National Science Foundation CAREER Award in 2023 to advance his work that centers engineering identities of Black men in engineering.

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Abstract

Humans have an innate need to feel connected to and valued by their community. Likewise, college students navigating early adulthood are not immune from feeling the need to connect to their campus community. The college years are a critical period of identity development, where belonging reflects the extent to which they feel recognized and valued as a member of their academic community. As such, research has consistently linked students' sense of belonging to persistence, engagement, and well-being. For Black college students, belonging is shaped not only by developmental processes, but also by racialized institutional contexts and experiences that often threaten their belonging. Although a growing body of STEM education research has examined belonging, relatively little work has attended to the specific experiences of Black male engineering students. Existing studies frequently aggregate Black males into broader minoritized groups, combine Black students (males and females), or examine belonging outside specific engineering contexts. This pattern contrasts with a more robust literature on Black females' experiences in engineering and STEM, leaving Black males' meaning-making around belonging in engineering underexplored.

This project, part of an ongoing longitudinal study, uses a single-case Interpretative Phenomenological Analysis (IPA) approach. We conducted two semi-structured interviews with a Black male undergraduate biomedical engineering student (Rashad) in his first year of study to answer our research question: *How does a Black male undergraduate engineering student experience a sense of belonging?* We analyzed the transcripts using an IPA approach, engaging in descriptive, linguistic, and conceptual coding to examine Rashad's lived experiences in depth. We inductively developed two themes, *Seeing and Being Seen*, and *The Meritocratic Hope*, which characterize Rashad's experiences of sense of belonging. Findings reaffirm the irreplaceable value of representation for Black students, in both broader campus and smaller classroom contexts, in fostering an engineering sense of belonging. At the same time, findings indicate a hidden balancing act with meritocratic beliefs, in which the participant simultaneously draws hope from meritocracy as a pathway to advancement while remaining cautious about fully embracing an ideal that may obscure structural inequities and undermine belonging. These findings address an important gap in the literature and add to the ongoing research on Black males in engineering.

Keywords: Sense of Belonging, single case IPA, Black male engineering

Introduction

Black Student Representation in Engineering

Engineering student representation, persistence, and degree completion have been a focus of the education community over the last several decades. Its motivation is often tied to a goal of increasing the STEM workforce towards the purpose of establishing and maintaining American

success and prosperity as a technological leader on the world stage [1]. Despite ongoing efforts to broaden participation in engineering in the United States (U.S.), Black students remain underrepresented in engineering undergraduate programs [2],[3]. For example, from 2010 to 2021, the percentage of engineering degrees awarded to Black students remained essentially unchanged, whereas those for other underrepresented populations increased steadily [4]. Furthermore, when disaggregating undergraduate groups by gender and ethnicity, Black male students have the lowest percentage of Bachelor's degrees awarded out of White, Asian, Latino/a, and Black female students. In engineering, only 2.8% of bachelor's degrees were awarded to Black males in 2020, even though Black males aged 18-24 constituted approximately 7% of the U.S. population [4].

Black Male Engineering Experiences

Several previous studies have examined the experiences of Black male students [5],[6],[7],[8]. This corpus of literature reveals that Black males have different and unique experiences from males of other ethnicities, and also from Black female students. For example, scholars have suggested that Black males often experience more blatant and directed negative experiences in the form of micro-aggressions that negatively impact their sense of belonging on their home campuses. This matters in that literature consistently links students' sense of belonging to persistence, engagement, and well-being. For Black male college students, belonging is shaped not only by developmental processes but also by racialized institutional contexts and experiences that often threaten their belonging. For example, in STEM classrooms Black males' sense of belonging is highly vulnerable to racist stereotypes and microaggressions [9]. On the other hand, asset-based literature on Black males in engineering has shown that they are intrinsically motivated to persist in engineering despite significant challenges [7],[10],[11]. Literature has also revealed that the support that undergirds the success and thriving of Black males in engineering includes factors such as family [12],[13], "prove them wrong" mindsets [10], social networks [14],[15], and faculty and mentors [16],[14],[17]. Despite these insights from this growing but limited body of knowledge, more research is needed to examine the nuanced experiences and meaning-making of undergraduate Black males studying engineering [18],[19], specifically related to their sense of belonging.

Sense of Belonging

Sense of belonging, as a conceptual framing for college students, has been defined in several ways. However, we adopt Strayhorn's definition for its comprehensiveness and clarity. Strayhorn asserts that sense of belonging is a "students' perceived social support on campus, a feeling or sensation of connectedness, and the experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community or others on campus such as faculty, staff, and peers" [20]. This concept is not unique to education but is rooted in psychology and philosophy. Maslow, in his book on motivation, sets forth a hierarchy of basic human needs [21]. This hierarchy places physiological needs at the bottom, as the most basic and must be met first, followed by safety needs, including financial and emotional security and stability, and then belonging needs. Belonging needs must be met before self-actualization can occur; for college students, this self-actualization corresponds to the goal of obtaining a college degree [20].

According to Strayhorn, there are seven core elements of sense of belonging. These core elements are summarized in the following list and shown in Figure 1.

Core Elements of Sense of Belonging

1. Everyone has the need to belong, and it applies within the context of college student persistence, but is not limited to that field
2. Sense of belonging drives human behavior – One’s perception of belonging within a particular context drives a change in behavior
3. Sense of belonging will take on greater significance in certain situations; In certain contexts, such as a newcomer to an established group; At certain times, such as early adulthood, when individuals are considering and forming their core identity; Among certain populations, such as marginalized populations at a university
4. Sense of belonging is related to, and a consequence of mattering;
5. Sense of belonging is affected by intersecting social identities – it can change depending upon the identity you relate to the most within a particular context
6. Sense of belonging engenders other positive outcomes – such as college persistence and success
7. Sense of belonging must be continually satisfied, and changes as conditions and contexts change.

