

## **A Narrative Analysis of Black, Latino/a/x, and Indigenous Students' Sense of Belonging in Engineering at a Predominantly White Institution**

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# **A Narrative Analysis of Black, Latino/a/x, and Indigenous Students' Sense of Belonging in Engineering at a Predominantly White Institution**

## **Abstract**

Though studies have examined how unequal outcomes manifest for Black, Latino/a/x, and Indigenous (BLI) engineering students and how to address these inequalities, not enough work to date has privileged BLI student narratives to understand how they make meaning in the engineering environment given their unique situated histories. To begin to fill this gap, we use narrative analysis to unpack and amplify the voices of BLI students at a Predominately White Institution and explore how BLI students make meaning of their experiences in engineering. Data were derived from a multi-institutional study that engages in an educational improvement activity and follows students longitudinally across their college experience. This qualitative study is based on interviews at two points in time with eight BLI participants. Narrative analysis was employed to understand and construct stories regarding the evolution of how participants interpreted their experiences of how sense of belonging was created, enhanced, or impeded within engineering environments. Findings from this study indicate that engagement in a range of communities can help to mitigate the negative effects of identity-related obstacles and can enhance BLI students' sense of belonging. Participants found and engaged in community in a variety of ways, through formal and informal capacities and in both individual and group contexts. Our results also indicate that despite the additional barriers that BLI students experience, they continue to espouse the meritocratic belief that anyone, regardless of identity, has an equal opportunity to become an engineer. The implications of this belief for BLI student success are discussed in the paper.

## **Introduction**

Black, Latino/a/x, and Indigenous (BLI) students currently represent less than 17% of bachelor's degrees in engineering [1], despite decades of effort aimed at addressing their underrepresentation. BLI students are uniquely affected by overt whiteness in engineering culture, especially at Predominately White Institutions (PWI), which can make classrooms feel unwelcoming and exacerbate experiences of systemic racism, stereotype threat, and imposter syndrome [2], [3]. The systemic racism that BLI students experience manifests through STEM curriculums that center the experiences of white<sup>1</sup> people and exclude minoritized populations, BLI stereotypes that assume academic incompetence, persistent microaggressions, intersectional oppression, exclusion and isolation, and lack of representation among faculty and peers of the same race or ethnicity [4]–[7]. Systemic racism leads to heightened stereotype threat and imposter syndrome in BLI students, by increasing the pressure to prove one's academic ability,

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<sup>1</sup> We deliberately chose to capitalize the terms Black, Latinx, and Indigenous while intentionally using lowercase when discussing whites and whiteness. In doing so, we resist notions of white hegemony that are often experienced by marginalized groups within higher education.

creating self-doubt in academic competence, and making it difficult or uncomfortable for BLI students to present themselves authentically, culturally, and racially [5]–[9]. Research in engineering has demonstrated that these issues result in BLI students feeling isolated, out-of-place, and excluded from the larger engineering community [7], [10]. Not only does this influence retention and persistence for BLI students, but it can lead students to pursue careers outside of engineering and STEM as a whole, even if they do persevere and earn a degree in one of these fields [11], [12].

Though studies have examined how unequal outcomes manifest for BLI engineering students and how to address these inequalities, not enough work to date has privileged BLI student narratives to understand how they make meaning in the engineering environment given their unique situated histories. To begin to fill this gap, we use narrative analysis to unpack the experiences of BLI students at a PWI with a large and well-regarded engineering program. While attempts to improve BLI student representation in engineering have not met expected targets, this study aims to springboard further efforts to support BLI students. In centering BLI voices through narrative, we explore their experiences in engineering contexts and demonstrate the nuance that varying levels of support can have on sense of belonging, as well as student ideals about meritocracy in engineering, and how the meritocratic ideal can negatively impact how BLI student see themselves in engineering spaces. This understanding informs where and what kind of resources may be needed to increase sense of belonging and the retention and persistence of this student population.

## **Literature Review**

In this review we frame and contextualize the experiences of the BLI students in STEM, focusing on studies specific to engineering where possible. First, we review the literature on the distinct experiences of minoritized students in engineering programs. Next, we present the growing body of work that examines how ideals of meritocracy within engineering impact BLI student engineers and the profession of engineering, and finally, we review the literature that explores the factors that contribute to a sense of belonging for BLI students and its importance in their college journeys.

### *Minoritized Student Experiences*

Research demonstrates that minoritized students in engineering programs are subjected to experiences that threaten their success in engineering [5], [6], [13]. Micro- and macro-aggressions, exclusion, and a lack of representation among mentors and faculty, all result from systemic racism that BLI students must navigate and overcome to be successful in engineering [7], [8], [10], [14]. Although most, if not all, minoritized students experience race- and ethnicity-based marginalization within higher education contexts, this oppression manifests in varying ways for undergraduate students from different backgrounds (i.e., Black, Latinx, and Indigenous). For example, Strayhorn et al. [7] and Tolbert Smith [15] found that Black students are subjected to looks and messaging that suggest they will not succeed in engineering and other

STEM-related careers. Similarly, McGee [8] found that Black men students were often stereotyped as being more suited for careers outside of STEM and their success in STEM coursework was attributed to them either being extremely intelligent or garnered through cheating, which hindered some students' ability to develop an affinity for their STEM discipline. Similarly, Black and Latinx students have reported feelings of isolation and loneliness which can also negatively impact their academic outcomes [4], [6], [7]. Research by Mwangi et al. [14] has demonstrated that Black students encounter classroom spaces that do not acknowledge racial issues, despite a desire for spaces to speak about these issues. When discussions do occur, Black students are uncomfortable with how they were facilitated and there is an expectation that Black students represent their race. As such, Black and Latinx students are known to develop strategies to cope with racial stereotypes from peers and faculty that cause emotional injury and negatively affect their overall college STEM experience [5], [16].

