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Faculty-Student Interactions as Experienced by Black Engineering and Computer Science Students

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Faculty-Student Interactions as Experienced by Black Engineering and Computer Science Students

Abstract

Previous literature indicates that Black engineering and computer science students face unique challenges. However, we know little about the active and inactive ways that Black students engage in their interactions with faculty members. We present an interpretative phenological analysis (IPA) of five interviews of Black engineering and computer science students to answer the question: How do Black students experience faculty-student interactions in computer science and engineering education? Through our analysis, we present four themes that characterize the experiences of our study participants: (1) Experiencing painful isolation from faculty and peers, (2) Facing increased pressure to succeed, (3) Seeking and finding connection with faculty and peers when faced with isolation, (4) Understanding themselves inside their respective programs. By comprehending the pervasive and hidden storylines influencing the interactions between faculty and Black students in computer science and engineering, faculty members can gain insights into how their actions can contribute to the success of these students.

Introduction and Background

Prior literature underscores the vital role that students' interactions with faculty play in influencing the nature of their experiences in engineering and computer science programs. Bjorklund et al. [1] delved into the dynamics of student learning and emphasized the impact of near-constant instructor feedback. According to their findings, students reported experiencing the most substantial gains in their academic performance when they received regular and constructive feedback. Additionally, Briody et al. [2] extend the discussion on faculty-student interactions by highlighting students' desires beyond traditional classroom learning. They identify how students who seek more personalized engagement with faculty, whether individually or within small groups. Throughout the literature, a consistent thread emerges that positive faculty-student interactions contribute significantly to the academic well-being of students.

When we consider prior literature on the relational assets of Black students in engineering and computer science, we can recognize the crucial role of faculty-student relationships in cultivating their success. For example, prior research demonstrates Black students' resilience in achieving success through crafting social networks and mentorship. Ross et al. [3] found that despite being in predominantly white institutions (PWI), Black graduates experience positive effects from learning environments that helped affirm their identity within their major. These structures provided students with several important factors such as role models and communities of practice. Additionally, Chance [4] found that Black students not only benefited from these structures (e.g., Black engineering communities) but actively sought to give support to these structures thus allowing future students to benefit. Chance [4] further highlights how by contributing to these programs in leadership positions, Black students were able to overcome discrimination against intersectional layers of identity and find success. Elaborating on individual characteristics, Henderson et al. [5] highlight reflection, resilience, and agency as being critical characteristics for the development of engineering identity. In other words, other

scholars have identified how Black engineering students create powerful assets that enable their success, even amid structural barriers.

Despite these benefits, previous research indicates that Black computer science and engineering students encounter structural and systematic barriers that work against their success in engineering. For example, prior literature demonstrates that Black students in engineering and computer science report negative feelings of disconnection and exhaustion from the forces of marginalization present within their degree programs. McGee [6] highlights a significant aspect of this phenomenon, showcasing that Black students frequently report feelings of exhaustion stemming from their encounters with stereotypes. Black students described a conflict between their identities as engineering or computer science students, a role traditionally occupied by White men, and their racial identity. This perceived incongruity furthered their sense of exhaustion and disconnection from their majors. This, in turn, exacerbated the conflict between their unique and multifaceted identities and the stereotype [7]. Further, Black students noted a constant pressure to live up to their racial identity while maintaining their identity as aspiring computer scientists and engineers. These stereotypes caused Black students to develop higher levels of uncertainty in their engineering and programming capabilities [6].

Despite the tremendous importance of faculty interactions on the well-being of Black computer science and engineering students, previous literature indicates that often mentorship for Black students is either lacking or ineffectual. Griffin [8] found that interactions between same-race faculty and students were more successful than cross-racial interactions due to the shared experiences of racial identity held by a faculty member and student. However, as Newman [9] reports, there is a dearth of Black faculty members in computer science and engineering. Due to this, teachers must provide additional support for Black students, especially in PWIs [10]. Additionally, engineering educators also need to recognize that their Black students represent a diverse range of individuals and must be treated as multifaceted rather than using a one-size-fits-all approach when interacting with their Black students [6, 11].