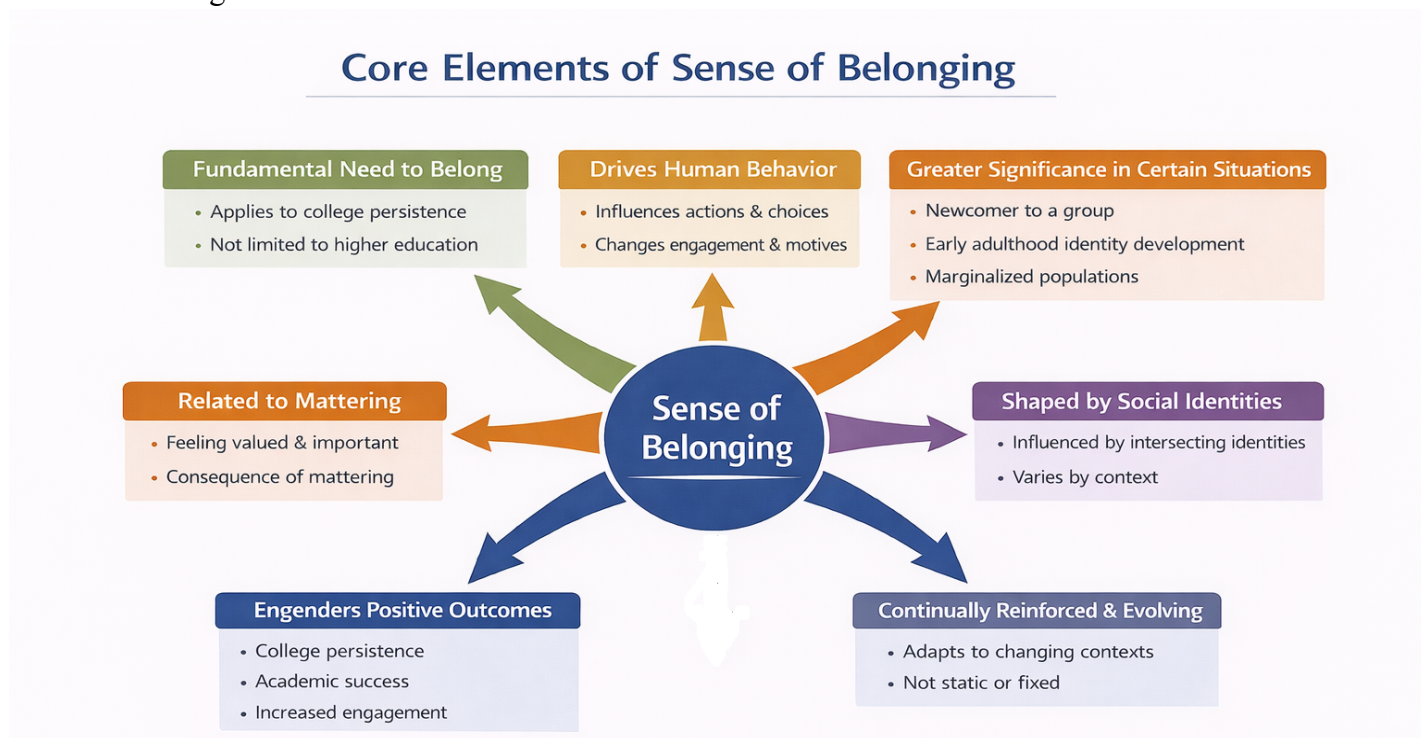


Figure 1: Core Elements of Sense of Belonging

Note: Modified from image generated using ChatGPT (DALL-E 3) by OpenAI on 3/2/2026

As a motivating force and driver of human behavior, a student’s sense of belonging can motivate him to take actions that help him persist and succeed in earning a bachelor’s degree. Sense of

belonging is, therefore, a lens through which to study the experiences of a Black male engineering student, particularly with respect to persistence and success.

Research has consistently shown that a sense of belonging on campus is vital to college student persistence and serves as a critical factor in predicting whether students remain enrolled [22],[23],[24],[25],[26],[27]. In light of sense of belonging's connection to student persistence, researchers have sought to understand its inner workings and its role in helping or hindering students' ability to earn a degree. In engineering/STEM literature, researchers have highlighted factors that influence students' sense of belonging in college/university settings. Studies have shown that positive interactions with student peers, faculty, and involvement with student organizations are significant to students' sense of belonging, as well as to its increase [28],[26],[20],[25]. In addition, students who engage with a diverse set of peers or perceive their campus as being a representation of diverse groups have a higher sense of belonging [29],[30],[31]. Research further suggests that interventions such as summer bridge and other cohort-based programs, which include faculty and peer mentoring, advising support, and components that build engineering capital, can also increase sense of belonging [32],[30],[33]. Conversely, perceptions of a poor campus climate are just as impactful and can reduce a student's sense of belonging [34].