Neglecting the cultural values and practices of BLI students in STEM programs also contributes to negative outcomes in these students. For instance, López et. al., [17] found that Latinx students intentionally seek out institutional spaces that integrate their academic pursuits and affirm their cultural values to help mitigate the hyper-competitive environment associated with STEM programs. In addition, Indigenous students are often tasked with managing the tension between Indigenous and scientific epistemologies, including participation in educational practices, which may challenge Indigenous ways of knowing and impose emotional, spiritual, and intellectual burdens on them [13]. In pursuing higher education, Indigenous students are forced to: “acquire certification in dominant epistemologies that devalue, delegitimize, and threaten [Indigenous] ways of knowing in order to “give back” to tribal communities...” [13, p. 761], highlighting the way the STEM curricula centers dominant groups' cultures and epistemologies. As a result, STEM programs may continue to see high rates of attrition among Indigenous students [18]. While students from different BLI groups have their own unique histories that shape the oppression they experience in STEM, some commonalities in BLI STEM students' challenges are experiencing systemic racism and navigating institutions that value the dominant groups' culture, which can be quite distinct from their own [5], [13], [16], [17]).

### *Meritocracy in Engineering*

Becoming an engineer includes learning core values of the profession, subliminally or explicitly, which may reflect the worldviews of privileged groups. While these values may instill positive traits in up-and-coming engineers, they can also reinforce problematic thought processes and behaviors [19]. For example, Cech [20] documents the ways in which engineering education reinforces the idea that the profession of engineering is objective and separate from political, cultural, or social issues. This “depoliticization” stems from positivist logic [20], [21]. Meritocratic ideals are one such issue that has been reified in engineering and can especially have a negative effect on BLI students' experiences in discipline-specific contexts. This concept, broadly defined as the belief that all rewards and success in life are solely the results of hard work, talent, training, and motivation, regardless of other differences in social status, is pervasive

in engineering education and the profession among engineers, engineering faculty, and students alike [20], [22]. Turpen et al. [23] describe meritocracy as one of the “pillars” of engineering education. They describe how these ideals cloak systemic characteristics of our society, such as the social constructs of gender, race, and class, which continue to undermine ideas of who can be an engineer and shape the knowledge and skills valued in engineering spaces. When combined with the belief that engineers only incorporate consideration of social justice issues if they perceive them to be pertinent to engineering practice [20], presenting meritocracy as a foundational element of engineering has helped to maintain an overall “chilly” environment for students holding minoritized identities [24]. By rendering certain characteristics as positive and desirable for engineers, meritocracy masks the prescribed American ideal the profession mirrors—“...whiteness, maleness, heterosexual identity, and whatever is seen to be bodily normalcy” [24, p. 175]. Engineering students are made to believe that anyone can become an engineer, although they may reveal the hypocrisy of that belief, if asked [25], [26]. As such, the ideal of meritocracy can fracture and exclude BLI engineering students through the emanation of a “survival of the fittest mentality” [26].

### *Sense of Belonging and Minoritized Students*

Scholars describe sense of belonging as the feeling of connectedness to peers, campus community, and being valued, cared about, and accepted [6], [27], [28]. Belonging serves as an important component of the college experience with studies by Fan et al. [29] and Thomas & Galambos [30] demonstrating that sense of belonging is a predictor of students’ overall satisfaction with their college experience. In the context of higher education, sense of belonging has been linked to outcomes such as retention, persistence, academic adjustment, and academic achievement [27], [28], [30]–[32]. Inversely, belonging uncertainty can threaten students’ ability to benefit from instructional activities [33]. Moreover, sense of belonging can be impacted by the salience of students’ social identities and the ways in which their identities are fostered, neglected, or even harmed throughout their college experience. Experiences both in and out of the classroom can positively contribute to a student’s sense of belonging through connecting with faculty and staff [34], positive interactions with peers [27], and involvement such as mentorship [35], student organizations [28], and study groups [36], [37]. For example, STEM peer organizations that cater to the distinct needs of minoritized students can help BLI students develop a support system that resists racist and gendered stereotypes in STEM and promotes a sense of community and belonging [6]. STEM faculty can also contribute to BLI students’ sense of belonging by maintaining high expectations for BLI students, challenging their racial biases, incorporating culturally relevant curriculum, and demonstrating a caring pedagogy [4], [38], [39]. Further, faculty can enhance BLI student academic integration through opportunities to participate in research labs, and internships relevant to careers in engineering [38]. As such, much research has been dedicated to better understanding various factors that positively contribute to students’ sense of belonging, including experiences within the classroom.

### **Positionality**

As authors, we entered this research with a commitment to better understanding and supporting the educational experiences of BLI engineering students in higher education. Our team consists of White, Black, and Latinx scholars. We took a social constructivist epistemological approach, which posits that knowledge is created through individuals' social and cultural lenses and that people make sense of their world based on their experiences with others and within specific contexts [40]. We recognize that each of our perspectives are shaped by our array of social identities and how they interact with social systems, lived experiences, and cultural backgrounds. Our team possesses both etic and emic perspectives [41]. The majority of our research team are social scientists (etic). However, one member is an engineer, and some members were STEM majors, giving them an emic perspective in understanding the distinct challenges that minoritized students experience in creating and maintaining a sense of belonging within the norms and culture of STEM disciplines.

