For Us, By Us: Recommendations for Institutional Efforts to Enhance the Black Student Experience in Engineering

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The pursuit of education in engineering is a challenging endeavor for students. However, for Black students, this challenging experience is also coupled with racialized challenges such as experiences with racism, isolation, microaggressions, and visibility. As such, the participation of Black students in engineering has remained disproportionately low for over a decade [1]. Black students seeking advanced degrees in engineering need support to navigate their experiences in the predominately White environment of the field. Ross and McGrade (2016) presented compelling evidence that being more socially integrated on campus and conscious of a racial identity positively influenced high-achieving Black students in college [2]. To increase representation of Black students, we must gain a comprehensive understanding of their psychosocial experiences at both the undergraduate and graduate levels. Although there are myriad ways in which these experiences can be observed, learning where the most immediate needs for intervention could prove beneficial in improving the Black student experience in engineering, and thus, positively impact recruitment to and retention in the discipline. Specifically, identifying action steps towards enhancing experiences from the vantage of the students—those directly experiencing the environments—may prove to be a successful approach in strengthening the quality of how Black students experience engineering environments.

This study seeks to learn from a group of students well-positioned to inform knowledge of ways the experiences of Black students can be improved at both the undergraduate and graduate levels. Specifically, a group of Black graduate students pursuing engineering doctoral studies at institutions across the United States were asked to provide explicit recommendations for what institutions could do to enhance the experiences of Black students navigating engineering environments. This work uses a student centric approach to recognize the value of the sentiments from those that have successfully navigated these environments and self-selected to continue in engineering at a more advanced level. Understanding the experiences of Black graduate students inclusive of supports as well as barriers can pinpoint specific avenues for improving satisfaction and potentially, retention and the promotion of positive outcomes.

By obtaining recommendations from Black students who have successfully navigated engineering at the undergraduate level, the insight shared in this paper will allow for a deeper and more lucid understanding of what is needed to enhance Black experiences in academic engineering environments. More importantly, aiming to address the recommendations of this first-hand insight may prove to be effective in affecting positive change. The fact that these students had success at the undergraduate level adds value as it represents personal accounts of structures, supports, activities and considerations that could have significantly enhanced their experiences. This paper presents stories in context to these recommendations to give further justification of the urgency for institutions to learn from those that have navigated these environments as a continuous effort to foster inclusivity, and thus a greater likeliness for a sense of belonging, for the future Black engineering students at both the undergraduate and graduate levels. This study aims to answer: What are the recommendations that Black graduate students in engineering for their institutions based on their experiences navigating that environment?

Theoretical framework

This work is situated in the Person-Environment Fit Theory (PE). The Person Environment (PE) Fit Theory seeks to gauge the correlation between one's personality type and their environment to see if there is a "fit" between the two [3]. It relies on the congruence between personal (i.e., one's abilities) and situational factors (i.e., professional, or academic demands) to lead to positive outcomes such as persistence, satisfaction, or success [4]. This is analogous to the interactionist perspective in psychology where the person and environment impact their behavior [5]. Person Environment Fit Theory is applicable to this study because we seek to reveal recommendations from graduate students based on their success in engineering programs. According to Hoffman and Woehr [6], a high PE fit correlates to a positive increase in an individual's performance in that environment, incentivizing the individual to remain in that environment. Conversely, a low PE fit, which characterizes the current fit for most Black graduate engineering students, would have negative repercussions for the individual's performance as well as the duration in which the students will be able to whether that environment. This theory will help us to examine the level of compatibility as described by Black graduate students and the academic environments they are successfully navigating.

As the goal is to explore how institutions might better create spaces where Black students feel their values and beliefs are espoused, person environment fit theory is used here to underscore the need to utilize real experiences of those who have previously navigated these hostile spaces to inform how these spaces can be climate controlled moving forward. In extant literature, there has been documentation of coping mechanisms that have been used by Black students to navigate white spaces; however, in this work, we choose to center the student, and utilize their perspectives on how their environments can be modified to be more accommodating for Black engineering graduate students. As a result, this will aid in informing how more inclusive engineering environments can be cultivated. Of particular interest, is identifying what this looks like at the graduate level where representation of Black students is most dismal. These recommendations can be translated across institution types to help increase the representation of Black students in engineering. Overall, these recommendations will serve as a preliminary guide for institutions searching for an intervention opportunity to broaden participation and enhance the Black experience in engineering, specifically.