Nonetheless, the impact of sense of belonging is not the same across all populations, as it affects individuals from underrepresented racial and gender groups differently [30]. For example, prior research identifies sense of belonging as a critical factor influencing Black students' persistence in engineering and other STEM fields. Scholars argue that persistence is contingent upon inclusive, supportive learning environments that foster students' perceptions of being valued and respected [30]. Although sense of belonging has received increasing attention across STEM education, examinations specific to the engineering field remain limited. This is particularly true for Black male engineering students, a group that continues to encounter disproportionate structural, cultural, and institutional barriers to degree completion and career advancement relative to more highly represented populations [34]. As a result, researchers have called for studies that move beyond aggregated "students of color" categorizations to illuminate how specific demographic subgroups experience belonging within particular engineering contexts. For example, Pichon emphasized the importance of centering Black students' sense of belonging experiences rather than subsuming them within broader racialized groupings. At the same time, Strayhorn advocated for deeper examinations of sense of belonging as a mechanism shaping Black male educational success [28], [34]. Recent work further suggests that belonging situated within major-specific contexts may be especially salient for persistence, underscoring the need for focused analyses within engineering education [32]. Responding to these gaps, this study seeks to advance understanding of the nuanced ways a Black male undergraduate engineering student experiences sense of belonging by addressing the following research question (RQ):

RQ: How does a Black male undergraduate engineering student experience a sense of belonging within engineering education contexts?

By amplifying the voice of the sole Black male participant in this study, we seek to "amass" more successful accounts [35], and to inform the development of data-driven interventions and

strategies that can expand access, visibility, and belongingness among Black males in engineering.

Methods

The Study & Single Case Interpretative Phenomenological Analysis

We used Interpretative Phenomenological Analysis (IPA) as our approach to explore how Black male engineering undergraduate students experience a sense of belonging. We chose this approach given that IPA has been used in engineering education research to investigate belongingness and identity [36],[37],[5]. IPA has its roots in phenomenology and emphasizes hermeneutics and idiography as its primary theoretical underpinnings. As a qualitative research method, IPA gives voice to participants' perceptions of unique lived experiences; therefore it serves as a fitting tool for analysis of sense of belonging, which is highly connected to participants' perceptions. IPA employs a double hermeneutic, where the researcher endeavors to make sense of how participants make sense of their experience. Put another way, IPA allows for the interpretation of the meaning participants derive from their perceived experience [38]. The idiographic nature of IPA lends itself to an analytical approach that examines participants on a case-by-case basis before comparing their experiences with those of others with similar experiences.

We leveraged the idiographic nature of IPA to explore a single case of how one Black male engineering student experiences sense of belonging. Although Smith and Nizza [39] have advocated for single-case designs, only a few researchers have published single-case IPA studies [6],[40]. After his first interview, we became interested in understanding Rashad's specific psychological experiences given their richness and his ability to serve as a good informant [41]. A good informant is a participant who is articulate, reflective, and willing to share with the interviewer [41]. Rashad is therefore the sole study participant [42], though this study constitutes a unit within a larger, ongoing IPA study.

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 in the college database whose self-identified gender was male and whose race was Black or African American. We also requested that the local student chapter of the National Society of Black Engineers (NSBE) share our recruitment email with its members. Recruitment for the larger grant-funded study yielded a total of 8 participants, one of them being Rashad.

Data Collection

Before interviews for the larger study this participant was taken from, each participant completed a demographic survey in which they self-reported their ethnic and gender identity, engineering major, and academic classification. Participants then participated in two semi-structured interviews, which we conducted via a University-Licensed Zoom Account. We conducted the first interviews between April 2025 and June 2025. We conducted the second interviews between

December 2025 and January 2026. Pseudonyms, selected by participants, were used to maintain anonymity. Each interview lasted approximately 75 minutes, and each participant was compensated with a \$25 Visa gift card after each interview. All interviews were audio- and video-recorded, and audio files were transcribed by an external transcription service.

Data Analysis

In our data analysis, we followed the well-documented IPA procedures [38]. We began by reading the transcript while re-listening to the interview recording to re-establish the interview's context and to gain a sense of the participants' responses as a whole. At the same time, we noted initial reactions to statements of interest or import in the margins of the transcript. Next, we reread the transcripts, focusing on generating descriptive and linguistic exploratory notes. Descriptive notes summarized the meaning of the participant's words. Linguistic notes commented on the participants' use of language; in particular, aspects such as false starts, repetitions, hesitations, metaphors, and tone were noted to inform interpretation [38]. We conducted a final reading of the transcript to create conceptual exploratory notes in the margins [5],[43]. Next, we formulated experiential statements based on the exploratory notes. We then clustered experiential statements to highlight how the participant made meaning of his experience [38]. We repeated this process for each transcript (i.e., interview 1 and interview 2). After analyzing each transcript individually, we examined the entire dataset and each interview to generate themes that captured the participants' holistic experiences. Finally, we developed themes that define and describe each cluster of experiential statements.

Meet the Single Case Participant

Rashad is a second-year student majoring in bioengineering at a large public research university. It should be noted that he was a first-year student at the time of the first interview. In high school, he chose a nursing pathway because of his strong desire to help others in a medical setting. As a college student, he chose bioengineering to avoid the high-stress working conditions of nurses while still being involved in helping others in a medical setting. Rashad describes himself as a family-oriented person who loves playing board games during family game nights. Although others would call him competitive, he describes himself as dedicated, and when he undertakes a task, he wants to give his all. Rashad is a first-generation college student and receives a lot of support from his family, who all refer to him as "Professor." Rashad acknowledges there was a time when he felt a lot of pressure and stress due to doubts that he was not as smart as his family professed to others he was. Now, instead of pressure, he sees his family's words as appreciation and uses them to motivate himself.