## **Methods**

The purpose of this study was to explore how BLI students make meaning of their experiences in engineering. We sought to understand and interpret our participants' sense of belonging in these contexts, and as such employed qualitative methodology [42]. Our research question was: How do BLI students describe their experience of (not) belonging in engineering?

We employed narrative analysis to construct stories of the participants' experiences (Kim, 2016). This analytical approach enabled us to gain an in-depth understanding of the meaning that participants attributed to their experiences within the particular context of engineering at a PWI [44], [45].

### *Data Collection*

Data for this qualitative study were derived from a multi-institutional study in engineering that engages in an educational improvement activity during the first-college year. As part of this larger study, at a PWI in the Midwest with a well-regarded engineering school, a cohort of engineering students is being followed longitudinally across their college experience. Interviews with students are conducted as part of this longitudinal work. Specifically, in the larger study, interviews with 35 students who began college full-time in 2022 are being conducted across their college experience. Among this group of interviewed students, the sample for this study comes from eight participants who have a BLI identity - two Black, five Latino/a/x, and one Indigenous, with two of the participants identifying as biracial.

The interviews were semi-structured, in-person interviews that lasted approximately one hour. As of the date of this study, two interviews in the series of planned interviews had been completed per student. The first interview occurred in the spring semester of students' first college year (spring 2023) and was designed to understand students' perceptions of themselves as engineers, how they experienced the classroom and other spaces on campus, and their attributions about their self-efficacy for student success. The second interview occurred in the

fall semester of the second college year (fall 2023) and was designed to understand students' experiences as they transitioned into their majors, and made sense of the major they choose. The interview also followed up on the areas explored in the initial interview. When possible to build and maintain trustworthiness, the original researcher who interviewed an individual participant conducted both the first and second interviews.

### *Data Analysis*

The use of narrative analysis enabled us to understand the evolution of how participants interpreted their experiences as they worked towards a particular goal in a unique context over a period of time; in the case of our study, how sense of belonging was created, enhanced or impeded within engineering environments [46]. Interview transcripts for all participants were analyzed, with data demonstrating frequent discussion around two ideas – the enhancement of sense of belonging through engagement in community and meritocratic ideals as hallmarks of students' perspectives about success in engineering. After data analysis of all transcripts was conducted, the stories of Malik and Hunter were selected as ideal representations of these two findings, given the presence and frequency of certain codes that underscored the findings. In creating constructed narratives for our participants, we crafted stories based on data provided by the students that demonstrate how individuals respond to particular events while working towards a goal [47]. It should be noted that in constructed narrative analysis, while stories may and, in the case of our paper do, include quotes from participants, narratives are not entirely composed of data that comes directly from participants. Words and phrases are added to the in vivo quotes in the data to enhance the flow and readability within the narratives [47]. The transcripts were coded inductively and deductively, with deductive coding focused on identifying and understanding instances of (not) belonging.

In order to establish trustworthiness, a number of methods were utilized, including purposeful sampling, rich descriptions, and peer review. The use of field notes during data collection helped to capture a more robust illustration of each participant, with researchers recording individuals' physical appearances, initial impressions that participants had on interviewers, general themes that arose, and any researcher biases that may have surfaced during the interviews. Peer review was conducted with several members of the larger research team to ensure that the findings were plausible. Those members of the research team who collected data, as well as the authors of this paper, some of whom were on the data collection team, employed reflexivity throughout the data collection and analysis processes by critically reflecting on our assumptions and incorporating peer review where interpretations were discussed and challenged [48].

### **Limitations**

Although several methods were applied to our research process to establish trustworthiness, there are limitations to this study. While some of the authors of this study share salient identities with the BLI students in our sample, those authors who collected data are either

white or present as white, which could have restricted the breadth and depth of information about race or ethnicity-based experiences that some participants were willing to share in their interviews. Additionally, although demographic data around gender and sexual orientation were collected, it was not analyzed specifically, as it was outside of the scope of this particular study.

## **Results**

Findings from this study indicate that engagement in a range of communities can help to mitigate the negative effects of identity-related obstacles and can result in an increase in BLI students' sense of belonging. Our results also indicate that despite the additional barriers that BLI students experience, they continue to uphold meritocratic ideals about who can become an engineer.

### *Community Enhances Sense of Belonging*

Our findings demonstrate that engagement in a range of communities can mitigate the negative effects of identity-related obstacles and can result in an increase in BLI students' sense of belonging. Participants subscribed to the belief that finding and engaging in communities, which ranged from formal identity-based programs to support from individual staff, professors, or peers, can support belonging. The students in our study discussed the spaces and people in which they found support, which enhanced their sense of belonging. Whether an active participant in a student support initiative, simply appreciating the presence of these programs, or attending Supplemental Instruction or informal study groups, these communities provided academic assistance, socialization, and encouragement.

The story of Malik, who identifies as Black and also indicated that he is mixed race, highlights how his experience with several university resources, but primarily a student support program for minoritized students in engineering, enhanced his sense of belonging, which enabled him to focus on his academic endeavors.