The Person Environment Fit Theory, coupled with identifying recommendations from an anti-deficit perspective will enable institutions to be better positioned to leverage the perspectives, knowledge, and experience of Black students in engineering. Harper [7] provides that an anti-deficit inquiry emphasizes understanding how achievers, in our case, Black engineering doctoral students, managed to successfully overcome environments that weren't designed for their success. The authors further explain that this approach seeks to illuminate how Black students in engineering establish positive relationships with those in their academic and professional settings [7]. The recommendations in this paper are derived from a non-deficit perspective of Black students in engineering.

Methods

This work involved Black graduate students currently enrolled in doctoral engineering programs across the country. As a recruitment strategy, we issued an interest survey was sent to several listservs associated with the advocation and support of underrepresented students in engineering, such as the National Association of Multicultural Engineering Program Advocates (NAMEPA) and its members, to generate awareness of the study among graduate students. The survey was shared across professional networks and resulted in snowball sampling of more than 60 doctoral graduate students interested in participating.

There was a total of sixteen participants included in this study all identifying as Black (female n=10; male n = 6). Participants attended two different types of universities, including Predominately White Institutions (PWIs) and Historically Black Colleges and Universities (HBCUs). Some students attended PWIs for both undergraduate and graduate education, while others matriculated HBCUs at both levels. A small portion of participants completed their bachelor's degrees at HBCUs and were pursuing graduate education at PWIs. We recognized that some participants were at PWIs that supported many Black students in engineering based on the information presented in the Engineering by the Numbers Report [1]. These institution types were given the designation of PWI-D (PWI-Diverse). Demographic information regarding the participants in included in Table 1.

Table 1: Participant Demographics

			Engineering Major		Institution Type	
Pseudonym	**Gender**	**Year**	**Undergraduate**	**Graduate**	**Undergraduate2**	**Graduate**
Alana	F	4th	Nuclear	Bioengineering	HBCU	PWI
Angie	F	1st	Industrial	Industrial	HBCU	HBCU
Celia	F	1st	Bioengineering	Bioengineering	PWI	PWI
Charisma	F	3rd	Mechanical	Mechanical	PWI-D	PWI-D
Christian	M	1st	Electrical	Electrical	HBCU	HBCU
Dani	F	3rd	Mechanical	Mechanical	PWI	PWI
Jazz	F	1st	Mechanical	Aerospace	PWI	PWI
Joshua	M	1st	Chemical	Chemical	PWI	PWI
Martin	M	1st	Chemical	Chemical	PWI-D	PWI
Nosa	F	2nd	Mechanical	Mechanical	PWI	PWI
Olivia	F	3rd	Industrial	Engineering Education	PWI	PWI
Ricky	M	5th	Civil	Civil	HBCU	PWI
Shasha	F	1st	Mechanical	Mechanical	PWI-D	PWI
Tony	M	3rd	Aerospace	Aerospace	PWI-D	PWI-D
Val	F	4th	Nuclear	Mechanical	HBCU	PWI
X	M	2nd	Mathematics	Industrial	HBCU	PWI

We conduced semi-structured interviews with the participants to understand their unique experiences in engineering as Black students. Since the participants held graduate status, they were able to reflect on their undergraduate and graduate experiences in their narratives. The interviews started with an open-ended question that allowed the participants to describe their engineering journeys up to their current status. Following the narration phase of the interview, semi-structured questions were asked to further the discussion related to topics introduced in the narration phase. Integrated as one of these questions was an intentional reflection on ways the students felt the institutions experienced could work to enhance the experiences of Black students at each level, undergraduate and graduate. The interviews lasted from 60-90 minutes and were audio recorded and transcribed. The qualitative analysis of the data was conducted in two cycles. As a first-cycle analysis, transcripts were coded deductively for recommendations [8]. All the codes for recommendations were then pattern coded for themes as a second-cycle coding mechanism to categorize recommendations according to their focus. Throughout the data collection and analysis phases, the research team created memos around the narratives and themes presented in the participants' stories.

Findings

The following three themes were the most reported across the participants. Underlying many of the recommendations was a desire for the institution to be intentional and accountable in their efforts to foster environments more inclusive to and aware of the Black student experiences. The specific themes were *faculty awareness and development, intentional recruitment and accountability and metrics to assess diversity, equity, and inclusion.*

Faculty Awareness and Development

Several participants discussed the necessity for platforms to voice their negative experiences with faculty who lacked cultural competence. Providing students with opportunities to talk about their experiences was anticipated to aid in the development of faculty training to help them to be intentional with maintaining equity and inclusion at the forefront. The participants shared similar sentiments around faculty providing equal treatment to all students and better understanding the demographic of students with whom they work. Imperative for many reasons, but most importantly, the students expressed needing to feel supported by faculty, despite their ethnic backgrounds.