Positionality

As researchers, we recognize that our identities and positionalities are important considerations in our research process. In the interest of transparency, we describe the multiple identities we hold that inform and shape our approach to all aspects of this project. The first author is a Black male in his fifth year of study as a doctoral student in a Biomedical Engineering Department. He is also an instructor of engineering and engineering technology at a local community college. He holds an undergraduate and a graduate degree in engineering. His insider status is unique and

derives from experiences occupying roles both as a student and an instructor. His own experiences, coupled with his interactions with his students, drive him to seek to understand the nuanced experiences of Black male engineering students. The second author is a Research Professor in a College of Engineering, and identifies as a Black male. His research and community interests are centered on the academic and co-curricular experiences and outcomes of Black males. The third author is an assistant professor of engineering, and he identifies as a Black male. His research interests focus on the lived experiences of Black males in engineering environments across the K-Career. He aims to develop research-based, research-informed interventions that enhance engineering identities and improve degree completion among Black males. His approach to research centers humanizing participants and lessening power dynamics.

Limitations

As with other studies, some study design choices may limit the study. For example, although this study is part of a larger longitudinal study, Rashad's compelling journey and the purposes of this work led to the inclusion of only one participant. This is a bold choice, and though acceptable in an IPA-based work [39],[6], we understand that Rashad's journey does not represent the lived experience of all Black male engineering majors. We do, however, recognize the value that his story can bring to the broader discussion of sense of belonging and share insights from two interviews with Rashad rather than one. Lastly, although he is a first-generation college student, we do not explicitly examine the intersection of this identity with his identity as a Black male. Given that several studies in the literature examine only first-generation college status and sense of belonging [36],[44],[45], we viewed our project as an opportunity to build on that work and address the research gap regarding Black men in engineering and their sense of belonging.

Quality

To establish quality in the process of "making" and "handling data," the team was guided by Walther et al.'s Qualifying Qualitative Research Quality (Q3) [46]. We use this framework because it offers a practical approach for the research team to focus on procedural, communicative, pragmatic, ethical, and process reliability [46],[47]. In "making data," we implemented several steps. For example, we focused on building rapport with participants to enhance relational validity [46]. We also decided to have a single team member (the first author) conduct all interviews to ensure consistent participant responsiveness [3]. After the first interview with this participant, the first author reflected on interview quality using the Interview Quality Reflection Tool (IQRT) to improve future interviews [48]. This team member also consulted with other team members to debrief interviews. During the interview, we reminded participants to use their own language and communication styles, rather than struggling to use "fancy" or formal language [5]. When participants requested additional time to reflect before responding or to seek clarification, we provided that time and space.

Our procedures for "handling data" started with using a professional transcription service to transcribe the interview audio recordings verbatim. The first author then updated the transcripts to remove apparent mistakes (process reliability). The team also spent considerable time with the data. For example, the first author conducted several rounds of analysis before developing final themes. The first author also engaged other team members in "time[s] of calibration" [17]. These

group discussions served two purposes. First, to ensure that findings were grounded in the social reality under investigation [46], and second, to consistently align findings with the theoretical underpinnings of IPA. Lastly, we situated ourselves in this research through a positionality statement to ensure awareness of aspects of our experiences that might influence the research process [49].

Findings

The purpose of this study was to investigate how an undergraduate Black male engineering student experiences a sense of belonging at a large public research institution. Through the use of IPA, we inductively developed two themes: Seeing and Being Seen and The Meritocratic Hope.

Seeing and Being Seen

This first theme describes how Rashad ascribes significance to seeing other engineers whom he considers like himself in terms of his cultural identity. At the same time, he has a strong need and desire to be seen by others with whom he interacts, and by those connected to or a part of his engineering education. Both of these aspects, seeing others like him in engineering contexts, and being seen or recognized by others as an engineer, increase his feelings that he belongs in engineering.

Rashad takes great pleasure in seeing other engineering students like him (i.e., Black male) in the same academic position and pursuing the same academic goals. In effect, walking the same path he is walking. Rashad's feelings are not based on seeing one or two others like him, but a result of seeing many others like himself. He internalizes it as confirmation that he is in the right place...a place or a path where he belongs. An example is Rashad's opportunity to attend the BEYA (Becoming Everything You Are) STEM conference during his first year in college. He said:

I enjoyed BEYA a lot. It was so pleasing to see that many Black people in an engineering setting. It was so great. It was great. That also helped me decide that I belong here. I need to stay here. (Interview 1)

Even though Rashad attends a university with a large Black student population, he was thrilled to be in a setting where he could see a large number of Black engineers, a marked difference from what he normally sees in his university setting. Since belonging is a basic human need, it is natural for him to look for signals that he belongs in the contexts in which he finds himself or places himself. A natural way to check whether he is in the right place is to see if others like him (Black people) are there or on the same engineering path. When he was in a setting (the BEYA STEM Conference) where he saw many others like him, it signaled and made him feel like he belonged in engineering. It also motivated him to pursue his engineering degree.

On the other hand, Rashad also experiences engineering spaces where he sees a lack of others like him. In this case, he internalizes his perception as an obstacle. He compares seeing engineering students like him at NSBE (National Society of Black Engineers) events to seeing a lack of other engineering students like him in his classes. He expresses a deep desire for change, almost pleading for circumstances to shift. He said:

None of my math classes or my engineering fundamental classes, the people I see in NSBE, I have no class with them. Either they're upperclassmen like juniors or something, or just sophomores, or they're not in Speed School [an accelerated engineering program of which he is a member]. So, it's like I love this [NSBE] space. If only it was in the classroom with me...I need you all to be in class. I need you all. It's hard. (Interview #1)

Rashad acknowledges a deep need to see other Black students in his engineering classes, as a manifestation of his need to belong in his engineering class setting. As a member of the Speed School of Engineering, his classes are on an accelerated track, which results in a Master's degree in engineering after five years. Considering the low percentage of Black engineers pursuing this accelerated track, it is reasonable to understand why Rashad does not see his NSBE colleagues in his classes. The lack of other students like him in this context creates an additional barrier to his engineering path, which he describes as hard to overcome. It is indeed hard to thrive in an environment where he feels he may not belong. Yet, even in the midst of his belonging uncertainty, Rashad finds purpose in his efforts to establish that he belongs in engineering and motivation to persist along his engineering path.