My dad is Black, and my mom is white. I was born in a city where my mom was the only white person I even met 'till I was four years old. And then I moved to a different state and it was kind of the opposite. I was one of the only minorities. So it always felt like wherever I lived, I kind of never really fit in exactly with any one group of people. I have felt like most of my life I've kind of stood out wherever I lived, and for a while, that bothered me, but as I got older, I kind of learned to appreciate it. I think kind of the challenge of being someone who doesn't necessarily fit into a category, but still being able to excel, kind of is something that motivates me and attracts me to engineering. I think a lot of that motivation to work hard comes from my dad who's a Black man. As a child, he always told me that because you are Black, there are going to be times where you're going to have to work harder than other people to achieve the same things and the importance of not letting that overwhelm you. You can't complain about what is or isn't



fair because that doesn't change it. And so looking at unfair situations and just instead of worrying about what you can't change, putting in the work to change what you can. That doesn't mean that I don't feel pressure to prove to people that I, and people like me, can be just as smart and just as good a student as anyone else because I definitely do feel pressure to show that to people. And I don't think that's something that I should have to prove, but like I said, I think that's a reality.

I think there's less than a 1,000 Black students on campus and I think in my class, like my year in chemical engineering, there's maybe five or six other Black students that at least I've seen or talked to in any way. And I think that's kind of always a constant thing, getting an effect of more people looking at me or a kid who's never met a Black person gets put in a group with me in an engineering project and doesn't know, like he thinks I'm a different species or something. I have never felt any malicious intent towards me at this institution purely because I am Black, but I have had experiences where I've had to deal with ignorance from my white peers. And I know that it happened just because they have never met a Black person before. So there's always this feeling that just knowing that the way I've maybe talked to someone in my family, I can't talk to a peer about like a complex engineering process. I can't necessarily just talk how I would to anyone about that, like in the same way that I'd talk to a family member because that could either take credibility away from me in their eyes or almost intimidate or confuse someone who's not used to, I don't know, hearing someone who talks like me or seeing someone who looks like me. So that's kind of a skill that I've just learned from life is understanding that, whether it's intentional or not, the way I look is going to have an effect on certain people and just understanding that that's not fair, but it's just kind of a fact of who I am. Having an intuition on how to present myself to people to get done what I need to get done and communicate things clearly to people is a skill that I've picked up just in life. So I feel like I have to prove myself and show people that by being Black, I am just as smart or smarter than my peers in engineering classes.

Experiences like that are why having people who can understand my experience as a Black engineering student have been really important to my sense of belonging in the major. And I'd actually go so far as to say that the minority engineering program was a big reason why I came here to the institution. That program is filled with a lot of, especially other minorities who are a few grades above me so it's really nice to have people like that who you can talk to who kind of relate to your experience and also know more about it. The minority engineering program also has a bunch of tutors so they're pretty effective at helping you out through tutoring and stuff, too. Before I got really involved in the minority engineering program, I felt pretty isolated. It's been so helpful to me that I actually just recently got a job with the program.

I also go to help rooms. There's a math help room and Supplemental Instruction sessions and those are pretty helpful. As a first-year student, I found that it was easy to look for help through the FYE program, but now that I'm no longer in that, this year I have to depend on myself to find resources for support. So it's on me to get help where I need it because it's not as readily available, and I'm getting into classes where they don't just have Supplemental Instruction sessions for it. So I'd say, as you advance in the engineering curriculum and your major, it's kind of more about getting to know professors and the right people who can help you with what you need and then figuring out what you need to do to succeed on your own.

Malik's story demonstrates how BLI students mitigate the negative effects of identity-related obstacles through connections with peers who share identities and the experiences they have in support services like the minority engineering program. Additional campus resources like tutoring centers, Supplemental Instruction, and individual interactions with professors and other student support staff enhanced Malik's sense of belonging and enabled him to focus on his academic endeavors.

### *Meritocratic Ideals*

We found that participants ascribe to the belief that anyone, regardless of identity, has an equal opportunity to become an engineer. This finding highlights the identity-related challenges that participants faced although they believe that anyone can become an engineer if they simply work hard enough. However, this belief in meritocracy came with an acknowledgement of various challenges, such as internal pressure, feelings of isolation, arduous learning environments, and intimidating instructors.

Hunter, a mechanical engineering student who came to the institution from out of state, discussed the nuances that being raised by a Mexican mom and white dad created for him growing up in a small, conservative town. His story, while complicated by his identity and social location, demonstrates how he came to develop meritocratic ideas about his ability to become an engineer, despite encountering a number of barriers.

I felt pretty ostracized in high school and had a pretty difficult experience because of my ethnicity, religious and political views, which all put me in the minority. My mom, who very much embraces her Mexican culture, is the town's high school math teacher so a lot of people know her and then me, of course, as her son. My mom is super, super Latina. She was raised two blocks from the border, has a very Hispanic lifestyle, and definitely fits some stereotypes, for sure. So people definitely looked at me as the one Mexican kid in town. Because of that experience, I was really happy to leave my hometown and come to this institution, which is much more diverse. Now, don't get me wrong, my mom is really sad because this school was the furthest out of all the places I considered, but she's also happy that I'm somewhere that I feel like I belong. My hometown...I want to

separate from that as much as possible. It was a very bad place for me, especially towards the end of my high school career and being here...although I'm currently swamped with work and have been sleep-deprived and am stressed about doing well and getting into my major, I feel like this is a place where I belong. There's other people like me here and that's a really good feeling. So my mom is happy about the fact that. I feel happy here, most of the time. I mean, our town, it's 95% white. There might have been three Black people in our entire town. I was known as the Mexican guy, even though I look pretty white, but I was the Mexican guy and so I was the face of that. Of course, I took that in stride. But coming here to experience all this diversity and seeing so many people from all over the country and all over the world, I think it's just really...For me, it sounds a little silly, but it's quite fascinating, coming from my little redneck town, it is very cool to talk to people who have...Even just people from here in this state who have very different life experiences than what I do. I think it's super interesting, and just talking and hanging out with these people. And I don't think about the fact that I am Mexican here as much as I did at home because there's a lot more people here that are a lot more 'ethnic' than I am or might have a higher percentage of Mexican in them. This is a weird statement, but I feel more white here.