Joshua claimed that faculty "say some really crazy stuff." He went on to talk about how some faculty are insensitive to students' backgrounds and that some have been known to make demeaning comments about Black students' hair. "I feel like it's just a discussion that I think faculty don't have enough. And I think that's a good way to also show on the outside that as an institution, we do care about the fact that you have students coming from non-white backgrounds." An inclusive faculty environment would be one that ensured faculty had the appropriate training to understand students across their differences, which could potentially help them to better engage with students from underrepresented populations. When Black graduate students experience microaggressions from faculty, it creates a barrier to feeling welcomed.

Another participant, Shasha, shared her concerns about students experiencing discrimination from faculty and how universities need to mitigate this from happening. “So, there are professors who treat students differently, and like that needs to be like, I guess more openly discussed and realized like that’s not okay and that if that happens to students, they should be able to like talk about that because that’s the only way that you can stop it.” If Black engineering graduate students are the victims of unequal treatment and insensitive comments, these issues should be discussed, as recommended by Shasha. Anthony agreed with the other participants and suggested that faculty need to “work together to find common ground, as far as how to address the issues that exist.” All four of these participants suggested that effective faculty training and development would call for everybody being on the same page. “Honestly, I think that’s the root of all of it, is making sure that you care, and that you listen to the concerns of those individuals,” explained Celia.

Intentional Recruitment

Many participants described an easy solution to the difficulty related to recruiting Black faculty and students—be intentional. Joshua explained that one way to have more Black faculty and students in engineering graduate programs was to start with diversifying the administration. He believes that diversifying leadership will lead to a more diverse faculty and student body. “I just think it really begins with recruiting Black people more across the board for everything. But primarily in places like faculty positions.”

Another participant, Martin, addressed the importance of intentionality when faculty are recruiting Black students. “You all need to go to NSBE. There’s no reason why all the kids you’re recruiting are from MIT and Stanford. There are plenty of highly qualified intelligent Black students. You guys are making a conscientious decision not to get them.” In a faculty meeting, Martin recommended that faculty need to “do more” when it comes to recruiting Black students. The participants felt that faculty aren’t intentional in their pursuit of adding Black students to engineering graduate programs.

Accountability and Metrics to Assess Justice, Equity, Diversity, and Inclusion

Many of the participants were disappointed in the efforts to assess diversity, equity, and inclusion (DEI) in their programs. Frustrated, X explained, “When I ask you questions such as, ‘How many Black students have graduated in the last five years?’, you should have these data available, and they don’t.” Students were disappointed in the lack of accountability taken by schools in regards to DEI. “I think what you need is a metric,” added Ricky. He went on to suggest that schools obtain “a physical description of a system and have a system outcome.” “So something like that where it’s like we can measure the physical description of the system and how well you’re doing with DEI based on a score,” said Ricky.

There were more students who recommended that schools should design tools to complete DEI assessments on their engineering programs. Additionally, Celia said that schools should “acknowledge the fact that there’s a lack of diversity.” The participants want more accountability on the part of faculty and leadership in engineering programs and intentionality in measuring DEI. Tony acknowledged that he has received surveys about DEI, which he

completed, but didn't believe that anyone had actually looked at it. In a conversation that he had with his school's engineering board, he expressed, "The first thing I would probably say is to openly listen to their concerns." He added, "I think listening and caring are the main issues here, and not just trying to fill a quota, 'cause sometimes, I think that's why a lot of us feel we're here. You're just trying to meet the percentage you need to have people of color." Participants recommended that if surveys are sent to students, then the leadership who sends it out should be ready and prepared to take action to address the students' expressed concerns regarding DEI. When students see a lack of accountability, it impacts their decision to contribute to and complete future surveys related to DEI as it seems like a gesture lacking follow-through.

Discussion

Among the recommendations provided, there are various areas for potential institutional development. The students made recommendations about increasing diversity and inclusion, student leadership training, mentorship, academic preparation for graduate school, and building community. These recommendations could promote institutions intentionally creating more opportunities for success among Black graduate students in engineering by leveraging their recommendations and utilizing them to implement practices that are both identity dependent and applicable to both undergraduate and graduate students. The recommendations varied amongst participants and institutional background. While certain recommendations were specific to academic level, others were appropriate for both undergraduate and graduate environments.