In addition, he resolves to be a trailblazer and create the class conditions he never had but desperately wanted. He said:

I need to keep doing this so that I could potentially create spaces like that [engineering class settings where there are other Black students] for the Black engineers at my school. There is NSBE at school and I'm a part of that but I don't have classes with any of them. I don't have classes with anybody in NSBE. That helped me see that that's something to keep doing and potentially create a space for. (Interview #1)

In this, we see that Rashad changes the focus of his experiences and adopts a perspective that continuing is for the benefit of others after him. Rashad not only ascribes seeing others like him as significant and meaningful, but he also ascribes being seen by others as significant and meaningful. This means that not feeling seen can affect his sense of belonging. Not only does Rashad feel unseen, but he also describes a deeper sense of being overlooked as a Black male studying engineering. He said:

Being Black, being a Black man in engineering, it definitely sometimes feels like I get overlooked a lot. I try not to put too much thought into it because I know at the end of the day, I'm going to do what I got to do. (Interview #1)

As a Black male in engineering, Rashad feels that he is often not seen for who he is and, therefore, is not considered important to the engineering community. His perception of being overlooked reduces his sense of belonging, as feeling important to the engineering community (or to those who represent it) is a critical component of his sense of belonging in engineering. He copes by not dwelling on what he feels he does not have much control over (i.e., being overlooked) and concentrates on what he feels he does have control over... making sure he works hard to make progress along his path to an engineering degree.

Negative interactions with faculty also substantiate Rashad's perception of being overlooked. For example, when visiting a professor during her office hours, she assumed he had a level of understanding well below his grasp of the material. He said:

I was like, I have an A in your class, I was like, Thank you. I don't know it just it felt she was trying to baby talk me a little bit like I was having a hard time...yes, that's an instance in which I felt kind of overlooked but I didn't know how to interpret that, but it

was like that the whole session. It's like, "Great. You're really picking up on this [says the professor]." I was like, I know this stuff, I'm picking up on it. This is review. (Interview #1)

Not being treated according to his ability made Rashad feel as if he was not being seen for who he was. It was as if it were assumed that he would have trouble with the material or that it was a given he would not be able to understand engineering concepts when in fact there was clear evidence (his current class standing) that he understood quite well. The faculty's failure to recognize and acknowledge his ability reveals a lack of support that Rashad clearly perceived.

On the other hand, Rashad's perceptions of being seen by others were not always negative. He recounted an interaction with another faculty member in which he believed he had submitted the entire assignment but inadvertently submitted only a portion, resulting in a poor grade. He shared:

He [the professor] reached out to me. He reached out to me, and so I was like - he's like, "Hey." He was seeing what went wrong. That showed me the trust that he had in me because he's saying he knows something went wrong because of the grade I got...For him to reach out to me and do that, I was like, that's - I respect that, and I appreciate that. (Interview #1)

In this case, Rashad felt seen because the professor recognized that the submission was not typical for him and took the time to contact him to determine what went wrong. His professor, rather than viewing him through a deficit-based perspective in which the low assignment grade was evidence that he lacked the discipline to complete his work, viewed him through an assets-based lens. As a result of this interaction, Rashad appreciates his professor for seeing him and knowing him as an engineering student who would not turn in an unfinished assignment. This experience for Rashad represents a stark contrast to his interaction with the professor who held a deficit perspective, assuming he had a poor grasp of the material and lower expectations of him during office hours.

Rashad discussed another instance in which a professor took the initiative, saw he needed help, and reached out to offer it. In this instance, it was after he took a test on which he felt he didn't do well. He said:

We had this one Chemistry exam, and afterwards, I was like, Dang, I need to eat. I'm walking, and I'm talking to a student, and behind me, because I was talking about the exam. I'm like, I don't know. Maybe I studied wrong...I just didn't feel too confident about that, and my professor was right behind me, and so we ended up talking for a little bit, and I went to their office hours after that because they were just like come follow up we can talk about the test [said the professor], and so we talked about it, we went back over the test, and it helped me understand a lot more, not only what I did and didn't do right on the test but studying methods I should incorporate into the future exams. For me, I was like, Dang. That just went to show me that my professors really do want me to succeed, and that was pretty significant for me...It's like I belong here, you want me here, and that helped me stay motivated to do good work in the class. (Interview #2)

Rashad ended his experience feeling like he belonged and that he mattered. That feeling made him act differently, motivating him to put extra effort into that particular course. The professor's actions outside of class showed Rashad she really wanted him to succeed and that she cared about him. This interaction meant a great deal to Rashad because it came from a professor.

Interactions with faculty are very impactful for students because the faculty are the ones through whom they acquire the knowledge needed to earn an engineering degree. Essentially, faculty are the gatekeepers, and through their interactions, they can communicate that students matter, increasing their sense of belonging, or that students do not, decreasing their sense of belonging.