While I feel a very strong sense of belonging at the institution and in the engineering school, in part because it's so diverse and I don't feel like I stand out, I am having a hard time balancing all of my commitments. I work part-time at a fast food restaurant on campus, try to exercise, and spend time with my friends, in addition to completing my schoolwork. I am definitely not sleeping much and generally am not happy with how I'm taking care of myself, but I have been reaching out for help and getting connected with resources. In fact, I am meeting with the Dean of Students office shortly to meet with a staff member who said they can help me plan better and talk about study skills and time management. I am grateful that my engineering professor connected me with the Dean's office when I went to him to ask for help.

I already see how difficult trying to become an engineer is and I am just starting out. If I'm being honest, I think I was one of the more smarter ones at my high school. I got a 4.0., had high SAT scores, and was very diligent in my work, but this school really put me in my place. I feel like there's a lot more people that have a lot more STEM experience even before coming into here. I have little to none. It was very humbling, but also I enjoy it because that's what I'm here to do. That's why I'm here to learn. I'm still learning and I'm still growing. And with how hard these classes are, it gives me so much more respect for people that are farther along in the process and people who have completed the process and are already engineers. Becoming an engineer doesn't really come down to talent, it comes to hardworking grit is what I think. I see hardworking people becoming engineers, respectable people, and I'm devout to my work. People know that I'm committed to becoming an engineer. They know I've been putting in the time and

dedicating myself to this. Even people from my hometown, engineering is something that they've known I really wanted to pursue and that I'm so excited to be here in order to hopefully accomplish, not hopefully, but to accomplish that goal. It will happen. Well, as long as I do the required classes and I have the required 3.2 GPA, it will happen. I will get into mechanical, and I will become an engineer. I have to do it. I did a bunch of calculations and I found out what grades I need in each class to make it by. I think it's possible. It's clearly a lot of work, but I'm going to thank myself when I get to sophomore year and I hit that mark and be like, 'All right, as long as you just pass, we'll be good.' And if I don't get that required 3.2 GPA, I'll take extra classes over the summer to bring up my GPA so I can reapply to mechanical in a future semester. You can't give up in times of hardship, that's what I learned. I can't stop trying because things are getting hard. I have to just push through because if and when I do make it, I'm going to be a whole lot stronger and more intelligent than if I just dropped it. And when things get hard, I think to myself 'Look at all these successful people. They didn't do it by giving up or saying it was too hard. They pushed through.' And so I'm telling myself that I have to push through. It's not an option to give up. I will push through. I will push through by staying dedicated. Just being determined and set on, 'I'm going to get this done, I have to get this done. I am going to do it.' And just keeping that mindset that there's no other option. What I have found is that everyone who works hard and puts in effort will be successful. It doesn't matter what the majority of people in this field look like, engineering is for everybody.

Hunter espoused the idea that anyone who works hard enough can become an engineer and saw himself as someone who would not be hindered by identity-based marginalization or lack of academic preparation. He held to these ideals even in the face of struggles he was experiencing and worked to embrace aspects of his identity that he perceived would help him be successful.

## **Discussion**

One of the key findings of this study pertains to the way that BLI engineering students navigate resources and opportunities to build community. Participants found and engaged in community in a variety of ways, through formal and informal capacities and in both individual and group contexts. Whereas particular resources provided academic support, such as Supplemental Instruction or exam reviews, other formal and informal resources such as identity-based programs and study groups provided community for BLI students. Previous research has also shown that engagement in student support services and positive interactions with faculty, staff, and peers can foster belonging [27], [28], [34]–[37]. Although not all BLI students utilize identity-based resources, they still found comfort in their presence and they interact with resources and support as they need them. This suggests that investing in the development of identity-based resources is important because the existence of such programs can signal, both explicitly and implicitly to BLI students that acknowledging and attending to their distinct

experiences is an institutional priority, which may support or enhance their sense of belonging. Therefore, it is important for institutions to not only recruit BLI students, but ensure that they are provided resources to support them throughout the totality of their college experience, affirming their place in the institution and engineering communities as well as the value their perspectives and experiences bring. Results from our research also extend the literature on the ways that BLI engineering students can be challenged by varying levels of support through resources and opportunities, or a lack thereof, to build community. For instance, we discovered that when BLI students are not provided with appropriate resources to support them, they must rely on their networks and knowledge to find the assistance needed. Finding such support in institutions where BLI students do not feel like they belong may be extremely challenging. Therefore, an additional and paramount implication of this study is the need for higher education to address challenges in finding support, as enhancing BLI students' experiences in engineering can increase belonging as well as academic performance and persistence through the mitigation of identity-associated barriers [6], [27], [28]. These findings extend the literature on the ways in which BLI engineering students interact with the resources available to them and how they manage their challenges if appropriate support is not present.