There was a consensus around recommendations related to increasing diversity in engineering. All the participants that completed undergraduate studies at PWIs and those that were pursuing graduate studies at PWIs at the time of interview provided recommendations about diversity. The top recommendation in this grouping was increasing Black faculty and students at both undergraduate and graduate levels. The primary reason for a desire to increase enrollment of Black students was to build community in environments by mitigating the occurrence of students being one of few—if not the only Black—student in their programs, especially at the graduate level[9], [10]. A specific recommendation highlighted for the undergraduate level was the need for more Black student ambassadors to be hired within admissions. This would provide prospective students who tour institutions the opportunity to inquire about the Black experience from Black students without the stigma of asking such questions in large groups with people unfamiliar with that experience. With respect to graduate students, the lack of palpable sources for professional development influenced the recommendation for graduate community spaces to prioritize writing retreats, peer mentoring and other activities critical to advancing students in their doctoral studies [11].

Participants at PWIs gave recommendations about inclusion which they believed would improve if there were more Black faculty hired in engineering programs. The overall reasoning to increase Black faculty was for mentorship and guidance as they navigated spaces that weren't inclusive for Black engineers. Participants recommended increasing Black faculty would help diversify these environments serving as an attractor for Black students at the graduate level [12]. To address concerns to promote inclusiveness among majority faculty, participants strongly

urged the need for cultural competency trainings to facilitate faculty learning how to engage with Black students appropriately and effectively.

There are two participants that attended HBCUs for undergraduate studies that are continuing their doctoral studies at HBCUs. Both participants provided recommendations surrounding the need for increased support at the undergraduate level. Recommendations considerate of the community college transfer student experience were articulated from one participant attending an HBCU. Specifically, the recommendation for schools to implement programs to support students transferring to 4-year degree programs highlights the need to continuously consider students at the intersection of race and transfer status. The specific observation was the lack of an established community for these students creates the likeliness for them to "slip through the cracks" upon transfer [13]. None of the participants who attended PWIs mentioned community college exposure or experiences.

Another recommendation that was unique to students at HBCUs was creating a student orientation that provided education and resources about life skills. Although the suggested topics to be discussed in this orientation were not engineering specific, they were conveyed as being critical to students that may be first generation college students and/or lacking awareness of time management skills and others that can be impactful for first time students.

The graduate students suggested numerous recommendations that have the potential to enhance the experiences of Black students in graduate engineering programs across the country. They shared what they viewed as the most influential recommendations that universities can employ to enhance the experiences of Black students in engineering as well as improve their transition from undergraduate to graduate education. Descriptions of the recommendations ranged from developing counterspaces for Black graduate students to increasing access to mental health professionals, but the most discussed recommendations involved faculty development and cultural competency [14]–[17].

Conclusion

Engineering programs across the country are seeking ways to enhance the experiences of Black students in both undergraduate and graduate school. Utilizing recommendations from students who have navigated these spaces provides personal insight that should be prioritized in efforts to improve these engineering environments. As engineering programs seek to enhance such experiences, students' recommendations are an ideal starting place to anchor their agenda of reform.

One limitation to the current study is that all participants were students that had successfully navigated engineering at the undergraduate level and self-selected to pursue engineering at the doctoral level. It is possible that the recommendations provided by students that were able to find achieve success may differ from those of Black students that left engineering prior to completing a bachelor's degree. We recognize this limitation and will aim to include the perspective of Black students that did not have successful outcomes in engineering as a critical voice in future work.

Nonetheless, bringing awareness to the marginalizing experiences of students at the hands of faculty is a step towards enhanced experiences overall. As conveyed by the participants, the next and more effective step lies in creating required opportunities for faculty training to learn about their own biases and behaviors as a means towards shifting cultures to being more inclusive. Moreover, providing a platform for students to talk about their experiences will help leadership better identify and dismantle the implicit biases abundant in engineering environments. As recommended by the participants of this study, being intentional in actions from recruitment to accountability is key for impacting change in the ways of doing in engineering to effect more positive experiences, and thus outcomes, for Black students.

We hope these recommendations will prove to be beneficial to individuals and institutions nationwide who wish to address the underrepresentation of Black students in engineering undergraduate and graduate programs. While this is work pertains specifically to Black students in engineering, we suspect these recommendations might also be applicable to students from other underrepresented groups in STEM. Although these were only some of the recommendations from the participants in this study, they serve as a great starting point for engineering programs looking to promote inclusion and equity for Black students. As recommended by the participants, intentionality is paramount for the first steps toward change.

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