In addition to faculty interactions, peer interactions in which Rashad felt seen were meaningful to him and made him feel valued as an engineering student. For example, when Rashad interacted with a student in his engineering class project group, some of their initial interactions were tense because of comments he perceived as insensitive. Rashad recounted this interaction. He said:

It was Super Bowl. The Super Bowl of the past, and he [Rashad's group member] was talking about the halftime show [2025 Super Bowl done by Kendrick Lamar]. He was like, "I really wasn't feeling it. I think it sucked." At first, I was doing like people talk. Obviously, you think it sucked, obviously. I was going to let it go...I was just like, "Why was that?" He was like, "I just think it was odd. He [Kendrick Lamar] just spent the whole half time show dissing someone."...I said "There were metaphors in there, especially about the way America is right now, it has been. It might have went over your head because you obviously don't see it that way." He was like, "I don't understand what you mean by how America is." I said, "Of course, you don't..." (Interview #1)

Rashad's group member dismissed and degraded the half-time show just because it consisted of racial commentary about being Black in America, which he [the group member] did not understand or have experience with. At that moment, Rashad's experience as a Black man was neither seen nor acknowledged by this group member.

Interestingly, despite the tension during their previous collaboration, that same group member expressed a desire to work with Rashad on class assignments later that year by asking about his schedule and trying to determine which classes they might have together. Rashad remembered and discussed that interaction. He said:

I guess he values me as some type of way for him to want to continue to do work with me in class and try to align a schedule up with mine. In that way, I'm kind of confused, but I do appreciate it underneath the surface a little bit. (Interview #1)

Rashad appreciates being seen as someone others seek to work with on engineering assignments and projects in class. This interaction makes Rashad feel valued as an engineer (an essential part of the definition of sense of belonging).

Capturing the theme, "Seeing and Being Seen" highlights the importance Rashad places on being aware of others like him who are walking the same academic path he is. It also emphasizes the importance Rashad places on those with whom he interacts, as he pursues an engineering path and recognizes their capacity to do the same.

The Meritocratic Hope

Rashad expressed a belief that hard work (or merit as a result of hard work) could overcome just about any obstacle he faced in his path to obtain an engineering degree. For example, Rashad believed that anyone could succeed in engineering if they were willing to work hard and learn. He applied this mindset to his own desire to overcome his lack of previous engineering

experience. This way of thinking gave him hope that he could belong in engineering, even in the midst of what he believed signaled he didn't belong. He said:

There are people who came from worse situations than me and still have been able to be a proficient engineer. I just have to remember and just stay focused and disciplined with my work. There are stages to learning. (Interview #1)

Rashad believed that relying on hard work and a willingness to learn would lead him to become an engineer, in spite of difficult situations he might face. Even when his lack of initial engineering knowledge and experience led him to consider switching majors, he leaned on his belief that being disciplined in his work and serious about learning would see him through.

Rashad particularly linked a willingness to learn with his idea of what it meant to work hard. He used these two ideas as a counterpoint anytime he began to feel he didn't belong in engineering. He said:

It's like, at first, I struggled with thinking, Do I really belong here? But I know my brain works. I know I can learn. I can work... As an engineer, I feel like, if you want to help people, you want to learn and you want to power your learning and you have the constant want to keep learning. That's really all you need to start out. So yes, I feel I belong because of those qualities. (Interview #1)

Instead of relating his engineering sense of belonging to his previous engineering knowledge and experience, Rashad actively connects his sense of belonging in engineering to his ability to learn and willingness to work as hard as is necessary to complete his engineering degree. In this way, uncertainty about belonging caused by his anxiety and fear of not knowing as much as his peers is tempered by his confidence in his work ethic and willingness to learn.

In another instance, Rashad talks about how working hard and overcoming an obstacle in his calculus class gave him confirmation that he belongs in engineering. He received a bad grade on a test, which dropped his course grade to a 'D', but he worked hard and studied for the final exam and ended up with a 'C' in the course. Because of this experience, he felt he could overcome any academic difficulties that might come his way. He said:

I just got a bad grade on, and it took me from a - I was maybe a low B, but it took me from a B to a D, and I was like, Man, I thought I had this. I thought it was - I was understanding what I was being taught. The final comes around, and the professor says, those who get at least a 70 on the final will have their lowest grade replaced by the grade that they get on the final, and so I just - my motivation goes through the roof. I'm like, I can pull this through. I don't want to take this class again. I ended up getting, I think it was a 78 on the final, and so I went from a 67 D to a 75 C, and so I was like listen, we passed the class. I was like, a C is not what I was shooting for...but I'm glad I got it, and so I was like, I can really do this. I belong here. I fought to get that C. I can overcome the struggles that I might face in calculus, because I know it's going to get harder. It's like, I know I can do it now, so I definitely belong. (Interview #2)

When Rashad received his first bad grade on a calculus test, he began to doubt himself, and the low grade increased his sense of belonging uncertainty. He attributed the grade as an indicator of his belonging in engineering, when the real cause was that he stayed up cramming the night before and didn't remember some key formulas for the test. In reality, the test was more about his lack of sleep than about whether he belonged in engineering, yet that was his perception. His reliance on working and learning as his connection to engineering meant that his belonging was

based on merit/performance. If he performs well, he should be in engineering, but the second he performs badly, he begins to question if he belongs. When Rashad was able to resurrect his course grade, it was a confirmation to himself that he could and can work his way out of a major crisis. This realization made him feel like he belonged in engineering, because the outcome of his hard work paid off. It also, for better or worse, solidified his reliance on his meritocratic hope, along with his meritocratic view of his engineering education.