Our findings also move forward scholarship on student ideals about meritocracy and the ideal representatives of engineering [25], [26]. In particular, this study provides a new contribution to the literature by exploring the ways in which meritocracy manifests in engineering contexts specifically. Additionally, our work demonstrates how meritocratic ideals directly affect BLI students. While our participants first acknowledged that engineering requires the willingness to work hard, they also described struggles they faced related to outside forces that impact the way they engage in their studies, such as their identity. In some cases, they discussed feeling compelled to work even harder than their white peers to demonstrate their competence. The extent that BLI students subscribe to meritocratic beliefs while simultaneously minimizing the impact that systemic inequities have on their lives, can lead BLI engineering students to question their ability and internalize their struggles [19], [23], [49]. By masking the reality of race and ethnicity-based obstacles through the lens of meritocracy, participants may be further harming themselves in ways that negatively impact self-efficacy, academic performance, and persistence [19], [23], [49]. An implication of this is that programming or curricula that explicitly acknowledges the reality of race and ethnicity-based challenges that BLI engineering students can and do experience may help to address feelings of inferiority and not belonging among this underrepresented population. To confront the harm that meritocratic beliefs may cause among BLI, future research is needed that specifically focuses on further understanding BLI students' attitudes around meritocracy and if and how those attitudes and understanding evolve over time. In conducting this work, scholars need to simultaneously and explicitly not only acknowledge the identity-based barriers that BLI students face but understand how students make meaning of these contradictions. This future work can provide additional direction on the ways in which the negative consequences of meritocratic ideals might be mitigated.

## **Conclusion**

Sense of belonging is an important factor in students' overall college experience. For BLI students entering engineering programs, sense of belonging not only plays a role in persistence in college overall but also in their ability to persist specifically within engineering. As BLI students encounter hurdles that challenge the ways in which they view themselves in the engineering environment and how that aligns with engineering culture, it is vital that they are provided the resources and support that not only assist them with mastering material, but also provide opportunities for genuine community building, helping them affirm their identity as a member of the engineering community. While BLI students may feel constant pressure to defy stereotypes related to their salient identities, and may assume that the only barriers to their success are their own abilities, institutions have a responsibility to not only admit BLI students, but to address and mitigate the specific identity-based barriers that appear for them over the course of their degree programs. Higher education must turn its attention to reflecting on and addressing ways that engineering environments reify inequality. An important place to start is in grappling with the ways that meritocratic idealism in engineering limits who becomes an engineer. Statistics on engineering degree completion suggest that support for BLI students in engineering is needed now, more than ever, as engineering degree completion has stagnated among BLI students.

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### **References**

- [1] National Center for Science and Engineering Statistics, "Diversity and STEM: Women, minorities, and persons with disabilities 2021," Special Report NSF 21-321, 2021. Accessed: Feb. 13, 2023. [Online]. Available: <https://ncses.nsf.gov/wmpd>
- [2] D. L. McCoy, C. L. Luedke, and R. Winkle-Wagner, "Encouraged or weeded out: Perspectives of students of color in the STEM disciplines on faculty interactions," *J. Coll. Stud. Dev.*, vol. 58, no. 5, pp. 657–673, 2017, doi: 10.1353/csd.2017.0052.
- [3] E. O. McGee, *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation*. Cambridge, Massachusetts: Harvard Education Press, 2020.
- [4] D. Dortch and C. Patel, "Black undergraduate women and their sense of belonging in STEM at predominantly white institutions," *NASPA J. Women High. Educ.*, vol. 10, no. 2, pp. 202–215, May 2017, doi: 10.1080/19407882.2017.1331854.

- [5] E. O. McGee, “Devalued Black and Latino racial identities: A by-product of STEM college culture?,” *Am. Educ. Res. J.*, vol. 53, no. 6, pp. 1626–1662, Dec. 2016, doi: 10.3102/0002831216676572.
- [6] S. L. Rodriguez and J. M. Blaney, “‘We’re the unicorns in STEM’: Understanding how academic and social experiences influence sense of belonging for Latina undergraduate students.,” *J. Divers. High. Educ.*, vol. 14, no. 3, pp. 441–455, Sep. 2021, doi: 10.1037/dhe0000176.
- [7] T. L. Strayhorn, L. Long, J. Kitchen, M. Williams, and M. Stentz, “Academic and social barriers to Black and Latino male collegians’ success in engineering and related STEM fields,” in *2013 ASEE Annual Conference & Exposition Proceedings*, Atlanta, Georgia: ASEE Conferences, Jun. 2013, p. 23.132.1-23.132.14. doi: 10.18260/1-2--19146.
- [8] E. McGee, “‘Black Genius, Asian Fail’: The detriment of stereotype lift and stereotype threat in high-achieving Asian and Black STEM students,” *AERA Open*, vol. 4, no. 4, p. 233285841881665, Oct. 2018, doi: 10.1177/2332858418816658.
- [9] J. L. Smith, E. Cech, A. Metz, M. Huntoon, and C. Moyer, “Giving back or giving up: Native American student experiences in science and engineering,” *Cultur. Divers. Ethnic Minor. Psychol.*, vol. 20, pp. 413–429, 2014, doi: 10.1037/a0036945.
- [10] J. Ingram, A. Castagno, R. Camplain, and D. Blackhorse, “Culturally-based ethical barriers for American Indian/Alaska Native students and professionals in engineering,” in *2021 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual Conference: ASEE Conferences, Jul. 2021, p. 36888. doi: 10.18260/1-2--36888.
- [11] M. A. Beasley and M. J. Fischer, “Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors,” *Soc. Psychol. Educ.*, vol. 15, no. 4, pp. 427–448, Dec. 2012, doi: 10.1007/s11218-012-9185-3.
- [12] G. Lichtenstein, H. L. Chen, K. A. Smith, and T. A. Maldonado, “Retention and persistence of women and minorities along the engineering pathway in the United States,” in *Cambridge Handbook of Engineering Education Research*, A. Johri and B. M. Olds, Eds., 1st ed. Cambridge University Press, 2014, pp. 311–334. doi: 10.1017/CBO9781139013451.021.
- [13] E. A. Cech, A. Metz, J. L. Smith, and K. deVries, “Epistemological dominance and social inequality: Experiences of Native American science, engineering, and health students,” *Sci. Technol. Hum. Values*, vol. 42, no. 5, pp. 743–774, Sep. 2017, doi: 10.1177/0162243916687037.
- [14] C. A. G. Mwangi, B. Thelamour, I. Ezeofor, and A. Carpenter, “‘Black Elephant in the Room’: Black students contextualizing campus racial climate within US Racial Climate,” *J. Coll. Stud. Dev.*, vol. 59, no. 4, pp. 456–474, 2018, doi: 10.1353/csd.2018.0042.
- [15] D. Tolbert Smith, “‘They are here to support me’: Community cultural wealth assets and precollege experiences of undergraduate Black men in engineering,” *J. Eng. Educ.*, vol. 111, no. 4, pp. 750–769, 2022, doi: 10.1002/jee.20480.
- [16] S. Fries-Britt and K. A. Griffin, “The Black box: How high-achieving Blacks resist