The purpose of this paper is to characterize Black students' experiences of faculty-student relationships. More specifically, we are interested in examining the active ways in which Black students shape their interactions with faculty. Although engineering and computing faculty play a crucial role in mentoring Black students on their pathway to becoming engineers, we know little about how Black students experience these relationships. By understanding how Black students experience these relationships, we can better understand how Black students improve their well-being when interacting with faculty. We can also better support faculty in relationally meeting the specific needs of Black students in their programs.

Specifically, our study goes against the backdrop of literature that details how Black students navigate faculty-student relationships as well as the challenges they experience through academic patterns of marginalization. Here, we understand faculty-student relationships to refer to the interactions, connectedness, and shared experiences of a faculty member and student. In this study, we acutely focus on students' lived experiences of these relationships.

Research Methods

We designed this qualitative investigation to answer the research question: How do Black students experience faculty-student interactions in computer science and engineering education?

To answer this question, we used interpretative phenomenological analysis (IPA) to guide our research.

IPA is a qualitative research method suited to investigating the personal, lived experiences of individuals [12]. IPA is foremost concerned with providing a detailed insight into lived experiences rather than predefined systems. By using IPA, we aim to "give voice" to participants by analyzing their experiences in their own words [13]. The nature of IPA is idiographic and, therefore, concerned with the specific experience of participants rather than focusing more broadly. Due to the highly personal and individualized nature of student interactions with faculty and the specificity of Black computer science and engineering students, IPA was the most conducive to answering the research questions. Additionally, to ensure that we achieve idiographic and contextually robust findings, we have ensured a focused sample size of five students. In doing so, we align with the best practices of high-quality IPA studies by conducting in-depth experiential analysis on individual cases of lived experience [12].

In a study that was approved by our university's IRB (#deidentified), we recruited potential participants through a study interest survey sent to students at two universities. Both universities were faith-based, teaching-focused universities in the Southern United States. Further, both universities were predominantly white institutions (PWIs). We intentionally recruited from these two similar institutions to both allow for depth of insight related to the students' varying institutional cultures. We further recruited from institutions at two similar types to help deidentify the study participants, both of whom could be conspicuously identified if they were tied to a single institution.

In the study-interest survey, respondents were asked to identify their major, gender, race, and interest in participating in an interview. Respondents were also asked to give a brief description of experiences they had while interacting with their faculty. Six individuals responded to the survey, but one participant did not meet the criterion of being an engineering or computer science major. Thus, while we used the study-interest survey to recruit a larger pool of potential interview participants, our efforts resulted in five participants who fit the study criteria of identifying as Black engineering or computer science students and who offered some level of explanation of how they had interacted with faculty.

Accordingly, we interviewed five participants, all identified as Black and were current undergraduate students majoring in computer science or engineering at the time of the interview. We use the term *engineering* in this paper to inclusively refer to software engineering pathways afforded by a computer science degree and career pathways afforded by engineering degrees. We intentionally do not share all of the social identities and affiliations of each participant so that we can authentically honor our commitment for confidentiality in their participation.

We conducted unstructured yet highly focused interviews to elicit participants' personal, lived experiences of their interactions with their faculty. In these interviews, we initially asked participants to narrate their life stories to give us further context and understanding of their experiences [14], consistent with the norms of unstructured interviews beginning with a single planned question [15]. We then focused more specifically on the interactions that participants had with faculty both inside and outside traditional class hours. In keeping with an unstructured interview style, we asked probing questions to uncover and further explore salient experiences of student-faculty interaction. For example, after a participant offered their life story, we would maybe focus on their chapters concerning their decision to major in engineering (e.g., "You

mentioned choosing an engineering major. Can you say more about this?"). Then, we would build from their account to focus on experiential accounts of interactions they had with faculty (e.g., "You mentioned [something] about a conversation you had [a professor]. Can you walk us through that conversation?"). Upon entering an episodic account with faculty, we would push for in-depth elaboration about the participant's lived experience (e.g., "Can you walk us through your inner world in that moment?"). At the end of the interview, we fully described our research goals to the participants and asked if they would like to make any additions or modifications to what they had said. This process of unstructured is documented more expansively elsewhere [16]. Interviews lasted from 63 to 142 minutes with an average length of 95 minutes.