Learning and working hard are the aspects of engineering with which Rashad most identifies. He relates his engineering identity to learning and staying disciplined (hard work). He said:

Engineering fits [into his identity] that way because I would say it helps keep me focused on being in that competitive mindset, to where I want to have the ambition to keep going out and keep learning more and keep staying disciplined. I feel like that's how engineering fits into my identity. (Interview #1)

Rashad feels comfortable identifying himself as someone who belongs in engineering because he can work hard and learn. These are traits he feels he can control and grow in. This means that where he starts is not where he will end, so he has a chance to gain the knowledge he believes his peers already have... and it is completely up to him. Although Rashad finds comfort in identifying himself as an engineer through his perspective, there is a danger in doing so. If he begins to struggle despite working extremely hard and trying to do what he can to learn, then he may perceive it as a sign he doesn't belong in engineering; despite the fact there could be other forces at play causing his struggles that he may not have considered.

Belief in the idea that he can achieve anything as long as he is willing to learn and work hard is really a belief in meritocracy, which saturates engineering education spaces. This idea provides hope to students like Rashad who enter the engineering program without prior engineering capital (knowledge, skills, or experience), as it is based on a growth mindset that allows him to grow, change, and become more knowledgeable about engineering processes, strategies, and analysis. His belief is a very important tool for him because it provides hope and agency. Hope that he can overcome any obstacle, and agency, in that he has control over whether he becomes an engineer or not.

Discussion

Representation across multiple contexts

In our study, we saw that representation was significant for Rashad's sense of belonging, with differences across multiple contexts. In particular, we observed three distinct contexts in which Rashad expressed his perceptions of Black representation in engineering. The first was a broad campus context in which he saw the diversity of the campus population. Research has shown that campus climate perceptions can predict sense of belonging among Black male STEM undergraduates [20]. Also, a perception of campus diversity increases sense of belonging, which can lead to improved persistence [31]. On the other hand, a perception of a hostile racial campus climate can reduce a student's sense of belonging [26]. Rashad's experience reveals how he relates a perception of diversity (seeing different cultural and ethnic groups represented on campus) to a feeling of connectedness to the campus community. Representation in this context prevents Black students like himself from feeling othered, as if they didn't belong on campus

because of their apparent ethnicity [5]. Instead, in this context, Rashad feels he belongs because he is part of the many cultural and ethnic groups present on campus.

The second context of representation, which was revealed, involved Rashad at an extracurricular event alongside other Black engineers who worked in industry. At the BEYA STEM conference, Rashad saw and interacted not just with other students but also with Black working engineers who had accomplished what he was trying to accomplish. In this sense, they occupied the space of a kind of role model for him. Exposure to role models can positively affect the sense of belonging of undergraduates studying STEM [50]. Similarly, the frequency of hearing about the contributions of minorities in one's field can predict sense of belonging among Black males in STEM [34]. Rashad's experience solidified his belief that he belonged on the engineering path. Likewise, having more confidence that he did belong on the engineering path brought him great pleasure, so much so that he exclaimed "it [his BEYA experience] was great" twice in the same sentence. Seeing Black engineers who worked in industry allowed Rashad to internalize the truth that if other Black people could become engineers, he could as well.

The third context was that of a smaller departmental or class setting in which Rashad did not see other students like him. The nature of sense of belonging is that it is highly contextual and it can change as circumstances, conditions, and contexts change [20]. Although Rashad described his feelings about the campus, saying he "loved the environment" and was very pleased with his experience at the STEM conference, these did not cancel out his feelings in his engineering class environments. In his class context, Rashad described feeling hurt, feeling relief when not in a class environment (as if burdened while in class), and he pleaded to have other Black students in class with him, saying it was "hard." All these come together to indicate a low sense of belonging in an engineering class context, along with an increased sense of belonging on his campus and in extra-curricular contexts.

Rashad's sense of belonging in class, contrasting with his sense of belonging in the two previous contexts, emphasizes its volatility and shows why sense of belonging is an ongoing need that must be satisfied regularly and on a continual basis [20]. The implication is that representation should be present in *all* contexts that are significant to the student so that the opportunity for sense of belonging is satisfied regularly and optimized. Typical contexts that are significant to Black students include peer and faculty interactions, and student organizations and other extra-curricular activities [29],[28],[51]. In fact, we submit that representation in the classroom is perhaps more significant than in other contexts, since students will spend an increasing amount of time in engineering classrooms as they progress through their degrees. Black faculty representation cannot be overlooked and is just as important in the classroom as peer representation [20]. Faculty support is found to be an important source of sense of belonging, particularly for male students [52]. Still, we also consider the current state of Black faculty representation (particularly at Predominantly White Institutions) and highlight that in the absence of representation in the classroom, representation in other contexts can be impactful for engineering students' sense of belonging, leading to greater opportunities for persistence and success in obtaining an engineering degree.

Belief in Meritocracy... Necessary Hope or Damaging Ideal?

Unique to this study, we observed Rashad continually referring to his ability to work hard and learn to overcome perceived obstacles that his peers did not experience. We named this belief “meritocratic hope” because Rashad placed his hope in the idea that hard work would earn him belonging in engineering, especially when he lacked other markers he associated with belonging, such as prior engineering knowledge. Rashad leaned on this meritocratic hope to draw motivation and persist through experiences that heightened his belonging uncertainty. Likewise, previous studies have implicitly utilized meritocracy in interventions designed to improve students' sense of belonging [53].

When examining other research on Black students, Rashad's use of meritocracy stands in contrast to the literature. Instead of the meritocratic hope, studies highlight students' beliefs in the meritocratic *ideal*, which negatively impacts Black students' sense of belonging [54]. The meritocratic ideal is “the belief that all successes in life are solely the result of hard work and training, regardless of other differences in identity or social status” [54]. In engineering spaces, it manifests as a belief that all students have an equal opportunity to succeed with enough hard work. Belief in the meritocratic ideal can cause students to minimize or dismiss the impact of systemic or institutional inequalities they may experience and to ascribe successes and failures solely to their level of commitment to learning and working. We posit that this is an area that warrants further study, particularly in understanding how students can draw on meritocratic hope to navigate challenges without internalizing the potential harms of the broader meritocratic ideal.