- stereotypes about Black Americans,” *J. Coll. Stud. Dev.*, vol. 48, no. 5, pp. 509–524, Oct. 2007.
- [17] E. J. López, V. Basile, M. Landa-Posas, K. Ortega, and A. Ramirez, “Latinx students’ sense of familismo in undergraduate science and engineering,” *Rev. High. Educ.*, vol. 43, no. 1, pp. 85–111, 2019, doi: 10.1353/rhe.2019.0091.
- [18] J. Page-Reeves, G. Leroy Cortez, Y. Ortiz, M. Moffett, K. Deerinwater, and D. Medin, “Situating giving back for Native Americans pursuing careers in STEM: ‘You Don’t Just Take, You Give Something Back.’” *Intersect. Crit. Issues Educ.*, no. 1, 2019.
- [19] M. Blair-Loy and E. A. Cech, *Misconceiving Merit: Paradoxes of Excellence and Devotion in Academic Science and Engineering*. Chicago ; London: The University of Chicago Press, 2022.
- [20] E. A. Cech, “The (mis)Framing of social justice: Why Ideologies of depoliticization and meritocracy hinder engineers’ ability to think about social injustices,” in *Engineering Education for Social Justice*, J. Lucena, Ed., in *Philosophy of Engineering and Technology*, vol. 10. Dordrecht: Springer Netherlands, 2013, pp. 67–84. doi: 10.1007/978-94-007-6350-0\_4.
- [21] E. A. Cech, “Culture of disengagement in engineering education?,” *Sci. Technol. Hum. Values*, vol. 39, no. 1, pp. 42–72, Jan. 2014, doi: 10.1177/0162243913504305.
- [22] A. Liu, “Unraveling the myth of meritocracy within the context of US higher education,” *High. Educ.*, vol. 62, no. 4, pp. 383–397, Oct. 2011, doi: 10.1007/s10734-010-9394-7.
- [23] C. Turpen, J. Radoff, A. Gupta, H. Sabo, and A. Elby, “Examining how engineering educators produce, reproduce, or challenge meritocracy and technocracy in pedagogical reasoning,” in *2019 ASEE Annual Conference & Exposition Proceedings*, Tampa, Florida: ASEE Conferences, Jun. 2019, p. 32778. doi: 10.18260/1-2--32778.
- [24] A. E. Slaton, “Meritocracy, technocracy, democracy: Understandings of racial and gender equity in American engineering education,” in *International Perspectives on Engineering Education*, S. H. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, and B. Newberry, Eds., in *Philosophy of Engineering and Technology*, vol. 20. Cham: Springer International Publishing, 2015, pp. 171–189. doi: 10.1007/978-3-319-16169-3\_8.
- [25] L. DeAngelo and D. V. Lewis, “‘Hey dude’: How first year women engineering students experience gendered faculty interactions,” presented at the American Educational Research Association, San Diego, CA, San Diego, CA, Apr. 2022.
- [26] J. Rohde *et al.*, “Anyone, but not everyone: Undergraduate engineering students’ claims of who can do engineering,” *Eng. Stud.*, vol. 12, no. 2, pp. 82–103, May 2020, doi: 10.1080/19378629.2020.1795181.
- [27] L. R. M. Hausmann, F. Ye, J. W. Schofield, and R. L. Woods, “Sense of belonging and persistence in white and African American first-year students,” *Res. High. Educ.*, vol. 50, no. 7, pp. 649–669, Nov. 2009, doi: 10.1007/s11162-009-9137-8.
- [28] T. L. Strayhorn, *College Students’ Sense of Belonging*, 2nd ed. Routledge, 2018. doi: 10.4324/9781315297293.