Consistent with the goals of IPA, we analyzed data from the interview transcripts to identify patterns relevant to how our participants experienced interactions with faculty. We began by ensuring that each interview transcript reflected an accurate representation of the audio file while also maintaining the anonymity of each participant. We then conducted three analytical passes of the transcript to expand our understanding of how each participant experienced interactions with faculty. First, we annotated and summarized the text and how the participants understood their experiences in their terms. Second, we analyzed the linguistic features of the transcript to understand how the participants' language colored the meaning in addition to the textual context. Next, we documented conceptual annotations for the same text using our analysis from the previous two passes to allow us to ask conceptual questions of the transcripts. The details of this process to attain experiential insights are more expansively documented elsewhere [12, 17].

After conducting these three initial passes of the transcript, we then reexamined the text to develop experiential statements, which were statements that summarized the specific pattern associated with a particular section of text. We then created a conceptual map of all the experiential statements for a participant, which served as a basis to develop broader themes that characterized the participant's experiences. After conducting a thorough analysis of a single participant in this manner, we then repeated the analysis for each participant. After completing individual analysis on each interview transcript, we organized the themes into four major categories, each with subthemes, to offer a detailed picture of how participants experienced and engaged with faculty in their respective programs [12]. All participants remain anonymous in the findings below, with their names replaced by pseudonyms and all identifiable details of their accounts removed.

Findings

We organized the theme to showcase the full range of our participants' experiences of faculty-student interactions, from feeling isolation from faculty to finding connection with them. Theme 1 illustrates the painful sense of isolation participants experienced during faculty interactions. Theme 2 examines the increased pressure participants experienced navigating their programs. Theme 3 examines how participants sought out and found connections when faced with isolation discussed in theme 1. Finally, in Theme 4, participants renegotiated their understanding of themselves inside their respective programs. The findings are summarized in a Table 1 below.

Theme 1: Experiencing painful isolation from faculty and peers.

When pursuing faculty-student interactions, participants experienced isolation from both peers and faculty as they navigated these relationships. These fraught experiences would often begin with the student feeling left behind in class meetings. To understand course content, participants

sought out one-on-one meetings with faculty. However, despite the more personal interaction with faculty, they experienced frustration and embarrassment during their interactions with faculty members, thereby increasing their sense of isolation from the faculty member.

Theme 1: Experiencing painful isolation from faculty and peers. Participants experienced isolation as they navigated course content, feeling this isolation through messages sent from faculty and peers.

Theme 2: Facing increased pressure to succeed while navigating through their programs. Amid the isolation, several participants felt a heightened sense of pressure from faculty to succeed in their course of study. They further felt the need to overcome felt negative racial stereotypes.

Theme 3: Seeking and finding relationships with faculty and peers when faced with isolation. Amid isolation and pressure to succeed, participants crafted relationships with faculty and peers that facilitated belonging and resilience.

Theme 4: Understanding themselves inside their respective programs. Through faculty-student interactions, participants not only felt positive relationships that facilitated belonging but also came to better understand themselves as engineers.

Table 1: Summary of Themes

Some participants' sense of isolation began in their immediate sense of disconnection with the course content. For example, Phoenix described her journey as an engineering major as one who just "slipped through the cracks" in an introductory programming course. Specifically, she felt as if she needed advanced programming skills to take the course, and she perceived that she was the only one to not have this readiness to complete the coding assignments. Thus, amid the course instruction, she felt as if she was the only student who was failing to achieve learning gains while "everyone else was excelling." Jaden also highlighted the adversarial experience that he felt in receiving course instruction from a faculty member, describing the experience as a "boxing ring" where he would need to "avoid the punches" and "eventually . . . fight back."