The way students view and use meritocracy has other manifestations within engineering education literature. For example, studies have shown that less-privileged undergraduate students identify themselves as smart enough to be engineers through *hard work and dedication* (belief in meritocracy). These students are more likely to question their identity as an engineer [55]. This is in contrast to students who are more privileged and identify themselves as smart enough to be engineers because of innate ability [55].

Implications for Research and Practice

As researchers, we are reflexive about our work. At the conclusion of this part of the study, and even during this write-up, additional project ideas and questions arose that would help advance the conversation related to sense of belonging among Black male engineering students. For example, in our future work, we plan to expand our study to include more Black male undergraduates, investigate sense of belonging over time, and examine more closely the role of meritocracy in Black males' sense of belonging. Specifically, we propose that longitudinal research on what we term the “meritocratic hope” to investigate how beliefs in meritocratic effort interact with structural conditions over time, clarifying when such beliefs function as protective mechanisms and when they may mask or exacerbate inequities in engineering education [56]. Additional recommendations include more studies examining everyday instructional practices, such as office hours interactions and faculty proactively reaching out to students, particularly in early-career coursework, where belonging uncertainty is pronounced [57].

Rashad's experiences point to several opportunities to enhance engineering practice, particularly at the faculty and departmental or program levels. In fact, if implemented strategically, professors' and departments' practices could incorporate approaches that position students' sense

of belonging as an emergent outcome of intentional practices (e.g., sound pedagogy and professional preparation) rather than a separate or ancillary goal that occurs for some students and not others. For example, we recommend training for faculty to remind them of practices such as ground office-hour interactions and feedback in evidence of student performance (e.g., grades, prior submissions) rather than in assumptions about students, as Rashad highlights. Professors might also implement brief, proactive outreach to students [58], a practice shown to be effective when students' performance deviates from course expectations, departmental norms, or university norms. At the department or college level, institutions might consider restructuring courses, especially early-year courses, to provide structured opportunities for students to form peer cohorts [59],[14]. Instructors could incorporate collaboration and teamwork norms into their courses to nurture positive learning climates [57],[60].

Conclusions

Although there is ample research on sense of belonging related to student persistence and success, calls for more studies on the sense of belonging of student sub-populations have largely gone unmet for Black male engineering students [33]. This reveals a gap, especially given that belonging impacts underrepresented groups differently [30]. Our findings reaffirm the irreplaceable value of representation for Black engineering students in campus communities, extracurricular, and, perhaps more importantly, in smaller classroom contexts for fostering an engineering sense of belonging. Black male students need to see themselves represented in engineering spaces, but also need to know that others see them as belonging in those spaces. In addition, findings indicate a delicate balancing act concerning meritocracy beliefs. Black males hope in meritocracy as a path to overcome obstacles manifested by structural and systemic inequalities, yet must be careful not to believe in a meritocratic ideal that minimizes the impacts of those same structural and systemic inequalities. We stress the need to examine the classroom context and call on institutions to prioritize increasing a sense of belonging by implementing simple changes that can make a difference for Black male undergraduate engineering students, as well as other marginalized student populations.

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The images in Figure 1 were generated using ChatGPT (DALL-E 3) by OpenAI.

Prompt: Create a clean, minimalist 2D conceptual diagram suitable for inclusion in a peer-reviewed journal article.

Title centered at the top: **Core Elements of Sense of Belonging**

Design specifications:

- White background
- Muted academic color palette (navy, deep teal, slate blue, muted green, soft gold, charcoal, dusty blue)
- No gradients
- No shadows
- No 3D effects
- Flat design only
- Clean vector lines
- Uniform arrow thickness
- Professional academic layout
- Balanced spacing and symmetry
- High readability at print scale
- Suitable for both color and grayscale printing

Layout:

- A single central circle labeled **“Sense of Belonging”** (navy fill, white text)
- Exactly **7 arrows** radiating outward from the center circle
- All arrows must originate from the center circle
- No extra arrows
- No floating arrows
- Arrows evenly spaced around the circle
- Each arrow terminates at a rectangular box
- Boxes arranged symmetrically in a circular layout around the center

Content for boxes (include headers and bullet points exactly as written):

1. **Fundamental Need to Belong**
 - Applies to college persistence
 - Not limited to higher education
2. **Drives Human Behavior**
 - Influences actions & choices
 - Changes engagement & motivation
3. **Greater Significance in Certain Situations**
 - Newcomer to a group
 - Early adulthood identity development
 - Marginalized populations
4. **Shaped by Social Identities**
 - Influenced by intersecting identities
 - Varies by context
5. **Continually Reinforced & Evolving**
 - Adapts to changing contexts
 - Not static or fixed
6. **Engenders Positive Outcomes**
 - College persistence

- Academic success
- Increased engagement
- 7. **Related to Matter**
- Feeling valued & important
- Consequence of mattering

Styling details:

- Use thin, clean arrows with solid color fills (no gradients)
- Each box should have a muted color distinct from the others
- Use consistent font (sans-serif, academic style)
- Ensure even spacing between all elements
- Ensure all arrows are the same thickness
- Maintain a balanced, symmetric radial layout
- Do NOT include any extra arrows or decorative elements

Created 3/2/2026