- [29] X. Fan, K. Luchok, and J. Dozier, "College students' satisfaction and sense of belonging: differences between underrepresented groups and the majority groups," *SN Soc. Sci.*, vol. 1, no. 1, p. 22, Nov. 2020, doi: 10.1007/s43545-020-00026-0.
- [30] E. H. Thomas and N. Galambos, "What satisfies students? Mining student-opinion data with regression and decision tree analysis," *Res. High. Educ.*, vol. 45, no. 3, pp. 251–269, May 2004, doi: 10.1023/B:RIHE.0000019589.79439.6e.
- [31] S. Hurtado, J. C. Han, V. B. Sáenz, L. L. Espinosa, N. L. Cabrera, and O. S. Cerna, "Predicting transition and adjustment to college: Biomedical and behavioral science aspirants' and minority students' first year of college," *Res. High. Educ.*, vol. 48, no. 7, pp. 841–887, Jul. 2007, doi: 10.1007/s11162-007-9051-x.
- [32] D. R. Means and K. B. Pyne, "Finding my way: Perceptions of institutional support and belonging in low-income, first-generation, first-year college students," *J. Coll. Stud. Dev.*, vol. 58, no. 6, pp. 907–924, 2017, doi: 10.1353/csd.2017.0071.
- [33] K. R. Binning *et al.*, "Changing social contexts to foster equity in college science courses: An ecological-belonging intervention," *Psychol. Sci.*, vol. 31, no. 9, pp. 1059–1070, Sep. 2020, doi: 10.1177/0956797620929984.
- [34] T. M. Freeman, L. H. Anderman, and J. M. Jensen, "Sense of belonging in college freshmen at the classroom and campus levels," *J. Exp. Educ.*, vol. 75, no. 3, pp. 203–220, Apr. 2007, doi: 10.3200/JEXE.75.3.203-220.
- [35] M. Apriceno, S. R. Levy, and B. London, "Mentorship during college transition predicts academic self-efficacy and sense of belonging among STEM students," *J. Coll. Stud. Dev.*, vol. 61, no. 5, pp. 643–648, 2020, doi: 10.1353/csd.2020.0061.
- [36] E. J. Abrica, T. B. Lane, S. Zobac, and E. Collins, "Sense of belonging and community building within a STEM intervention program: A focus on Latino male undergraduates' experiences," *J. Hisp. High. Educ.*, vol. 21, no. 2, pp. 228–242, Apr. 2022, doi: 10.1177/1538192720974884.
- [37] D. R. Johnson *et al.*, "Examining sense of belonging among first-year undergraduates from different racial/ethnic groups," *J. Coll. Stud. Dev.*, vol. 48, no. 5, pp. 525–542, 2007, doi: 10.1353/csd.2007.0054.
- [38] C. Newman, "Engineering success: The role of faculty relationships with African American undergraduates," *J. Women Minor. Sci. Eng.*, vol. 17, no. 3, pp. 193–207, 2011, doi: 10.1615/JWomenMinorScienEng.2011001737.
- [39] C. M. Vogt, "Faculty as a critical juncture in student retention and performance in engineering programs," *J. Eng. Educ.*, vol. 97, no. 1, pp. 27–36, Jan. 2008, doi: 10.1002/j.2168-9830.2008.tb00951.x.
- [40] B. Kim, "Social Constructivism," in *Emerging Perspectives on Learning, Teaching and Technology*, 2001.
- [41] J. W. Creswell, *Qualitative Inquiry and Research Design: Choosing Among Five Traditions*. Thousand Oaks, Calif: Sage Publications, 1998.
- [42] Z. Austin and J. Sutton, "Qualitative research: Getting started," *Can. J. Hosp. Pharm.*, vol.

67, no. 6, pp. 436–440, 2014.

- [43] Jeong-Hee Kim, *Understanding Narrative Inquiry: The Crafting and Analysis of Stories as Research*. Thousand Oaks, Calif: Sage Publications, 2016. doi: 10.4135/9781071802861.
- [44] M. Butina, “A narrative approach to qualitative inquiry,” *Am. Soc. Clin. Lab. Sci.*, vol. 28, no. 3, pp. 190–196, Jul. 2015, doi: 10.29074/ascls.28.3.190.
- [45] K. Ntinda, “Narrative research,” in *Handbook of Research Methods in Health Social Sciences*, P. Liamputtong, Ed., Singapore: Springer Singapore, 2019, pp. 411–423. doi: 10.1007/978-981-10-5251-4\_79.
- [46] L. McAlpine, “Why might you use narrative methodology? A story about narrative,” *Eesti Haridusteaduste Ajak. Est. J. Educ.*, vol. 4, p. 32, Apr. 2016, doi: 10.12697/eha.2016.4.1.02b.
- [47] N. Kellam, K. Gerow, and J. Walther, “Narrative analysis in engineering education research: Exploring ways of constructing narratives to have resonance with the reader and critical research implications,” in *2015 ASEE Annual Conference and Exposition Proceedings*, Seattle, Washington: ASEE Conferences, Jun. 2015, p. 26.1184.1-26.1184.20. doi: 10.18260/p.24521.
- [48] T. Koch and A. Harrington, “Reconceptualizing rigour: The case for reflexivity,” *J. Adv. Nurs.*, vol. 28, no. 4, pp. 882–890, Oct. 1998, doi: 10.1046/j.1365-2648.1998.00725.x.
- [49] R. Stevens, D. Amos, A. Jocuns, and L. Garrison, “Engineering as lifestyle and a meritocracy of difficulty: Two pervasive beliefs among engineering students and their possible effects,” in *2007 Annual Conference & Exposition Proceedings*, Honolulu, Hawaii: ASEE Conferences, Jun. 2007, p. 12.618.1-12.618.17. doi: 10.18260/1-2--2791.