Not only did our participants experience isolation from faculty, but in the climate of these learning experiences, they also experienced further isolation from peers. For example, Theo described his experience as a Black male who remained in his engineering major as follows:

> You feel like you're going in with a team, you know, you're heading into a dark tunnel with a torch and you think you got a bunch of people behind you and then slowly but surely they all start dropping off because they're scared. And so then you're in the middle of the tunnel, you look back and nobody's behind you.

Theo's use of this dark tunnel metaphor indicates a fear of having "nobody behind you." He felt abandoned when talking about losing his "team" throughout his time in the program, leaving him isolated from others. His description also illustrates the anxiety that participants may have felt when navigating their program with the help of other students to guide them along the way.

Theme 2: Facing increased pressure to succeed while navigating through their programs.

Participants experienced heightened pressure to succeed while navigating through their programs, often while encountering negative stereotypes about being Black in their programs. They felt burdened by expectations to overcome negative racialized experiences while pursuing success in their academic performances.

As has been reported by many engineering students, participants described their learning experiences in engineering courses as a struggle where they felt overwhelmed by the learning goals and content of the course. Such a sentiment formed the basis of their relationships with faculty. Theo, for example, describe, "I know a teacher can't account for . . . every possible schedule type or workload. But if they could at least balance out or be more thoughtful . . . in such a way that, you know, I guess the students don't have to be as, um, overwhelmed." Likewise, Jaden characterized his journey as one trying to "keep [his] head above water." Accentuating the felt adversarial relationship with faculty, he added, "But it just feels like someone pushing me down."

With the foundation of this fraught relationship with their faculty members, participants generally experienced their struggle as a racialized phenomenon. For example, amid describing her academic struggles, Phoenix stated, "If I'm not trying or they think that I'm not trying, they're just going think – they just going to get a stereotype about me . . I don't want anyone thinking—just because 1) I'm a woman in a tech field and 2) I'm a Black woman in a tech field."

Phoenix captured a concern that any failure on her part will be reflected onto others view of Black women inside of engineering, a sentiment that was shared among participants. In addition, Theo highlighted a similar burden as he viewed fellow Black students change majors outside of computer science or engineering. In watching the people around him "back out" of their respective engineering programs, Theo felt acute pressure to persevere through his struggles in the program. While such a perseverance is often celebrated in engineering programs, our findings highlighted the emotional strain of such persistence for students experiencing racialized pressure.

Theme 3: Seeking and finding relationships with faculty and peers when faced with isolation.

In contrast to the experiences of isolation and pressure described in Themes 1 and 2, participants crafted and experienced meaningful relationships with faculty and peers. The difficult experiences in which they felt vulnerable gave rise to communal experiences where they felt supported. Several participants experienced meaningful and positive interactions with faculty in one-on-one environments. For example, Phoenix described her connection with a faculty member who offered to provide one-on-one guidance to her after she had decided to leave her degree program. Ultimately, she persisted with the program and recounted how this faculty member supported her efforts: "He taught me exactly what button to do [in a lab exercise] . . . and why. And he made me like give feedback. So like that is that's actually what really kept me . . . because there was a time where I wanted to leave." Paul also expressed similar sentiments regarding his interactions with faculty one-on-one, highlighting "the extra mile that they go to make this a safe environment for students to learn.

Participants noted how faculty would specifically reach out to connect with them. At times, these relational efforts were individualized, such as Theo's receiving an encouraging letter from a

faculty member after he had left the program and returned to it. At times, these relational connections were shared in the context of a class lecture, such as Jaden's professor who shared their experience of academic struggle when they were a student: "We just got to talk about like real, the realness of trying to make it through this, to the degree. And actually felt heard and understood, you know, cuz he, he went through the same thing."

Such positive interactions with faculty bolstered the confidence of participants as they navigated their degree programs. In this theme, we emphasize the agency of participants in navigating these relationships. At times, participants initiated these relationships through expressing their felt needs in the programs. At other times, faculty proactively initiated positive messages to connect with students. Yet the student participants chose to actively maintain these relationships and thus support their experiences of resilience within their degree programs.

Theme 4: Understanding themselves inside their respective programs.

Through both challenging and affirming relationships with faculty, participants came to understand their identities as engineers. As participant navigated their way toward the end of the program, they continued to strive for and find success as Black students in their programs and as future professionals in computer science and engineering. They spoke with pride and authentic excitement about their connection to their engineering pathways, feeling not only the accomplishment of persisting with their degrees but also the joy of developing their professional identities.

Over time, participants began to experience a deeper understanding of what it means to be engineers in their various fields. Theo, for example, contrasted what he thought about being a software engineer versus his perception held at the beginning of his program. Initially, he considered competence as being "the smartest person in the room or the person," but toward the end of his career, he appreciated that he was a "good programmer" by competently attending to specific tasks of programming in ways that interacted well with his team. Likewise, Jaden, Sarah, Phoenix, and Paul highlighted the role of faculty relationships in strengthening their sense of connectedness to their respective degree programs. As succinctly put by Phoenix when reflecting on her growth in the program, mediated by faculty relationships: "[A faculty member] took time out and [they were] like, I'll teach you, I'll show you. And [they] did. And I gotten so much better at it. I'm more confident in it."

Discussion and Implications

The findings of this study illustrate Black engineering and computer science students' role in navigating faculty-student interactions. We turn to literature on professional shame to offer some theoretical dialogue on how we make sense of these findings. As discussed in Theme 1 and Theme 2, our participants experienced increased isolation and pressure causing our participants to view themselves as failures on a holistic level. We connect these findings to literature on professional shame, the painful emotional state that one encounters when failing to meet identity-relevant standards in a professional domain. In these themes, we recognize how participants' sense of well-being is connected to messages about what it means to be an engineer [18, 19]. However, Theme 3 and Theme 4 showcases the positive ways in which participants were able to navigate professional shame. By seeking help from faculty and peers, participants were able to dispel their previous negative views of themselves and create a more positive self-image [18].

By understanding the ubiquitous and covert narratives that shape the faculty-student interactions experienced by Black computer science and engineering students, faculty may better understand how their actions can support their students' success. Firstly, it remains critical that faculty understand that Black students represent a wide range of salient experiences, such as the intersectional experiences of Phoenix and Sarah as well as the cross-cultural experiences of both Paul and Jaden, and that Black students not be treated as a monolith [11]. Thus, a more individualized and multifaceted approach would benefit, such as how Phoenix benefited from interacting one-on-one with a faculty member.

Further, faculty play a critical role in creating a sense of security in their major, as evidenced by Theo and how receiving a thoughtful letter from faculty caused him to gain a greater sense of belonging in his program. A further example of this is Phoenix and how her one-on-one interaction with a faculty member was key in her decision to persevere within her program. Further, the findings demonstrate guidance for academic programs to structure faculty-student relationships in ways that promote belonging and well-being for Black students in engineering and computer education. As experienced by Sarah, creating, and supporting spaces for minoritized groups allows Black computer science and engineering students to gain greater security in their major and further support others [9].

Our findings align with previous research examining Black student experiences in engineering and their respective faculty-student interactions. In particular, we found that faculty may proactively mitigate students' painful feelings of isolation through one-on-one interactions. Case [20] similarly documented how chemical engineering students experienced de-alienation and improved affective engagement when their lecturer used active learning strategies, met with students in small groups and one-one-one, and exhibited enthusiasm for the topic and care for the students. More recently, McIntyre, et al. [21] defined several strategies for faculty and administrators for reducing student isolation based on engineering student experiences during COVID-19 which included creating open dialogue, responding to student needs outside of class, integrating practices outside of dominant norms of high stress and overwork, and recognizing how administrative policies can impact student wellbeing. Other outlets for faculty to bolster Black student success include improving access and exposure to student organizations such as the National Society of Black Engineers, the National Action Counsel for Minorities in Engineering, etc. In particular, Henderson et al. [22] demonstrated that faculty who engage in these initiatives offered noteworthy educational and emotional support to students leading to solidifying Black students' cultural capital beyond their programs, often PWIs, and overall success in their engineering programs.

Acknowledgments

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